Fuji Electric

Innovating Energy Technology

High-Performance Inverter

FRENIC-Ace (E3) Series

User's Manual

⚠CAUTION

Thank you for purchasing our FRENIC-Ace series of high-performance standard inverters.

- This product is designed to drive a three-phase motor under variable speed control. Read through this user's manual and become familiar with the handling procedure for correct use.
- Incorrect handling may hinder normal operation, or result in a shortening of the product life or failure.
- Deliver this manual to the end user of this product.
- Keep this manual in a safe place until this product is discarded.
- For how to use an optional device, refer to the instruction and installation manuals for that optional device.

The Japanese version of this document can be downloaded from the following site.

https://www.fujielectric.co.jp/products/drive-download/

The English version of this document can be downloaded from the following site.

https://www.fujielectric.com/products/drive-download/

中文版的这个文件可以从以下站点下载。 The Chinese version of this document can be downloaded from the following site.

https://www.fujielectric.com.cn/download_list.php

24A7-E-0174a

The information contained herein is subject to change without prior notice for improvement.

Every effort has been made to ensure the accuracy of the content of this manual, however, please contact your dealer or relevant Fuji Electric sales office at the end of this manual if there is anything that is unclear, or if any errors and so on are found.

Preface

Thank you for purchasing our “FRENIC-Ace” series of high-performance, standard inverters. This product is designed to drive a three-phase motor under variable speed control.

This manual provides all the information on the FRENIC-Ace series of inverters including its operating procedure and selection of peripheral equipment. Read this User's Manual carefully beforehand to ensure correct use. Incorrect handling may hinder normal operation, or result in a shortening of the product life or failure.

FRENIC-Ace related documents are listed in the following table. Please refer to these documents based on the purpose.

Name	Document No.	Description
Catalog	24A1-E-0174☐	Product overview, features, specifications, outline drawings, options, etc.
Instruction Manual (Basic/ EMC filter built-in type)	INR-SI47-2550☐-E	Instruction manual packaged with the product
Instruction Manual (Ethernet built-in type)	INR-SI47-2552☐-E	
RS-485 Communications User’s Manual	24A7-E-0082☐	Overview of functions implemented by using FRENIC-series RS-485 communications facility, its communications specifications, Modbus RTU/Fuji general-purpose inverter protocol, function codes and related data formats
Inverter Support Software (FRENIC-Loader4) Instruction Manual	INR-SI47-2104☐-E	Manual for the inverter support loader software for Windows. With FRENIC-Loader4, you can set the inverter’s function codes, manage data, create customizable logic functions, etc., from a PC. * In this User’s Manual, this software is referred to as either “PC Loader” or “FRENIC Loader,” depending on the contents being described.

Revisions are made to the above documents whenever required, and therefore the latest version should be obtained before use.

How this manual is organized

This manual is configured as follows.

Chapter 1 BEFORE USE

This chapter describes the items to be checked before the use of the inverter.

Chapter 2 INSTALLATION AND WIRING

This chapter describes the important points in installing and wiring inverters.

Chapter 3 OPERATION USING THE KEYPAD

This chapter describes inverter keypad operation.

Chapter 4 TEST RUN PROCEDURE

This chapter describes basic settings required for making a test run.

Chapter 5 FUNCTION CODES

This chapter explains the table of function codes used by FRENIC-Ace, indexed per purpose, and the details of each function code.

Chapter 6 TROUBLESHOOTING

This chapter describes troubleshooting procedures to be followed when the inverter malfunctions or detects an alarm or a warning condition. Firstly, check whether any alarm code or the " warning" indication is displayed or not, and then proceed to the troubleshooting items.

Chapter 7 MAINTENANCE AND INSPECTION

This chapter describes the maintenance and inspection items of the inverter.

Chapter 8 BLOCK DIAGRAMS FOR CONTROL LOGIC

This chapter describes the main block diagrams of the control section.

Chapter 9 COMMUNICATION FUNCTIONS

This chapter describes an overview of inverter operation through RS-485 communication and Ethernet communication. For details on RS-485 communication, refer to the “RS-485 Communications User's Manual (24A7-E-0082☐)”.

Chapter 10 SELECTING OPTIMAL MOTOR AND INVERTER CAPACITIES

This chapter provides you with information about the inverter output torque characteristics, capacity selection procedure, and equations for calculating capacities to help you select optimal motor and inverter models. It also helps you select braking resistors, inverter mode (HHD, HND, HD, or ND), and motor drive control.

Chapter 11 SELECTING PERIPHERAL EQUIPMENT

This chapter describes how to use a range of peripheral equipment and options, FRENIC-Ace's configuration with them, and requirements and precautions for selecting wires and crimp terminals.

Chapter 12 SPECIFICATIONS

This chapter describes the inverter output ratings.

Chapter 13 EXTERNAL DIMENSIONS

This chapter gives external dimensions of the inverter.

APPENDICES

CONTENTS

■ Safety precautions

Be sure to read this User's Manual thoroughly prior to installation, wiring (connection), operation, maintenance, or inspection to ensure correct use of the product. Furthermore, ensure a thorough understanding of device knowledge, safety information, as well as all related precautions.

Safety precautions contained in this User's Manual have been categorized as follows.

⚠WARNING	Indicates possible danger, leading to death or serious injury if the product is handled incorrectly.
⚠CAUTION	Indicates possible danger, leading to minor or moderate injury, or physical property damage only if the product is handled incorrectly.

Failure to heed the information contained under the CAUTION title may also result in serious consequences.

All items indicate important content and must therefore be observed.

Application

⚠WARNING

- The FRENIC-Ace is a piece of equipment used to run three-phase induction motors and permanent magnet synchronous motors (hereafter, "PMSM"). It cannot be used for single-phase motors or other applications.

  Failure to observe this could result in fire or an accident.
- The FRENIC-Ace cannot be used as is for applications which may have a direct effect on the human body such as life support machines.
- Strict quality control has been observed in the manufacture of this product, however, safety devices should be installed when the product is used for equipment which may result in a serious accident or loss in the event of failure.

  Failure to observe this could result in an accident.

Installation

⚠WARNING⚠

- Install on non-combustibles such as metal.
- Do not install near combustibles.

  Failure to observe this could result in fire.
- If using an optional DC reactor, there is a possibility of users coming into contact with main circuit terminal block parts (live parts). In such cases, take measures such as installing the product in a location where it will not easily come into contact with people.

  Failure to observe this could result in electric shock or injury.

⚠CAUTION

- Do not hold the surface cover when transporting the product.

  Failure to observe this could result in injury if the product is dropped.
- Take measures to prevent foreign material such as lint, wastepaper, wood shavings, dust, or metal scraps getting into the inverter, or adhering to the cooling fan.
- Use the specified screws for changing the mounting base.

  Failure to observe this could result in fire or an accident.
- Do not install or run inverters with damaged external or internal parts.

  Failure to observe this could result in fire, an accident, or injury.

Wiring

⚠WARNING⚠
• If no zero-phase current (earth leakage current) detective device such as a ground-fault relay is installed in the upstream power supply line in order to avoid the entire power supply system's shutdown undesirable to factory operation, install a residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) individually to inverters to break the individual inverter power supply lines only. • Connect to the power supply via a molded case circuit breaker or earth leakage circuit breaker (with overcurrent protection function) for each inverter. Use the recommended molded case circuit breaker or earth leakage circuit breaker, and do not use devices that exceed the recommended capacity. • Be sure to use the specified wire size. • Tighten terminals with the prescribed tightening torque. • If there are multiple inverter and motor combinations, do not use multi-core cables for the purpose of bundling and storing wiring for multiple combinations. • Do not install a surge suppressor to the inverter output side (secondary side). • Be sure to connect an optional DC reactor (DCR) when the capacity of the power supply transformer exceeds 500 kVA, and is at least 10 times the inverter rated capacity. **Failure to observe this could result in fire.** • Ground the inverter in compliance with the national or local electric code. • Always connect the ground line to the inverter grounding terminal [⏚G] **Failure to observe this could result in electric shock or fire.** • Wiring work should be carried out by qualified professionals. • Carry out wiring work after ensuring that the power has been turned OFF. **Failure to observe this could result in electric shock.** • Always carry out wiring after installing the unit. **Failure to observe this could result in electric shock or injury.** • Ensure that the number of phases and rated voltage of the product input power supply matches that for the connected power supply. • Do not connect the power lines to the inverter output terminals [U], [V], [W]. • When connecting a DC braking resistor (DBR), never connect it to terminals other than terminals [P(+)]-[DB]. **Failure to observe this could result in fire or an accident.** • Control signal lines generally do not have a reinforced insulation coating, and therefore if control signal lines come into contact with live parts of the main circuit, the insulation coating may be damaged for some reason. In such a case, there is a danger that high voltage from the main circuit will be applied to the control signal lines, and therefore care should be taken to ensure that they do not come into contact with live parts of the main circuit. **Failure to observe this could result in an accident or electric shock.**

⚠WARNING⚠
• Switch all switches after first waiting 5 minutes after turning OFF the power, ensuring that the LED monitor and charge lamp are OFF, and use a device such as a tester to ensure that the DC intermediate circuit voltage across main circuit terminals [P(+)] and [N(-)] has dropped to a safe level (+25 VDC or less). **Failure to observe this could result in electric shock.**

⚠CAUTION
• The inverter, motor, and wiring generate electric noise, which may cause nearby sensors and devices to malfunction. Employ noise countermeasures to prevent malfunction. **Failure to observe this could result in an accident.**

Operation

WARNING

- Be sure to attach the inverter surface cover before turning the power ON. Do not remove the surface cover while the power is ON.
- Do not operate the unit with wet hands.

Failure to observe this could result in electric shock.

- If the product stops after being tripped when the retry function is selected, depending on the cause of the trip, the product will restart automatically, and the motor will rotate. Design the machinery in such a way as to ensure the safety of the human body and surrounding area even when operation is resumed.
- There may be times when the stall prevention function (torque limiting) causes the product to run at an acceleration/deceleration time or speed different from the set values. Design the machinery in such a way that safety is ensured even at such times.

Failure to observe this could result in an accident.

- The keypad STOP key is enabled only when keypad operation is selected with function code F02. Please prepare a separate EMERGENCY STOP switch When function code H96 has been set to “0” or “2”, the STOP key will be disabled if the operation command method is changed from operation command with the keypad by selecting link operation "LE".
- If any of the protective functions has been activated, first remove the cause. Then, after checking that all run commands are set to OFF, release the alarm. If the alarm is released while any run command is set to ON, the inverter may supply the power to the motor, running the motor.

Failure to observe this could result in an accident.

- By selecting the momentary power failure resume operation (F14 = 3 to 5), operation will resume automatically following recovery. Design the machinery in such a way as to ensure operator safety even when operation is resumed.
- Set function codes after ensuring a sufficient understanding of this User's Manual. If operation is performed after recklessly changing function code data, the motor may rotate at a torque and speed at which the machine is unable to tolerate.
- When auto tuning is started, the motor rotates. Conduct a sufficient check to ensure that there is no danger even when the motor rotates.

Failure to observe this could result in an accident or injury.

- Even if the inverter cuts off the supply of power to the motor, if voltage is being applied to main power supply input terminals [L1/R], [L2/S], and [L3/T] or [L1/L] and [L2/N], voltage may be output to inverter output terminals [U], [V] and [W].
- Even if the motor is stopped by DC braking operation or pre-excitation operation, voltage will be output to the inverter output [U], [V] and [W] terminals.

Failure to observe this could result in electric shock.

- Inverter high-speed operation settings can be specified easily. If settings are changed, use the product after sufficiently checking the motor and machine specification.

Failure to observe this could result in injury.

CAUTION

- The cooling fans and braking resistors become very hot. Do not touch.

Failure to observe this could result in burns.

- Mechanical holding is not possible with the inverter brake function.

Failure to observe this could result in injury.

- The digital input terminals are equipped with a function used to start and stop operation or change the speed command with the "FWD" operation command or "BX" free-run command and so on. Depending on the digital input terminal status, operation may start suddenly, or the speed may change significantly simply by changing the function code settings. Make changes to function code settings after sufficiently ensuring safety.
- With digital input, functions ("SS1, SS2, SS4, SS8", "Hz2/Hz1", "Hz/PID", "IVS", "LE", etc.) used to change the operation procedure for operation commands or command procedure for speed commands can be assigned. Depending on the conditions, changes to these signals may result in operation being started suddenly or the speed changing suddenly.
- Ensure safety before modifying customizable logic related function code settings (U codes and related function codes) or turning ON the "Cancel customizable logic" terminal command CLC. Depending upon the settings, such modification or cancellation of the customizable logic may change the operation sequence to cause a sudden motor start or an unexpected motor operation. Carry out a sufficient safety check beforehand.

Failure to observe this could result in an accident or injury.

Speed control mode

⚠CAUTION
• If the control constant for the automatic speed regulator (ASR) used with speed control is not at an appropriate value, even if the operation command is turned OFF, deceleration control may not be performed, and stop conditions may not be met due to such reasons as hunting caused by a high gain setting. As a result, operation may continue. • Hunting due to a high response may occur in the low-speed area when decelerating, the speed detection value may deviate from the zero-speed area before the continuous zero speed control time (F39) has elapsed, the mode may change to low-speed mode again without stop conditions being met, and operation may continue. • If the actual speed deviates from the speed command after adjusting the ASR control constant to an appropriate value and applying the speed mismatch alarm function, an alarm is tripped, allowing the motor to be stopped safely. Furthermore, taking measures such as changing the ASR control constant setting based on the speed, or judging stop speed detection with a speed command value allows the inverter to successfully control the motor. **Failure to observe this could result in an accident or injury.**

Torque control mode

⚠CAUTION
• When performing torque control, in cases such as when the motor is being rotated from the load side with torque greater than that specified with the torque command, there are times when torque conditions are not met, and operation continues even when the operation command is turned OFF. • If wishing to cut the inverter output at such times, take measures such as changing to speed control and bringing the motor to a decelerated stop, or issuing a coast to stop command. **Failure to observe this could result in an accident or injury.**

Maintenance and inspection, and parts replacement

⚠WARNING⚠
• Carry out inspection after waiting 5 minutes or longer after turning OFF the power. Furthermore, ensure that the LED monitor and charge lamp are OFF, and use a device such as a tester to ensure that the DC intermediate circuit voltage across main circuit terminals [P(+)] and [N(-)] has dropped to a safe level (+25 VDC or less). **Failure to observe this could result in electric shock.** • Be sure to perform the daily inspection and periodic inspection described in the instruction manual. Lengthy use of the product without inspection could result in inverter failure and damage, or accident and fire. • A periodic inspection cycle of 1 to 2 years is recommended, however, the cycle may be shortened depending on the usage conditions. • It is recommended that parts for periodic replacement be replaced after the standard number of years indicated in the instruction manual. Lengthy use of the product without replacing parts could result in inverter failure and damage, or accident and fire. • Contact outputs [30A/B/C] use relays, and may remain ON or OFF, or in an indefinite state when the life is reached. In the interests of safety, equip the product with an external protection function. **Failure to observe this could result in fire or an accident.** • Maintenance and inspection, and part replacement should only be carried out by the authorized personnel. • Remove all metal objects (watches, rings, etc.) before beginning work. • Be sure to use insulated tools. • Never modify the product. **Failure to observe this could result in electric shock or injury.**

Disposal

⚠CAUTION
• If disposing of the FRENIC-Ace, handle as industrial waste. **Failure to observe this could result in injury.**

General precautions

⚠CAUTION
• The drawings in this User's Manual are used to provide detailed descriptions, and therefore some may be drawn with covers or safety shields removed. When running the product, do so only after returning covers or shields to their prescribed original locations, and then run as described in the User's Manual. • In an open network system using Ethernet technology, while it is easier to connect to the outside, the risk of cyberattacks such as unauthorized access and deliberately increasing the volume of communication data and causing a network failure is also high. Countermeasures against such risks must be taken by the customer. • If you have questions about your network system or problems, contact your network system administrator. • We shall assume no responsibility for any trouble, accident, or damage caused by unauthorized external access in the system using this product.

Icons

The following icons are used in this instruction manual.

Note — Incorrect handling due to negligence of the description accompanying this icon may undermine the true performance of the FRENIC-Ace, and incorrect operation or settings may result in an accident.

Tip — Indicates reference items helpful for operation and data entry for the inverter.

📖 — Indicates references.

Chapter 1
BEFORE USE

This chapter describes the items to check before the use of the inverter.

Contents

1.1 Acceptance Inspection (Nameplates and Inverter Type)

Unpack the package and check the following:

(1) The package contains both the inverter unit and instruction manual, and the product has suffered no damage (breakage, dents, parts that have fallen off) during transport.

(2) The Main nameplate is attached to the inverter at the location shown in Figure 1.2-1. Check that the product corresponds to what you have ordered.

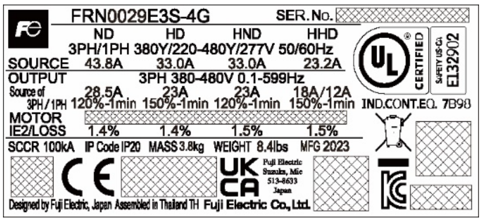
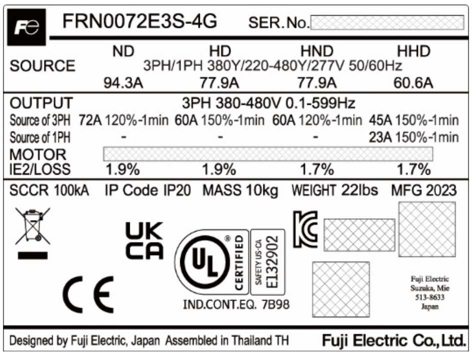
<table>
<tr><td></td><td>FRN0001 to 0040E3☐-2G
FRN0002 to 0029E3☐-4G
FRN0001 to 0012E3☐-7G</td><td>FRN0056 to 0115E3☐-2G
FRN0037 to 0072E3☐-4G</td></tr>
<tr><td>(a) Main nameplate</td><td>
</td><td>
</td></tr>
<tr><td>(b) Sub-nameplate</td><td>
</td><td>
</td></tr>
</table>

Figure1.1-1 Nameplates

TYPE: Type of inverter

FRN 0001 E 3 S - 2 G

Code	Series name
FRN	FRENIC series

Three-phase 200V

Code	Standard applicable motor output [kW]			
	HHD	HND	HD	ND
0001	0.1	0.2	-	-
≀	≀	≀	-	-
0115	22	30	-	-

Three-phase 400V

Code	Standard applicable motor output [kW]			
	HHD	HND	HD	ND
0002	0.4	0.75	0.75	0.75
≀	≀	≀	≀	≀
0072	22	30	30	37

Single-phase 200 V

Code	Standard applicable motor output [kW]			
	HHD	HND	HD	ND
0001	0.1	0.2	-	-
≀	≀	≀	-	-
0012	2.2	3.0	-	-

Code	Destination/Manual
G	Global/English

Code	Input power supply
2	Three-phase 200V
4	Three-phase 400V
7	Single-phase 200V

Code	Construction
S	Basic type
E	EMC filter built-in type
N	Ethernet built-in type

Code	Development series
3	3

Code	Applicable scope
E	High-performance standard

Figure1.1-2 Type of inverter

Note The inverter types indicated in all tables in this manual are expressed in the form "FRN****E3☐-2G, FRN****E3☐-4G, FRN***E3☐-7G".

■ Functional differences by construction type

The FRENIC-Ace series of inverters has different functions depending on the construction type. The main differences are listed in the table below.

For other differences, refer to Chapter 12 “12.2 Common Specifications.”

Functional differences Y: Equipped; N: Not equipped

<table>
<tr><th colspan="2" rowspan="2">Main functional differences</th><th colspan="3">Construction type</th><th rowspan="2">Reference</th></tr>
<tr><th>E3S</th><th>E3E</th><th>E3N</th></tr>
<tr><td rowspan="5">Control circuit terminal functions</td><td>No. of control circuit terminals (Input [X], Output [Y])</td><td colspan="2">5, 2</td><td>3, 1</td><td rowspan="5">Chapter 2</td></tr>
<tr><td>No. of analog output terminals [FM]</td><td colspan="2">2</td><td>1</td></tr>
<tr><td>RS-485 communication port 1 (RJ-45 connector)</td><td colspan="2">Y
(When CBAD-CP option is equipped.)</td><td>N</td></tr>
<tr><td>RS-485 communication port 2 (control circuit terminal)</td><td colspan="2">Y</td><td>N</td></tr>
<tr><td>Ethernet communication port 1/2, DC24V input</td><td colspan="2">N</td><td>Y</td></tr>
<tr><td rowspan="2">Keypad functions</td><td>Operation (including remote operation)</td><td colspan="2">Possible</td><td>Not possible</td><td>Chapter 3 (other than E3N)
Chapter 9 (E3N)</td></tr>
<tr><td>7-segment display</td><td colspan="2">4 digits</td><td>2 digits</td><td></td></tr>
<tr><td colspan="2">Function codes</td><td colspan="2">Common</td><td>Dedicated</td><td>Chapter 5</td></tr>
<tr><td colspan="2">Option card installation</td><td colspan="2">Possible</td><td>Not possible</td><td>Chapter 11</td></tr>
</table>

■ Switching the rating specification

There are four modes of inverter, HHD, HND, HD and ND *1*2, and the modes change based on the load applied to the inverter.

Specifications in each mode are printed on the main nameplate.

*1: Only the HHD mode is available for the single-phase 200 V series EMC filter built-in type.

*2: Only the HDD and HND modes are available for the three-phase 200 V series and single-phase 200 V series, except for the EMC filter built-in type.

For details on HHD/HND/HD/ND, refer to Chapter 4 “4.5 Switching the Applicable Motor Rating (ND, HD, HND and HHD Modes)” or Chapter 10 “10.4 Selecting an Inverter Drive Mode (ND/HD/HND/HHD).”
Furthermore, the rated current differs for the HHD/HND/HD/ND modes, and the diameter of the wiring and the applicable instruments and devices will therefore differ.

For details on the applicable wiring, refer to Chapter 2 “2.2 Wiring” in this manual.

For details on molded case circuit breakers, earth leakage circuit breakers, and magnetic contactors, refer to Chapter 11 “11.3 Molded Case Circuit Breaker (MCCB), Residual-current-operated Protective Device (RCD)/Earth Leakage Circuit Breaker (ELCB) and Magnetic Contactor (MC).” For details on other applicable instruments and devices, refer to Chapter 11 in this manual.

HHD : Designed for heavy-duty load applications.
Overload capability: 150% for 1 min of rated output current, 0.5 s at 200%

HND : Designed for general load applications.
Overload capability: 120% for 1 min.

HD : Designed for heavy-duty load applications.
Overload capability: 150% for 1 min.

ND : Designed for general load applications.
Overload capability: 120% for 1 min.

SOURCE : Number of input phases (three-phase: 3 PH), input voltage*1, input frequency, input current
*1 For the 400 V series, this is shown as “line voltage Y/voltage to ground – line voltage Y/voltage to ground.”
For a power supply voltage range of 380 - 480 V, the input voltage would be shown as “380Y/220-480Y/277.”

OUTPUT : Number of output phases, rated output voltage, output frequency range, rated output current, and overload capability

MOTOR : Applicable motor

IE2/LOSS : ErP (Energy related products) command notation (grade/loss (%))
Loss data that occurs under all operating conditions can be referenced from a QR code.

MFG : ErP (Energy related products) command notation (year of manufacture (Western calendar))

IP CODE : Protection level

SCCR : Short-circuit capacity

MASS : Mass of the inverter in kilograms

SER.No. : Product number 3 1 A 1 2 3 A 0 5 7 9 AA

AA — Product version

Production week 6 0 1

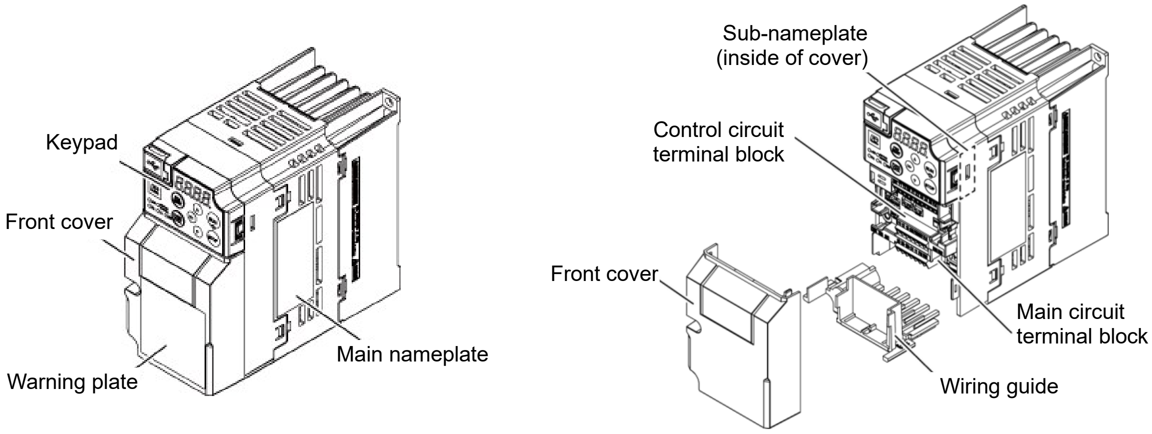
0 1 — Production week: This indicates the week number that is numbered from 1st week of January. The 1st week of January is indicated as '01.'

6 — Production year: Last digit of year

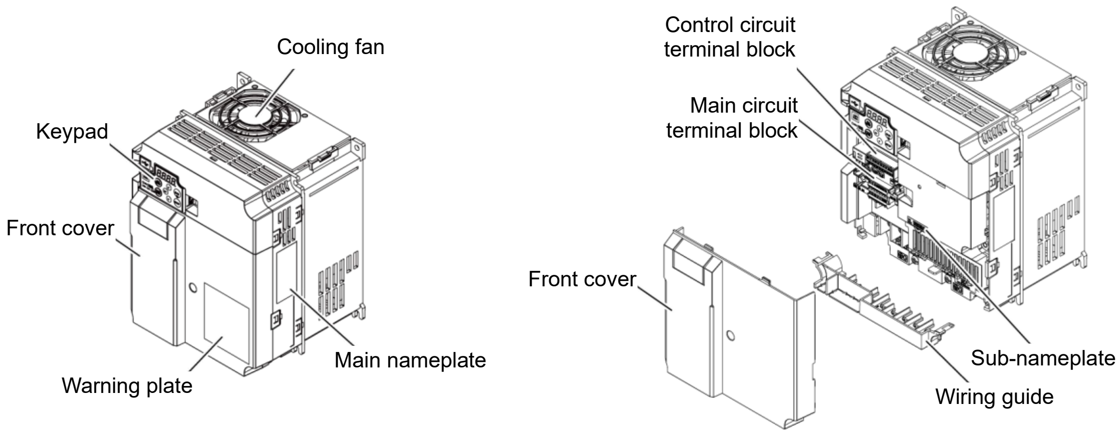
If you suspect the product is not working properly or if you have any questions about your product, contact your Fuji Electric representative.

1.2 Product External Appearance

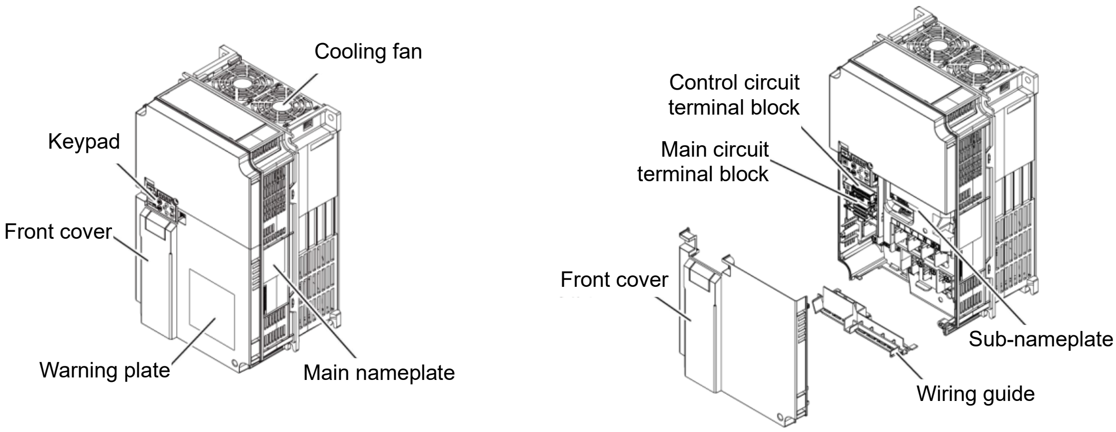
(1) Overall External Appearance



(a) FRN0006E3S-2G



(b) FRN0069E3S-2G



(c) FRN0115E3S-2G

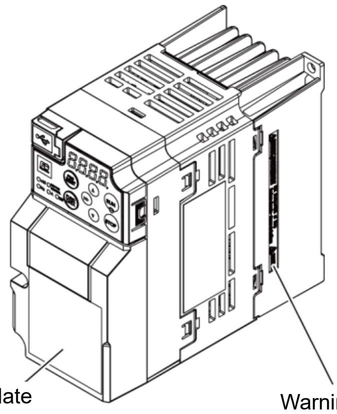
Figure 1.2-1 Overall external appearance

(2) Warning plate and label

(a) FRN0001 to 0020E3☐2G,
FRN0002 to 0012E3☐4G,
FRN0001 to 0012E3☐7G

(b) FRN0030 to 0115E3☐2G
FRN0022 to 0072E3☐4G

Warning label



Warning plate

Warning label

Figure 1.2-2 Warning plate and label

1.3 Precautions for Using Inverters

This section provides precautions when applying inverters, e.g. precautions for installation environment, power supply lines, wiring, and connection to peripheral equipment. Be sure to observe these precautions.

1.3.1 Operating environment

Install FRENIC-Ace in an environment that satisfies the operating environment requirements listed in Table1.3-1.

Table1.3-1 Operating environment

Item	Specifications
Site location	Indoors
Ambient temperature	[FRN-E3S (Basic type), FRN-E3N (Ethernet built-in type)] HHD/HND: -10 to +55 °C (14 to 131 °F) (Current derating is necessary in the +50 to +55 °C (122 to 131 °F) range.) (Note 4) HND: -10 to +50 °C (14 to 122 °F), three-phase 200 V type for FRN0012E3☐-2G to FRN0020E3☐-2G, three-phase 400 V type for FRN0007E3☐-4G to FRN0012E3☐-4G, single-phase 200 V type for FRN0004E3☐-7G to FRN0012E3☐-7G (Current derating is necessary in the +40 to +50 °C range.) (Note 4) HD/ND: -10 to +50 °C (14 to 122 °F) (Current derating is necessary in the +40 to +50 °C (104 to 122 °F) range.) (Note 4) When installed closely side-by-side (Note 3): HHD/HND: -10 to +40 °C (14 to 104 °F) HND: -10 to +30 °C (14 to 86 °F), three-phase 200 V type for FRN0012E3☐-2G to FRN0020E3☐-2G, three-phase 400 V type for FRN0007E3☐-4G to FRN0012E3☐-4G, single-phase 200 V type for FRN0004E3☐-7G to FRN0012E3☐-7G HD/ND: -10 to +30 °C (14 to 86 °F) [FRN-E3E (EMC filter built-in type)] HHD/HND: -10 to +55 °C (14 to 131 °F) (Current derating is necessary in the +50 to +55 °C (122 to 131 °F) range.) (Note 4) HND: -10 to +50 °C (14 to 122 °F), three-phase 400 V type for FRN0007E3☐-4G to FRN0012E3☐-4G (Current derating is necessary in the +40 to +50 °C range.) (Note 4) HD/ND: -10 to +50 °C (14 to 122 °F) (Current derating is necessary in the +40 to +50 °C (104 to 122 °F) range.) (Note 4) When installed closely side-by-side (Note 3): HHD/HND: -10 to +40 °C (14 to 104 °F) HND: -10 to +30 °C (14 to 86 °F), three-phase 400 V type for FRN0007E3☐-4G to FRN0012E3☐-4G HD/ND: -10 to +30 °C (14 to 86 °F)
Relative humidity	5 to 95% RH (No condensation)
Atmosphere	The inverter must not be exposed to dust, direct sunlight, corrosive gases, flammable gases, oil mist, vapor or water droplets. (Pollution Degree 2 (IEC60664-1)) (Note 1) The atmosphere can contain a small amount of salt (0.01 mg/cm^2 or less per year). The inverter must not be subjected to sudden changes in temperature that will cause condensation to form.
Altitude	1,000 m (3,300 ft) max. (Note 2)
Atmospheric pressure	86 to 106 kPa

Item	Specifications				
Vibration	Type of inverter	2 to less than 9 Hz	9 to less than 20 Hz	20 to less than 55 Hz	55 to less than 200 Hz
	FRN0001 to 0115E3☐-2G	3 mm mm (Max. amplitude)	9.8 m/s^2	5.9 m/s^2	1 m/s^2
	FRN0002 to 0072E3☐-4G				
	FRN0001 to 0012E3☐-7G				

(Note 1) Do not install the inverter in an environment where it may be exposed to lint, cotton waste or moist dust or dirt which will clog the heat sink of the inverter.
If the inverter is to be used in such an environment, install it in a dustproof panel of your system.

(Note 2) If you use the inverter at an altitude above 1,000 m (3,300 ft), you should apply an output current derating factor as listed in Table 1.3-2.

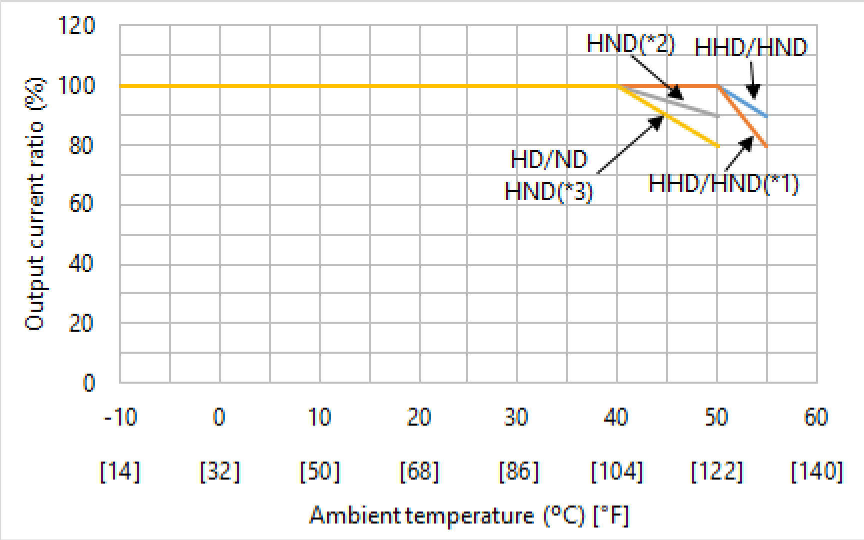
Table 1.3-2 Output current derating factor relative to altitude

Altitude	Output current derating factor
1,000 m or lower (3,300 ft or lower)	1.00
1,000 to 1500 m (3,300 to 4,900 ft)	0.97
1,500 to 2,000 m (4,900 to 6,600 ft)	0.95
2,000 to 2,500 m (6,600 to 8,200 ft)	0.91
2,500 to 3,000 m (8,200 to 9,800 ft)	0.88

(Note 3) When installing inverters side-by-side, take vibrations, shocks, and installation tolerances into consideration to ensure that the inverters do not interfere with each other. Furthermore, please note that mounting adapters for keypad options may be difficult to remove depending on the inverter capacity.

(Note 4) Output current derating is necessary when using the inverter in an environment exceeding the specified ambient temperature.

【FRN-E3S (Basic type), FRN-E3N (Ethernet built-in type)】



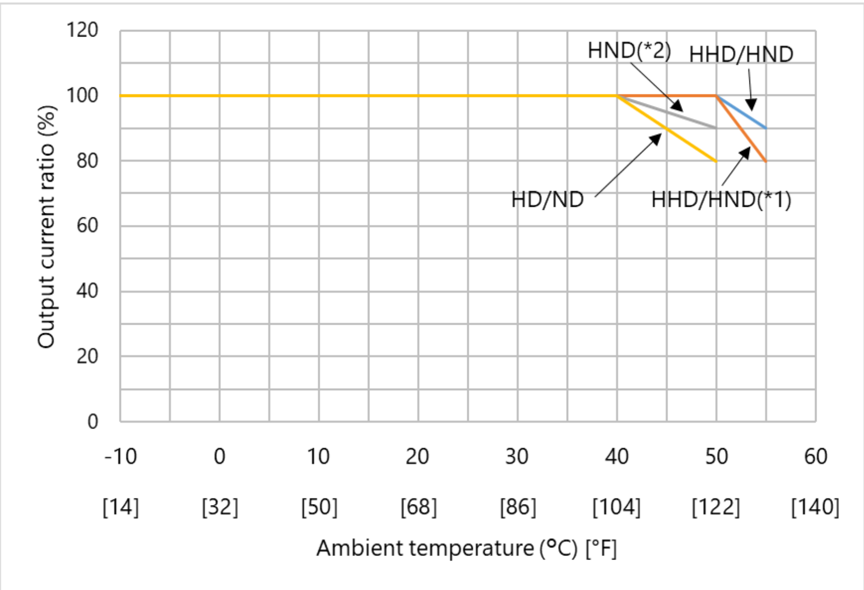
(*1) FRN0002/0004E3▲-2G (HND mode) and FRN0059E3■-4G

(*2) FRN0012/0020E3▲-2G (HND mode) and FRN0007/0012E3■-4G (HND mode)

(*3) FRN0004E3▲-7G to FRN0012E3▲-7G (HND mode)

■: S (Basic type) or N (Ethernet built-in type) or E (EMC filter built-in type)
▲: S (Basic type) or N (Ethernet built-in type)

【FRN-E3E (EMC filter built-in type)】



(*1) FRN0002/0004/0006E3E-4G (HND mode) and FRN0059E3E-4G

(*2) FRN0007/0012E3E-4G (HND mode)

Fig. 1.3-1 Output current derating according to ambient temperature

Fuji Electric strongly recommends installing inverters in a panel for safety reasons.

When installing the inverter in a place outside the specified environmental requirements, it is necessary to derate the inverter or consider a panel design or installation location suitable for that environment. For details, refer to the Fuji Electric technical information “Design of Panels” or consult your Fuji Electric representative.

The special environments listed below require using specially-designed panels or consideration of the panel installation location.

Environments	Possible problems	Sample measures	Applicable industries
Highly concentrated sulfidizing gas or other corrosive gases	Corrosive gases cause parts inside the inverter to corrode, resulting in an inverter malfunction.	Any of the following measures may be necessary. • Mount the inverter within sealed paneling with IP6X or air-purge mechanism. • Place the paneling in a room free from effects of the gases.	Certain applications in paper manufacturing, sewage or sludge treatment, tire manufacturing, gypsum manufacturing, metal processing, and textile manufacturing.
A lot of conductive dust or foreign material (e.g., metal powders or shavings, carbon fibers, or carbon dust)	Entry of conductive dust into the inverter causes a short circuit.	Any of the following measures may be necessary. • Mount the inverter within sealed paneling. • Place the paneling in a room free from effects of the conductive dust.	Wiredrawing machines, metal processing, extruding machines, printing presses, combustors, and industrial waste treatment.
A lot of fibrous or paper dust	Fibrous or paper dust accumulated on the heat sink lowers the cooling effect. Entry of dust into the inverter causes the electronic circuitry to malfunction.	Any of the following measures may be necessary. • Mount the inverter within sealed paneling that shuts out dust. • Ensure a maintenance space for periodical cleaning of the heat sink in panel design. • Employ external cooling when mounting the inverter within paneling for easy maintenance, and perform periodic maintenance.	Textile manufacturing and paper manufacturing
High humidity or dew condensation	In an environment where a humidifier is used or where the air conditioner is not equipped with a dehumidifier, high humidity or dew condensation results, which causes a short-circuiting or malfunction of electronic circuitry inside the inverter.	• Put a heating module such as a space heater within the paneling.	Outdoor installation, film manufacturing line, pumps and food processing.
Vibration or shock exceeding the specified level	If a large vibration or shock exceeding the specified level is applied to the inverter, for example, due to a carrier running on seam joints of rails or blasting at a construction site, the inverter structure gets damaged.	• Insert shock-absorbing materials between the mounting base of the inverter and the paneling for safe mounting.	Installation of inverter paneling on a carrier or self-propelled machine. Ventilating fan at a construction site or a press machine.

Environments	Possible problems	Sample measures	Applicable industries
Fumigation for export packaging	Halogen compounds such as methyl bromide used in fumigation corrodes some parts inside the inverter.	• When exporting an inverter built within paneling or attached to other equipment, pack them in a previously fumigated wooden crate. • When packing a lone inverter for export, use laminated veneer lumber (LVL).	Exporting.

1.3.2 Storage environment

The storage environment in which the inverter should be stored after purchase differs from the usage environment. Store the FRENIC-Ace in an environment that satisfies the requirements listed below.

[1] Temporary storage

Table 1.3-3 Storage and transport environments

<table>
<tr><th>Item</th><th colspan="2">Specifications</th></tr>
<tr><td rowspan="2">Storage temperature</td><td>During transport: -25 to +70 °C (-13 to +158 °F)</td><td rowspan="3">Places not subjected to abrupt temperature changes or condensation or freezing</td></tr>
<tr><td>During storage: -25 to +65 °C (-13 to +153 °F)</td></tr>
<tr><td>Relative humidity</td><td>5～95 % RH(Note 1)</td></tr>
<tr><td>Atmosphere</td><td colspan="2">The inverter must not be exposed to dust, direct sunlight, corrosive gases, flammable gases, oil mist, vapor, water droplets or vibration.
The atmosphere can contain a small amount of salt (0.01 mg/cm^2 or less per year).</td></tr>
<tr><td rowspan="2">Atmospheric pressure</td><td colspan="2">86 to 106 kPa (during storage)</td></tr>
<tr><td colspan="2">70 to 106 kPa (during transportation)</td></tr>
</table>

(Note 1) Even if the humidity is within the specified requirements, avoid such places where the inverter will be subjected to sudden changes in temperature that will cause condensation or freezing.

Precautions for temporary storage

(1) Do not leave the inverter directly on the floor.

(2) If the environment does not satisfy the specified requirements listed in Table 1.3-3, wrap the inverter in an airtight vinyl sheet or the like for storage.

(3) If the inverter is to be stored in a high-humidity environment, put a drying agent (such as silica gel) in before wrapping.

[2] Long-term storage

The long-term storage method of the inverter varies largely according to the environment of the storage site. General storage methods are described below.

(1) The storage site must satisfy the requirements specified for temporary storage.

However, for storage exceeding three months, the surrounding temperature range should be within the range from -10 to +35 °C (14 to 95 °F). This is to prevent electrolytic capacitors in the inverter from deterioration.

(2) The wrapping must be airtight to protect the inverter from moisture. Add a drying agent (such as a silica gel) inside the airtight wrapping to maintain the relative humidity inside the package within 70%.

(3) If the inverter has been installed to the equipment or paneling, and left at construction sites or other places where it may be subjected to humidity, dust or dirt, then temporarily remove the inverter and store it in the environment specified in Table 1.3-3.

Precautions for storage over 1 year

If the inverter has not been powered on for a long time, the special properties of the electrolytic capacitors may deteriorate.
Power the inverters on once a year and keep the inverters powered on for 30 to 60 minutes.
Do not connect the output (secondary) circuit or run the inverter.

1.3.3 Precautions for connection of peripheral equipment

[1] Phase-advancing capacitors for power factor correction

Do not mount a phase-advancing capacitor for power factor correction in the inverter's input (primary) or output (secondary) circuit. Mounting it in the input (primary) circuit has no effect.

To correct the inverter power factor, use an optional DC reactor (DCR). Mounting it in the output (secondary) circuit causes an overcurrent trip, disabling operation.

An overvoltage trip that occurs when the inverter is stopped or running with a light load is assumed to be due to surge current generated by opening/closing of phase-advancing capacitors in the power system. An optional DC/AC reactor (DCR/ACR) is recommended as a measure to be taken on the inverter side.

Inverter input current contains harmonic components that may affect other motors and phase-advancing capacitors on the same power supply line. If the harmonic components cause any problems, connect a DCR/ACR to the inverter.

In some cases, it is necessary to insert a reactor in series with the phase-advancing capacitors.

[2] Power supply lines (Application of a DC/AC reactor)

Use a DC reactor (DCR) when the capacity of the power supply transformer is 500 kVA or more and is 10 times or more the inverter rated capacity or when there are thyristor-driven loads on the same power supply line. If no DCR is used, the percentage-reactance of the power supply decreases, and harmonic components and their peak levels increase. These factors may damage rectifiers or capacitors in the converter section of the inverter or decrease the capacitance of the capacitors.

If the input voltage interphase unbalance rate is between 2% and 3%, use an optional AC reactor (ACR).

Interphase unbalance rate [%] = Max. voltage [V] - Min. voltage [V[/ Three-phase average voltage [V] x 67 (see IEC/EN61800 - 3)

[3] DC reactor (DCR) for correcting the inverter input power factor (for suppressing harmonics)

To correct the inverter input power factor (to suppress harmonics), use a DCR. Using a DCR increases the reactance of inverter’s power source so as to decrease harmonic components on the power source lines and correct the power factor of the inverter.

DCR models	Input power factor	Remarks
DCR2/4-☐☐D	Approx. 90% to 95%	-

Note
- Select a DCR matching not the inverter capacity but the standard applicable motor.
  Applicable reactors differ depending on the HHD/HND/HD/ND modes even with the same type of inverter.
- For applied motors of 75 kW or above, be sure to connect a DCR to the inverter.

[4] PWM converter for correcting the inverter input power factor

Using a PWM converter (High power-factor, regenerative PWM converter, RHC series) corrects the inverter power factor up to nearly “1.”

When combining an inverter with a PWM converter, disable the main power down detection by setting the function code H72 to “0.” If the main power down detection is enabled (H72 = 1, factory default), the inverter interprets the main power as being shut down, ignoring the entry of run commands.

[5] Molded case circuit breaker (MCCB) / residual-current-operated protective device (RCD) / earth leakage circuit breaker (ELCB)

Install a recommended MCCB or RCD/ELCB (with overcurrent protection) in the primary circuit of the inverter to protect the wiring. Since using an MCCB or RCD/ELCB with a lager capacity than recommended ones breaks the protective coordination of the power supply system, be sure to select recommended ones. Also select ones with short-circuit breaking capacity suitable for the power source impedance.

⚠WARNING
If no zero-phase current (earth leakage current) detective device such as a ground-fault relay is installed in the upstream power supply line in order to avoid the entire power supply system's shutdown undesirable to factory operation, install a residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) individually to inverters to break the individual inverter power supply lines only. **Failure to observe this could result in fire.**

[6] Magnetic contactor (MC) in the inverter input (primary) circuit

Avoid frequent ON/OFF operation of the magnetic contactor (MC) in the input circuit; otherwise, the inverter failure may result. If frequent start/stop of the motor is required, use “FWD” or “REV” terminal signals or the RUN/STOP keys on the inverter's keypad.

The frequency of the MC's ON/OFF should not be more than once per 30 minutes. To assure 10-year or longer service life of the inverter, it should not be more than once per hour.

Tip

- From the system's safety point of view, it is recommended to employ such a sequence that shuts down the magnetic contactor (MC) in the inverter input circuit with an alarm output signal “ALM” issued on inverter's programmable output terminals. The sequence minimizes the secondary damage even if the inverter breaks. When the sequence is employed, connecting the MC's primary power line to the inverter's control power auxiliary input makes it possible to monitor the inverter's alarm status on the keypad.
- The breakdown of a braking unit or misconnection of an external braking resistor may cause damage of the inverter's internal parts (e.g., charging resistor). To avoid such a breakdown linkage, introduce an MC and configure a sequence that shuts down the MC if a DC link voltage establishment signal is not issued within three seconds after the MC is switched on. This measure can prevent the spread of damage in the case of a failure by using the sequence that shuts down the MC. For the braking transistor built-in type of inverters, assign a transistor error output signal “DBAL” on inverter's programmable output terminals to switch off the MC in the inverter input circuit.

[7] Magnetic contactor (MC) in the inverter output (secondary) circuit

If a magnetic contactor (MC) is inserted in the inverter's output (secondary) circuit for switching the motor to a commercial power source or for any other purposes, it should be switched on and off when both the inverter and motor are completely stopped. This prevents the contact point from getting damaged due to a switching arc of the MC. The MC should not be equipped with any main circuit surge killer.

Applying a commercial power source to the inverter's output (secondary) circuit breaks the inverter. To avoid this, interlock the MC on the motor's commercial power supply side with the one in the inverter output circuit so that they are not switched ON at the same time.

[8] Surge absorber/surge killer

Do not install any surge absorber or surge killer to the inverter's output (secondary) circuit.

1.3.4 Noise reduction

If noise generated from the inverter affects other devices, or that generated from peripheral equipment causes the inverter to malfunction, follow the basic measures outlined below.

(1) If noise generated from the inverter affects the other devices through power wires or grounding wires:

- Isolate the grounding terminals of the inverter from those of the other devices.
- Connect a noise filter to the inverter power wires.
- Isolate the power system of the other devices from that of the inverter with an insulated transformer.
- Decrease the inverter's carrier frequency (F26). See Note below.

(2) If induction or radiated noise generated from the inverter affects other devices:

- Isolate the main circuit wires from the control circuit wires and other devices' wires.
- Put the main circuit wires through a metal conduit pipe, and connect the pipe to the ground near the inverter.
- Install the inverter into the metal paneling and connect the whole paneling to the ground.
- Connect a noise filter to the inverter power wires.
- Decrease the inverter's carrier frequency (F26). See Note below.

(3) When implementing measures against noise generated from peripheral equipment:

- For inverter's control signal wires, use twisted or shielded-twisted wires.
  When using shielded-twisted wires, connect the shield of the shielded wires to the common terminals of the control circuit.
- Connect a surge absorber in parallel with magnetic contactor's coils or other solenoids (if any).

Note) Running a permanent magnet synchronous motor (PMSM) at a low carrier frequency may heat the permanent magnet due to the output current harmonics, resulting in demagnetization. When decreasing the carrier frequency setting, be sure to check the allowable carrier frequency of the motor.

1.3.5 Leakage current

A high frequency current component generated by insulated gate bipolar transistors (IGBTs) switching on/off inside the inverter produces leakage current through stray capacitance of inverter input and output wires or a motor. If any of the problems listed below occurs, take an appropriate measure against them.

Problem	Measures
An earth leakage circuit breaker (with overcurrent protection) that is connected to the input (primary) circuit has tripped.	1) Decrease the carrier frequency. 2) Make the wires between the inverter and motor as short as possible. 3) Use an earth leakage circuit breaker with lower sensitivity than the one currently used. 4) Use an earth leakage circuit breaker that features measures against the high frequency current component (Fuji SG and EG series).
An external thermal relay was falsely activated.	1) Decrease the carrier frequency. 2) Increase the current setting of the thermal relay. 3) Use the electronic thermal overload protection built in the inverter, instead of the external thermal relay.

Note) Running a PMSM at a low carrier frequency may heat the permanent magnet due to the output current harmonics, resulting in demagnetization. When decreasing the carrier frequency setting, be sure to check the allowable carrier frequency of the motor.

Chapter 2
INSTALLATION AND WIRING

This chapter describes the important points in installing and wiring inverters.

Contents

2.1 Installation

2.1.1 Installation environment

Please install FRENIC-Ace in locations which meet the conditions specified in Chapter 1 “1.3.1 Operating environment.”

2.1.2 Installation surface

Please install the inverter on non-combustibles such as metal. Also, do not mount it upside down or horizontally.

⚠WARNING
Install on non-combustibles such as metal. **Failure to observe this could result in fire.**

2.1.3 Surrounding space

Secure the space shown in Figure 2.1-1 and Table 2.1-1. When enclosing FRENIC-Ace in cabinets, be sure to provide adequate ventilation to the cabinet, as the ambient temperature may rise. Do not contain it in small enclosures with low heat dissipation capacity.

Table 2.1-1 Surrounding space (mm)

Type of inverter	A	B	C
FRN0001 to 0115E3☐-2G FRN0002 to 0072E3☐-4G FRN0001 to 0012E3☐-7G	10	100	0

C: Space in front of the inverter unit

Secure the necessary space for the cable when using USB connection.

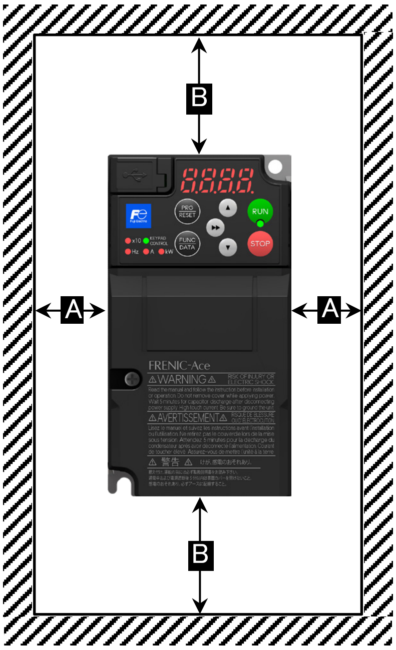


Figure 2.1-1 Installation Direction

■ Installation of Multiple Inverters

When installing 2 or more units in the same equipment or cabinet, generally mount them to the side of each other, not above each other. When the inverters are mounted above each other, attach partitioning boards to prevent the heat dissipated from the lower inverter from affecting the upper inverter.

For ambient temperature below 40°C (104°F) only, the units can be installed side-by-side.

Note Please note the following when installing inverters side-by-side.

- Take vibrations, shocks, and installation tolerances into consideration to ensure that the inverters do not interfere with each other.
- Keypad and Mounting adapters for option cards may be difficult to remove depending on the inverter capacity.

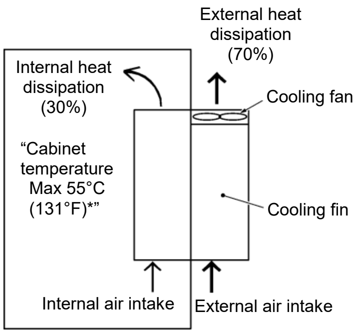
■ Installation with external cooling

The external cooling reduces the generated heat inside the paneling by dissipating approximately 70% of the total heat generated (total heat loss) through the cooling fins protruding outside the equipment or cabinet.

Installation with external cooling is possible for types FRN0030E3□-2G to 0115E3□-2G and FRN0022E3□-4G to 0072E3□-4G by adding attachments (optional) for external cooling.

(For the external dimensions drawings, refer to Chapter 11 “11.11 External Cooling Attachment.“)

⚠CAUTION
Prevent lint, wastepaper, wood shavings, dust, metal scrap, and other foreign material from entering the inverter or from attaching to the cooling fins. **Failure to observe this could result in fire or an accident**



* Current derating is necessary in the +50 to +55°C (122 to 131°F) range.

Figure 2.1-2 Installation with external cooling

2.2 Wiring

2.2.1 Basic connection diagrams

[1] FRN-E3S-2G/4G/7G, FRN-E3E-4G/7G

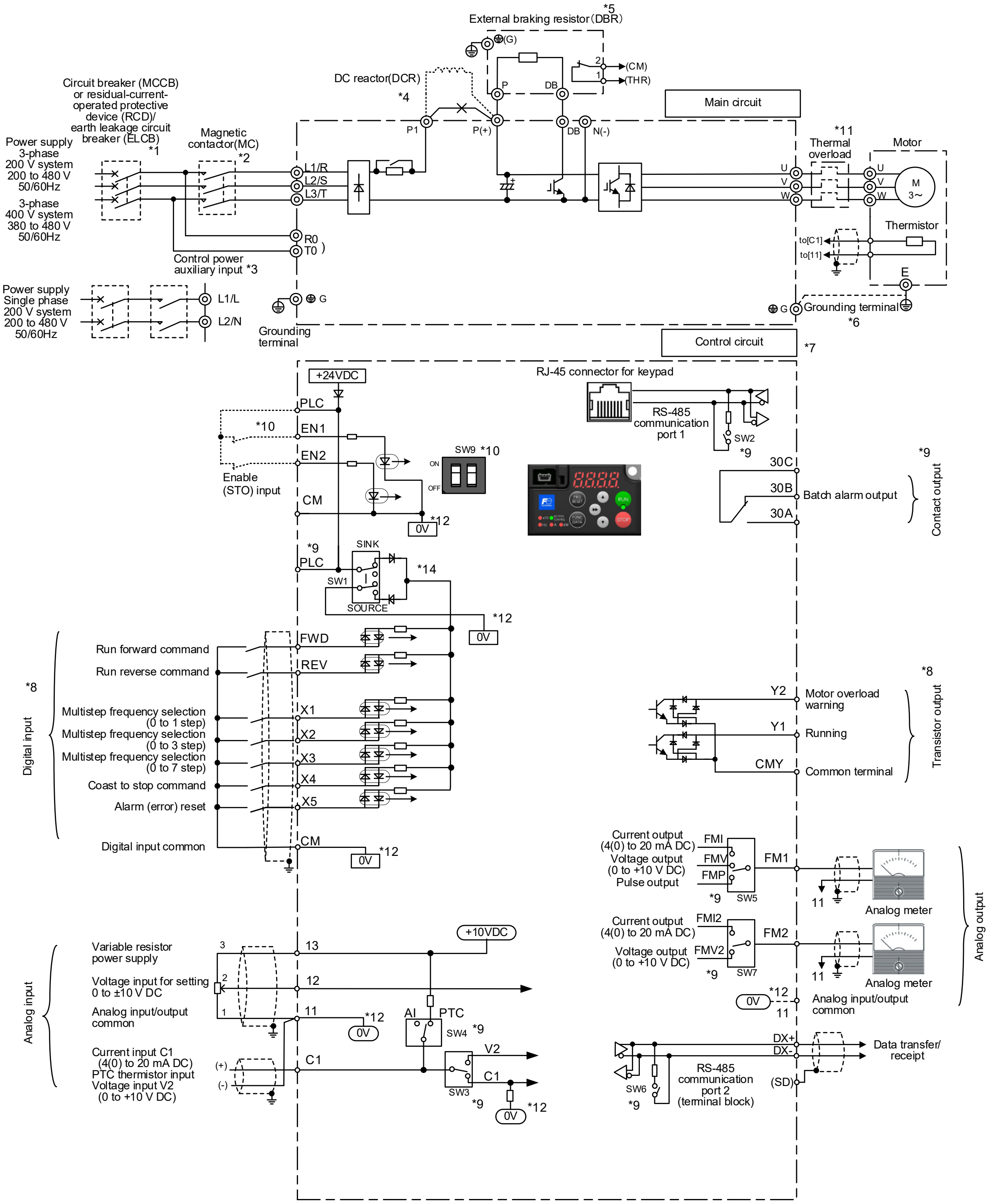


Figure 2.2-1 Basic connection diagram
(FRN■■■■E3S-2G/4G/7G)
(FRN■■■■E3E-4G/7G)

(*1) Install the molded case circuit breakers (MCCB) or residual-current-operated protective device (RCD)/earth leakage circuit breakers (ELCB) (with overcurrent protective function) recommended for each inverter on the input (primary) circuit for wiring protection.
Do not use a circuit breaker that exceeds the recommended rated current.

(*2) Install recommended magnetic contactors (MC) as necessary on each inverter as these will be used to disconnect the inverter from the power supply separately from the MCCB or RCD/ELCB. Additionally, when installing coils such as MC or solenoid close to the inverter, connect surge absorbers in parallel.

(*3) When it is desired to retain the alarm signal for the activation of the protective function even when the inverter main power supply is shut off, or when it is desired to continuously display the keypad, connect this terminal to the power supply.
(Equipped on the FRN0088 to 0115E3S-2G, FRN0059 to 0072E3S/E-4G)
The inverter can be operated without connecting power to this terminal.
If connecting to a PWM converter, refer to Figure 2.2-12 Example of connection of [R0], [T0] terminals in combination with PWM converter" before connecting.

(*4) Remove the shorting bar between the inverter main circuit terminals [P1]-[P(+)] before connecting the direct current reactor (DCR) (option).
Use a DC reactor (DCR) when the capacity of the power supply transformer is 500 kVA or more and is 10 times or more the inverter rated capacity or when there are thyristor-driven loads.

(*5) The inverter has built-in braking transistors, allowing direct connection of braking resistors between [P(+)] and [DB].

(*6) This terminal is used for grounding the motor. Connect if required.

(*7) Use twisted lines or shielded lines for the control signals.
Generally, the shielded line requires grounding, but when the effect of externally induced noise is large, connecting to [CM] may suppress the effect of noise. Separate the line from the main circuit wiring and do not enclose in the same duct. (Separation distance of over 10 cm is recommended.) If lines intersect, ensure that they do so almost perpendicularly to the main circuit wiring.

(*8) The various functions listed for terminals [FWD], [REV], and terminals [X1] to [X5] (digital input), terminals [Y1] to [Y2] (transistor output), and terminal [30A/B/C] (contact output) indicate functions assigned by factory default.

(*9) The slide switches on the control PCB define the settings for the inverter operation.
For details, refer to "2.2.7 Switching switches."

(*10) Shorting bars are connected between the safety function terminals [EN1] and [EN2] as factory default.
Remove the shorting bars when using these functions.

(*11) Install a thermal relay if necessary. Make the molded case circuit breakers (MCCB) or the magnetic contactors (MC) trip by the thermal relay auxiliary contacts (manual recovery).

(*12) $\boxed{0V}$ and 0V are separated and insulated.

(*13) The factory default setting for SW1 of FRN****E3E-4G is "SOURCE".

[2] FRN-E3N-2J/4J/7G

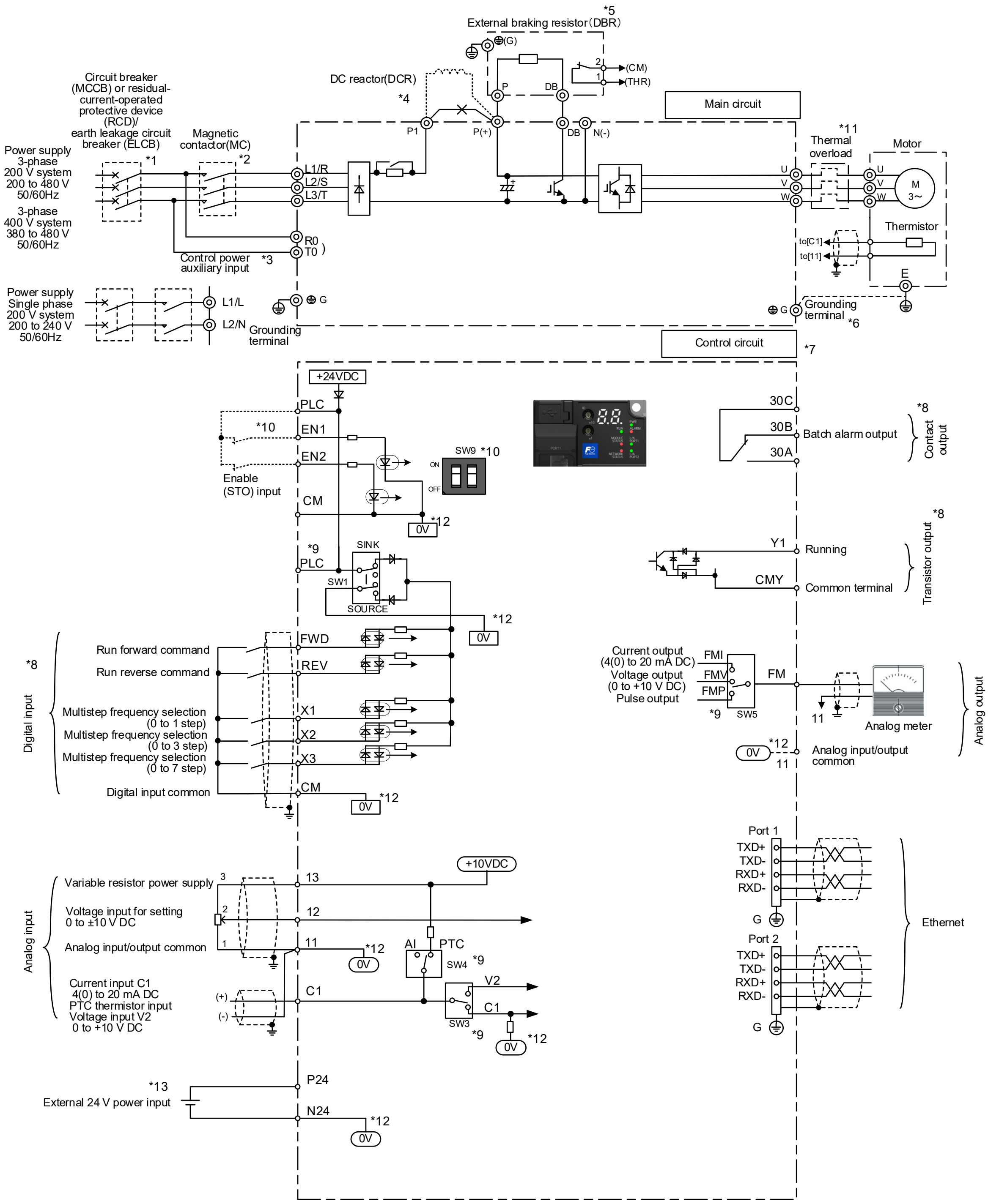


Figure 2.2-2 Basic connection diagram (FRN■■■■E3N-2G/4G/7G)

(*1) Install the molded case circuit breakers (MCCB) or residual-current-operated protective device (RCD)/earth leakage circuit breakers (ELCB) (with overcurrent protective function) recommended for each inverter on the input (primary) circuits for wiring protection. Do not use a circuit breaker that exceeds the recommended rated current.

(*2) Install recommended magnetic contactors (MC) as necessary on each inverter as these will be used to disconnect the inverter from the power supply separately from the MCCB or RCD/ELCB. Additionally, when installing coils such as MC or solenoid close to the inverter, connect surge absorbers in parallel.

(*3) When it is desired to retain the alarm signal for the activation of the protective function even when the inverter main power supply is shut off, or when it is desired to continuously display the keypad, connect this terminal to the power supply.
(Equipped on the FRN0088 to 0115E3N-2G, FRN0059 to 0072E3N-4G)
The inverter can be operated without connecting power to this terminal.
If connecting to a PWM converter, refer to Figure 2.2-12 Example of connection of [R0], [T0] terminals in combination with PWM converter" before connecting.

(*4) Remove the shorting bar between the inverter main circuit terminals [P1]-[P(+)] before connecting the direct current reactor (DCR) (option).
Use a DC reactor (DCR) when the capacity of the power supply transformer is 500 kVA or more and is 10 times or more the inverter rated capacity or when there are thyristor-driven loads.

(*5) The inverter has built-in braking transistors, allowing direct connection of braking resistors between [P(+)] and [DB].

(*6) This terminal is used for grounding the motor. Connect if required.

(*7) Use twisted lines or shielded lines for the control signals.
Generally, the shielded line requires grounding, but when the effect of externally induced noise is large, connecting to [CM] may suppress the effect of noise. Separate the line from the main circuit wiring and do not enclose in the same duct. (Separation distance of over 10 cm is recommended.) If lines intersect, ensure that they do so almost perpendicularly to the main circuit wiring.

(*8) The various functions listed for terminals [FWD], [REV], and terminals [X1] to [X3] (digital input), terminal [Y1] (transistor output), and terminal [30A/B/C] (contact output) indicate functions assigned by factory default.

(*9) The slide switches on the control PCB define the settings for the inverter operation.
For details, refer to "2.2.7 Switching switches."

(*10) Shorting bars are connected between the safety function terminals [EN1] and [EN2] as factory default. Remove the shorting bars when using these functions.

(*11) Install a thermal relay if necessary. Make the molded case circuit breakers (MCCB) or the magnetic contactors (MC) trip by the thermal relay auxiliary contacts (manual recovery).

(*12) $\boxed{\text{0V}}$ and 0V are separated and insulated.

(*13) When you want to keep the Ethernet connection even when the inverter main power supply is shut off, connect this terminal to the power supply.
The inverter can be operated without connecting power to this terminal.

Route the wiring following the steps below (the descriptions assume that the inverter has already been installed).

2.2.2 Removal and attachment of the front cover and wiring guide

⚠CAUTION
If using the RS-485 communication cable for such purposes as remotely operating the keypad, always remove the RS-485 communication cable from the RJ-45 connector before removing the front cover. **Failure to observe this could result in fire or an accident.**

(1) Loosen the screws of the front cover. To remove the front cover, put your finger in the dimple of the front cover and then pull it up toward you.

(2) Push the wiring guide upward and pull. Let the wiring guide slide and remove it.

(3) After routing the wires, attach the wiring guide and the front cover reversing the steps above.

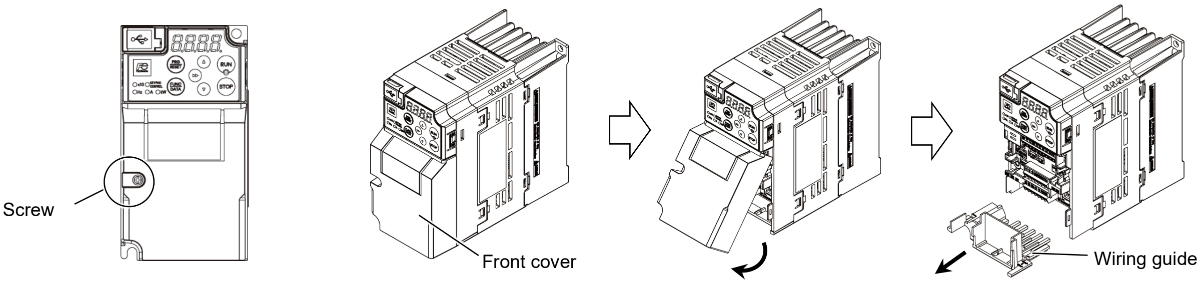


Figure 2.2-3 Removal of the front cover and the wiring guide (for FRN0006E3S-2G)

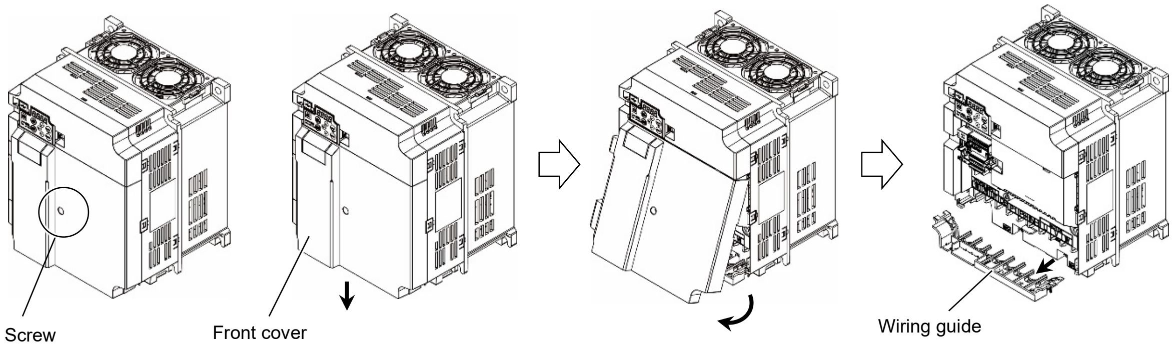


Figure 2.2-4 Removal of the front cover and the wiring guide (for FRN0069E3S-2G)

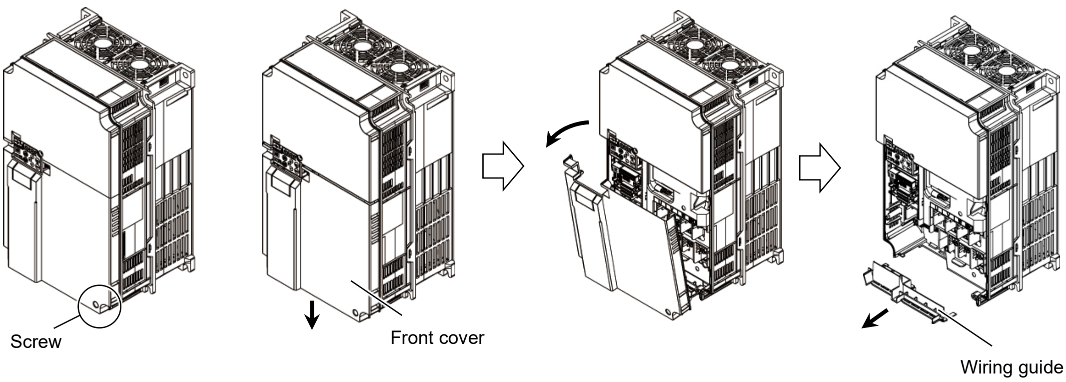


Figure 2.2-5 Removal of the front cover and the wiring guide (for FRN0115E3S-2G)

2.2.3 Precautions for wiring

Pay attention to the following when wiring.

(1) Confirm that the power supply voltage is within the input voltage range described on the Main nameplate.

(2) Always connect the power lines to the inverter main power input terminals [L1/R], [L2/S], [L3/T] (three-phase) or [L1/L], [L2/N] (single-phase). (The inverter will be damaged when power is supplied if the power lines are connected to the wrong terminals.)

(3) Always route the ground wire to prevent accidents such as electric shock and fire and to reduce noise.

(4) For the lines connecting to the main circuit terminals, use crimped terminals with insulating sleeves for high connection reliability, or use crimped terminals in conjunction with insulating sleeves.

(5) Separate the routing of the lines connecting the input (primary) and output (secondary) circuits of the main circuit terminals and the lines connected to the control circuit terminals.
The control circuit terminal lines should be routed as far as possible from the main circuit routing.
Malfunction may occur due to noise.

(6) To prevent direct contact with the main circuit live sections (such as the main circuit terminal block), route the control circuit wiring inside the inverter as bundles using cable ties.

(7) After removing a main circuit terminal screw, always return the terminal screw to its position and tighten even if lines are not connected.

(8) The wiring guide is used to separately route the main circuit wiring and the control circuit wiring. The main circuit wiring and the control circuit wiring can be separated. Pay attention to the order of wiring.

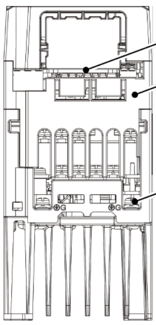


Figure 2.2-6 Case of FRN0006E3S-2G

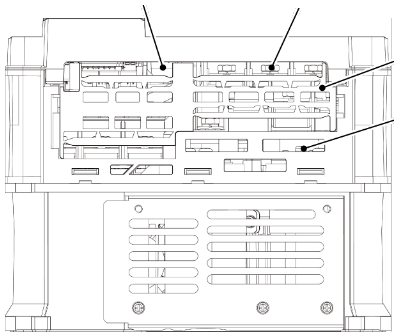


Figure 2.2-7 Case of FRN0115E3S-2G

■ **Handling the Wiring Guide**

The wiring space may become insufficient when routing the main circuit wires, depending on the wire material used. In these cases, the relevant cut-off sections (refer to the figures below) can be removed using a pair of nippers to secure routing space. Be warned that removing the wiring guide to accommodate the enlarged main circuit wiring will result in non-conformance to IP20 requirements.

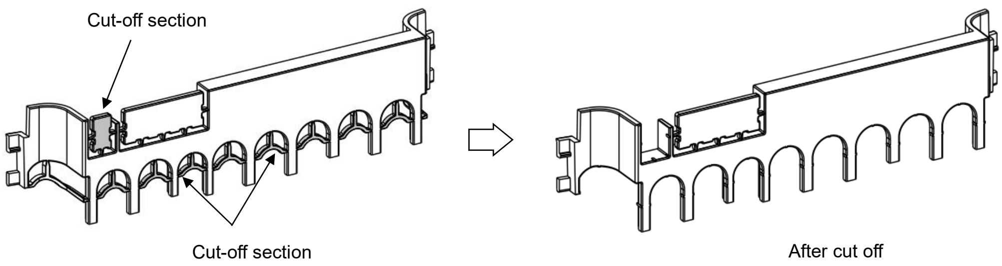


Figure 2.2-8 Wiring Guide (FRN0069E3S-2G)

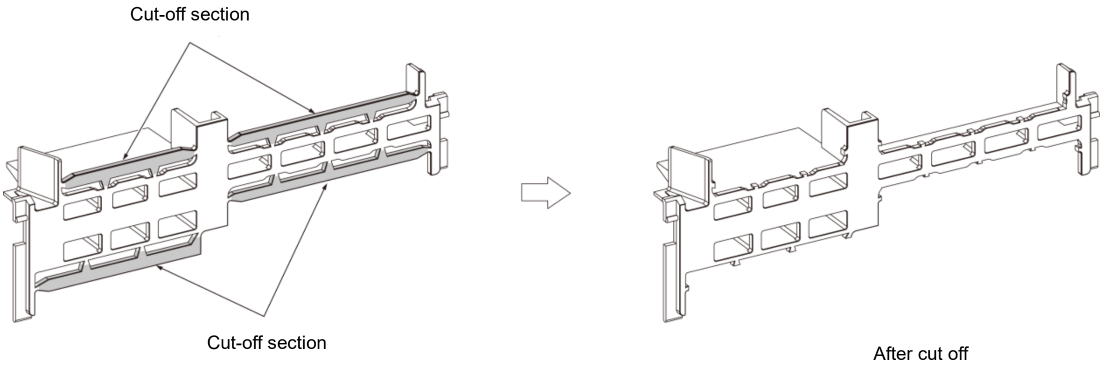


Figure2.2-9 Wiring Guide (FRN0072E3S-4G)

(9) Depending on the inverter capacity, straight routing of the main circuit wires from the main circuit terminal block may not be possible. In these cases, route the wires as shown in the figure below and securely attach the front cover.

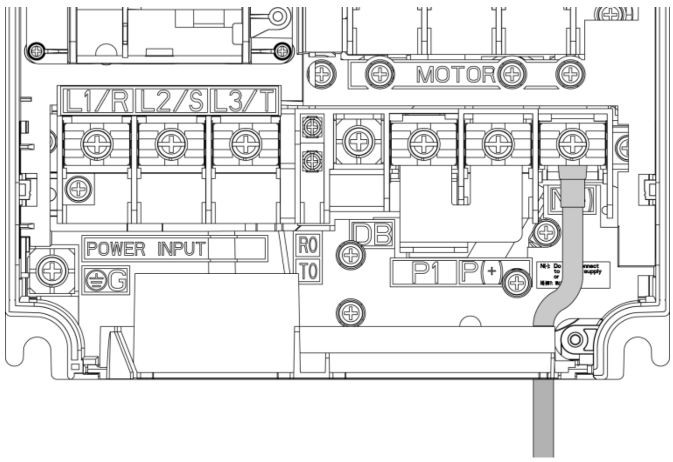


Fig. 2.2-10

2.2.4 Precautions for long wiring (between inverter and motor)

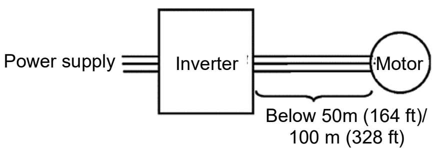
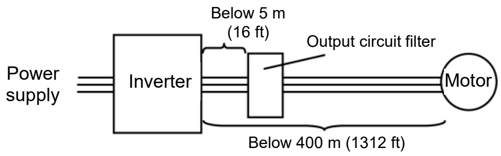
(1) When multiple motors are connected to one inverter, the wiring length is the total of all wire lengths.

(2) Precautions for high-frequency leakage current

Precautions shall be taken for high frequency leakage current when the wiring length from the inverter to the motor is long; in this case the high frequency current may flow through the stray capacitance between the wires with various phases. The effect may cause the inverter to become overheated, or trip due to overcurrent. Leakage current may increase and the accuracy of the displayed current may not be ensured. Depending on the conditions, excessive leakage current may damage the inverter. To avoid the above problems when directly connecting an inverter to a motor, keep the wiring distance 50 m (164 ft) or below for inverters FRN0001 to 0020E3S/N-2G, FRN0002 to 0012E3S/N/E-4G, FRN0001 to 0012E3S/N/E-7G, and below 100 m (328 ft) for inverters FRN0030 to 0115E3S/N-2G, FRN0022 to 0072E3S/N/E-4G.

To operate with longer wiring lengths than the ones mentioned above, reduce the carrier frequency to 5 kHz or less, or, in the case of a 400 V series, use optional output circuit filters (OFL-☐☐☐-4A).

When multiple motors are operated in parallel connection configuration (group operation), and especially when shielded cables are used in the connections, the stray capacitance to ground is large. Reduce the carrier frequency to 5 kHz or less, or, in the case of a 400 V series, use optional output circuit filters (OFL-☐☐☐-4A).

Without output circuit filter	With output circuit filter
	

When the output circuit filter is used, the total wiring length should be below 100 m (328 ft) (or below 400 m (1312 ft) in case of using V/f control).
For motors with encoders, the wiring length between the inverter and motor should be below 100 m (328 ft). This restriction comes from the encoder specifications. For distances beyond 100 m (328 ft), insulation converters should be used. Please contact Fuji Electric when operating with wiring lengths beyond the upper limit.

(3) Precautions on the surge voltage when driving the inverter (especially for 400 V series motor)
When motors are driven by inverters using the PWM method, the surge voltage generated by the switching of the inverter elements is added to the output voltage and is applied onto the motor terminals.
Especially when the motor wiring length is long, the surge voltage can cause insulation degradation in the motor.
Please perform one of the countermeasures shown below.

- Use motor with enhanced insulation (Fuji's standard motors have enhanced insulation)
- Connect an output circuit filter (OFL-☐☐☐-4A) to the inverter output (secondary) circuit.
- Reduce the wiring length from the inverter to the motor to 10 to 20 meters (33 to 66ft) or less.

(4) When an output circuit filter (OFL-☐☐☐-4A) is inserted in the inverter, or when the wiring length is long, the voltage applied to the motor will decrease due to the voltage drop caused by the filter or wiring, and current vibration or insufficient torque may occur. Furthermore that when performing auto torque boost, or control such as voltage compensation for dynamic torque vector control or vector control with sensor/sensorless vector control, voltage for which the voltage drop has been compensated with auto-tuning is output. However, if running the inverter near to or higher than the base frequency, it is not possible to compensate for voltage drop.
Refer to "TEST RUN PROCEDURE" in Chapter 4 for details on the auto-tuning method.

⚠WARNING⚠

- Connect to the power supply via a molded case circuit breaker or residual-current-operated protective device/earth leakage circuit breaker (with overcurrent protection function) for each inverter.
  Use recommended molded case circuit breakers and earth leakage breakers and do not use breakers which exceed the recommended rated current.
- Be sure to use the specified wire size.
- Tighten terminals with the prescribed tightening torque.
- When multiple combinations of inverters and motors exist, do not use multi-core cables for the purpose of bundling the various wires.
- Do not install a surge suppressor to the inverter output (secondary) circuit.
  Failure to observe this could result in fire.
- Ground the inverter in compliance with the national or local electric code.
- Always connect the ground wire to the inverter grounding terminal [⏚G].
  Failure to observe this could result in electric shock or fire.
- Wiring work should be carried out by qualified professionals.
- Carry out wiring work after ensuring that the power has been turned OFF.
  Failure to observe this could result in electric shock.
- Always carry out wiring after installing the unit.
  Failure to observe this could result in electric shock or injury.
- Ensure that the number of phases and rated voltage of the product input power supply match that for the connected power supply.
- Do not connect power supply lines to the inverter output terminals [U], [V], [W].
  Failure to observe this could result in fire or an accident.

2.2.5 Main circuit terminals

The specifications for the screws used in the main circuit wiring and the wire sizes are shown below. Exercise caution as the terminal position varies depending on inverter capacity. In the diagram in "[[2] Terminal layout diagram (main circuit terminal)]," the two ground terminals [⏚G] are not differentiated for the input (primary) and output (secondary) circuits.

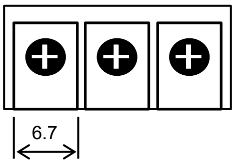
Also, use crimped terminals with insulating sleeves compatible for the main circuit or terminals with insulating tubes. The recommended wire sizes are shown depending on temperature inside the paneling and wire type.

[1] Screw specifications (main circuit terminals)

Table 2.2-1 Screw specifications

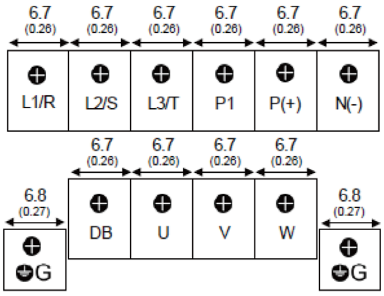
Type of inverter			Ref.	Screw specifications					
				Main circuit		Grounding		Control power auxiliary input [R0], [T0]	
Single-phase 200 V	Three-phase 200 V	Three-phase 400 V		Screw size (driver size)	Tightening torque (N·m)	Screw size (driver size)	Tightening Torque (N·m)	Screw size	Tightening Torque (N·m)
FRN0001E3□-7G	FRN0001E3□-2G	–	Figure A	M3.5	0.8	M3.5	1.2	-	-
FRN0002E3□-7G	FRN0002E3□-2G	–							
FRN0004E3□-7G	FRN0004E3□-2G	–							
FRN0003E3E-7G	–	–							
FRN0006E3□-7G	FRN0006E3□-2G	–							
FRN0005E3E-7G	–	–	Figure K						
–	FRN0010E3□-2G	FRN0002E3□-4G	Figure B	M4	1.2	M4	1.8		
FRN0010E3□-7G	FRN0012E3□-2G	FRN0004E3□-4G							
–	–	FRN0006E3□-4G							
–	–	FRN0007E3□-4G							
–	–	FRN0002E3E-4G	Figure G						
–	–	FRN0004E3E-4G							
FRN0012E3□-7G	FRN0020E3□-2G	FRN0012E3□-4G	Figure C						
FRN0008E3E-7G	–	FRN0006E3E-4G	Figure H						
FRN0011E3E-7G	–	FRN0007E3E-4G							
–	–	FRN0012E3E-4G							
–	FRN0030E3□-2G	FRN0022E3□-4G	Figure D	M5	3	M6 (No.3)	5.8		
–	FRN0040E3□-2G	FRN0029E3□-4G							
–	–	FRN0022E3E-4G	Figure I	INPUT M4(Φ 4.5 No2) Other M5 (No.2)	INPUT 1.2 Other 3.0	INPUT M6NUT Other M5	INPUT 4.0 OUTPUT 3.0		
–	–	FRN0029E3E-4G							
–	FRN0056E3□-2G	FRN0037E3□-4G	Figure E	M6	3	M8	13.5		
–	FRN0069E3□-2G	FRN0044E3□-4G							
–	–	FRN0037E3E-4G	Figure J	INPUT M4(Φ 4.5 No2) Other M6 (No.3)	INPUT 1.8 Other 3.0	INPUT M6NUT Other M6	INPUT 4.0 OUTPUT 3.0		
–	–	FRN0044E3E-4G							
–	FRN0088E3□-2G	FRN0059E3□-4G	Figure F	M6 (No.3)	5.8	M6 (No.3)	13.5	M3.5	1.2
–	FRN0115E3□-2G	FRN0072E3□-4G							

[2] Terminal layout diagram (main circuit terminal)



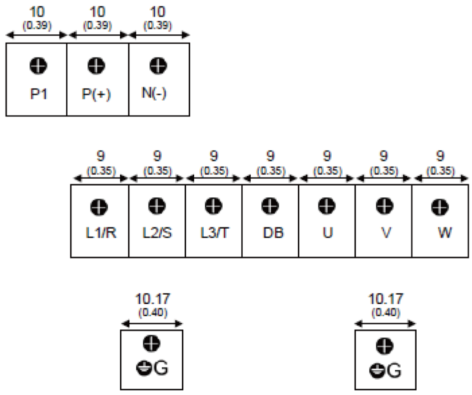
The dimensions for each terminal indicate the “dimensions between walls” as shown in the diagram on the left.

Figure A



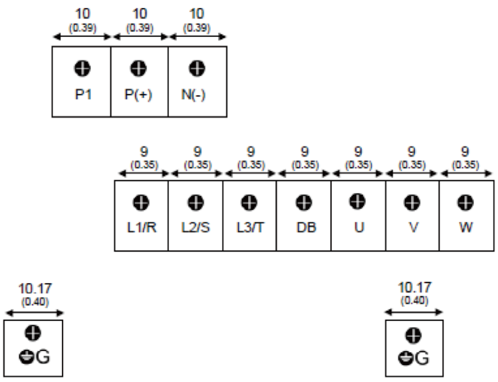
Single-phase 200V series: L1/R⇒L1/L, L3/T⇒L2/N

Figure B



Single-phase 200V series: L1/R⇒L1/L, L3/T⇒L2/N

Figure C



Single-phase 200V series: L1/R⇒L1/L, L3/T⇒L2/N

Figure D

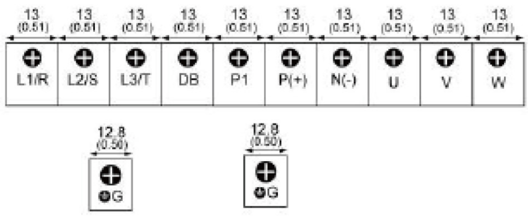


Figure E

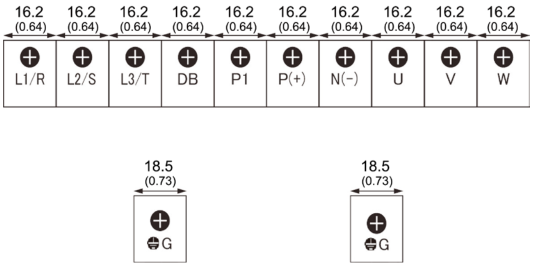


Figure F

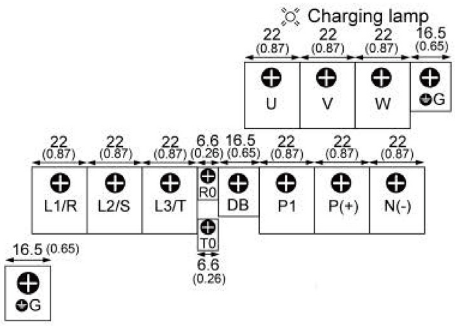


Figure G

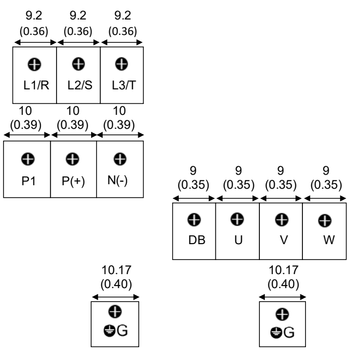


Figure H

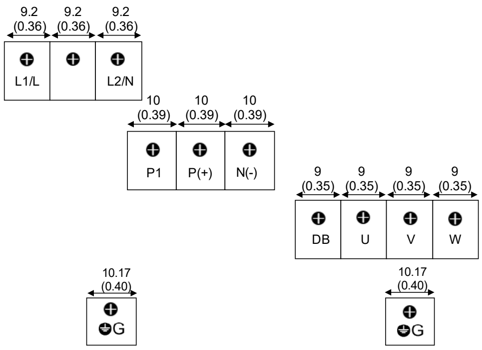


Figure I

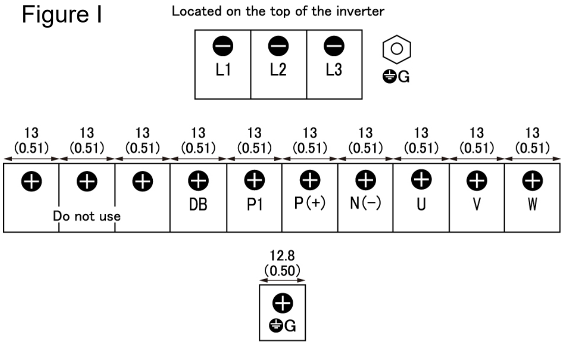


Figure J

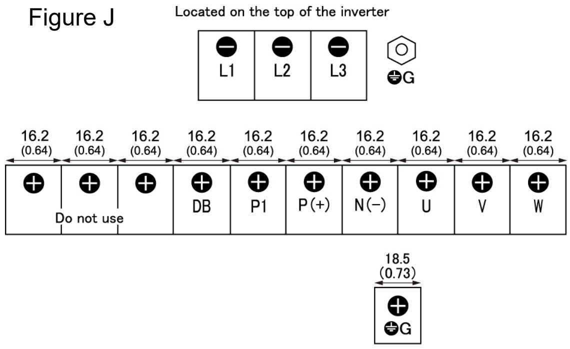
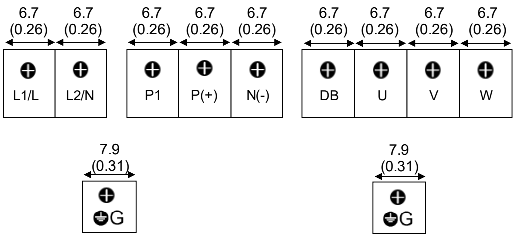


Figure K



WARNING

The following terminals will have high voltage when power is ON.

Main circuit: [L1/R], [L2/S], [L3/T], [L1/L], [L2/N], [P1], [P(+)], [N(-)], [DB], [U], [V], [W], [R0], [T0], AUX-contact ([30A], [30B], [30C])

Insulation level

Main circuit - Casing:	Basic insulation (overvoltage category III, degree of contamination 2)
Main circuit - Control circuit:	Enhanced insulation (overvoltage category III, degree of contamination 2)
Contact output – Control circuit:	Enhanced insulation (overvoltage category II, degree of contamination 2)

Failure to observe this could result in electric shock.

[3] Recommended wire size (main circuit terminals)

The following wires are recommended unless special requirements exist.

If using in an ambient temperature of 50 to 55 °C (122 to 131 °F), select wires by referring to the 55 °C field in Appendix E "Permissible Current of Insulated Wires."

■ 600 V vinyl insulation wire (IV wire)

This wire is used in circuits except the inverter control circuit. The wire is difficult to twist and is not recommended for inverter control circuit. The maximum allowable temperature for the insulated wire is 60°C (140°F).

■ 600 V type 2 vinyl insulation wire or 600 V polyethylene insulation wire (HIV wire)

In comparison to the IV wire, this wire is smaller, more flexible, and the maximum allowable temperature for the insulated wire is 75°C (167°F), making it suitable for both the inverter main circuit and control circuit. However, the wiring distance should be short and the wire must be twisted for use in the inverter control circuit.

■ 600 V cross-linked polyethylene insulation wire (FSLC wire)

This wire is used mainly in the main circuit and the grounding circuits. The size is even smaller than the IV wire or the HIV wire and it is also more flexible. Due to these features, the wire is used to reduce the area occupied by wiring and to improve work efficiency in high temperature areas. The maximum allowable temperature for the insulated wire is 90°C (194°F). As a reference, Furukawa Electric Co., Ltd. produces Boardlex which satisfies these requirements.

■ Shielded-twisted cables for internal wiring of electronic/electric instruments

This product is used in inverter control circuits. Use this wire with high shielding effect when risk of exposure to or effect of radiated noise and induced noise exists. Always use this wire when the wiring distance is long, even within the paneling. Furukawa Electric's BEAMEX S shielded cables XEBV or XEWV satisfy these requirements.

Table 2.2-2 Recommended wire sizes (Common terminals)

Common terminals	Recommended wire size (mm^2)	Remarks
Control power auxiliary input terminals [R0], [T0]	2.0	—

☐ Ambient temperature: 50°C (122°F)° and below

Table2.2-3 Wire sizes (Main power supply input and inverter output)

HHD: Heavy-duty load
HND: General load

HHD: Heavy-duty load

Power supply voltage	Standard applicable motors (kW)	Inverter type	Recommended wire size (mm^2)																	
			Main power supply input [L1/R], [L2/S], [L3/T]						Ground terminal			Inverter Output [U], [V], [W]			For DC reactor connection [P1], [P(+)]			For braking resistor connection [P(+)], [DB]		
			With DC reactor (DCR)			Without DC reactor (DCR)														
			Allowable temperature (Note 1)			Allowable temperature (Note 1)			Allowable temperature (Note 1)			Allowable temperature (Note 1)			Allowable temperature (Note 1)			Allowable temperature (Note 1)		
			60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F
Three-phase 200 V	0.1	FRN0001E3■-2G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	0.2	FRN0002E3■-2G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	0.4	FRN0004E3■-2G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	0.75	FRN0006E3■-2G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	1.5	FRN0010E3■-2G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	2.2	FRN0012E3■-2G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	3.7	FRN0020E3■-2G	2.0	2.0	2.0	5.5	2.0	2.0	2.0	2.0	2.0	3.5	2.0	2.0	3.5	2.0	2.0	2.0	2.0	2.0
	5.5	FRN0030E3■-2G	5.5	2.0	2.0	8.0	3.5	3.5	3.5	3.5	3.5	5.5	3.5	2.0	5.5	3.5	2.0	2.0	2.0	2.0
	7.5	FRN0040E3■-2G	8.0	3.5	2.0	14	5.5	5.5	5.5	5.5	5.5	8.0	3.5	3.5	14	5.5	3.5	2.0	2.0	2.0
	11	FRN0056E3■-2G	14	5.5	5.5	22	14	8.0	5.5	5.5	5.5	14	8.0	5.5	22	8.0	5.5	2.0	2.0	2.0
	15	FRN0069E3■-2G	22	14	8.0	38 *3	14	14	5.5	5.5	5.5	22	14	8.0	38 *3	14	14	2.0	2.0	2.0
	18.5	FRN0088E3■-2G	38 *6	14	14	60 *7	22	14	8.0 *1	8.0 *1	8.0 *1	38 *6	14	14	38 *6	22	14	2.0	2.0	2.0
	22	FRN0115E3■-2G	38 *6	22	14	60 *7	38 *6	22	8.0 *1	8.0 *1	8.0 *1	38 *6	22	14	60 *7	22	22	2.0	2.0	2.0
Three-phase 400 V	0.4	FRN0002E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	0.75	FRN0004E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	1.5	FRN0006E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	2.2	FRN0007E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	3.7	FRN0012E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	5.5	FRN0022E3■-4G	2.0	2.0	2.0	3.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	7.5	FRN0029E3■-4G	2.0	2.0	2.0	5.5	2.0	2.0	2.0	2.0	2.0	3.5	2.0	2.0	3.5	2.0	2.0	2.0	2.0	2.0
	11	FRN0037E3■-4G	5.5	2.0	2.0	8.0	3.5 *5	3.5 *5	3.5 *5	3.5 *5	3.5 *5	5.5	2.0	2.0	5.5	3.5 *5	2.0	2.0	2.0	2.0
	15	FRN0044E3■-4G	8.0	3.5 *5	2.0	14	5.5	5.5	5.5	5.5	5.5	8.0	3.5 *5	2.0	14	5.5	3.5 *5	2.0	2.0	2.0
		FRN0044E3E-4G	8.0	3.5	2.0	10	5.5	5.5	5.5	5.5	5.5	8.0	3.5*5	2.0	14	5.5	3.5*5	2.0	2.0	2.0
	18.5	FRN0059E3■-4G	14	5.5	3.5 *5	22	8.0 *1	5.5	5.5	5.5	5.5	14	5.5	3.5 *5	14	5.5	5.5	2.0	2.0	2.0
	22	FRN0072E3■-4G	14	5.5	5.5	22	14	8.0 *1	5.5	5.5	5.5	14	8.0 *1	5.5	22	8.0 *1	5.5	2.0	2.0	2.0
Single-phase 200 V	0.1	FRN0001E3■-7G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	0.2	FRN0002E3■-7G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	0.4	FRN0004E3■-7G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	0.75	FRN0006E3■-7G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	1.5	FRN0010E3■-7G	2.0	2.0	2.0	3.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	2.2	FRN0012E3■-7G	3.5	2.0	2.0	5.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.5	2.0	2.0	2.0	2.0	2.0

*1 For compatible crimped terminals, please use model 8-L6 by JST Mfg. Co., Ltd. or equivalent.

*2 For compatible crimped terminals, please use model 22-S5 by JST Mfg. Co., Ltd. or equivalent.

*3 For compatible crimped terminals, please use model 38-S6 by JST Mfg. Co., Ltd. or equivalent.

*4 For compatible crimped terminals, please use model CB60-S6 by JST Mfg. Co., Ltd. or equivalent.

*5 For compatible crimped terminals, please use model R5.5-6 by JST Mfg. Co., Ltd. or equivalent.

*6 For compatible crimped terminals, please use model 38-6 by JST Mfg. Co., Ltd. or equivalent.

*7 For compatible crimped terminals, please use model 60-6 by JST Mfg. Co., Ltd. or equivalent.

HND: General load

Power supply voltage	Standard applicable motors	Inverter type	Recommended wire size (mm^2)																	
			Main power supply input [L1/R], [L2/S], [L3/T]						Ground terminal			Inverter Output [U], [V], [W]			For DC reactor connection [P1], [P(+)]			For braking resistor connection [P(+)], [DB]		
			With DC reactor (DCR)			Without DC reactor (DCR)														
			Allowable temperature (Note 1)			Allowable temperature (Note 1)			Allowable temperature (Note 1)			Allowable temperature (Note 1)			Allowable temperature (Note 1)			Allowable temperature (Note 1)		
			60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194° F
Three-phase 200 V	0.2	FRN0001E3■-2G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	0.4	FRN0002E3■-2G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	0.75	FRN0004E3■-2G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	1.5	FRN0006E3■-2G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	2.2	FRN0010E3■-2G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	3.0	FRN0012E3■-2G	2.0	2.0	2.0	3.5	2.0	2.0	3.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	5.5	FRN0020E3■-2G	3.5	2.0	2.0	-	3.5	3.5	3.5	3.5	3.5	3.5	2.0	2.0	5.5	3.5	2.0	2.0	2.0	2.0
	7.5	FRN0030E3■-2G	8.0	3.5	2.0	14	5.5	5.5	5.5	5.5	5.5	8.0	3.5	2.0	14	5.5	3.5	2.0	2.0	2.0
	11	FRN0040E3■-2G	14	5.5	5.5	-	14	8.0	5.5	5.5	5.5	14	5.5	3.5	-	8.0	5.5	2.0	2.0	2.0
	15	FRN0056E3■-2G	22	14	8.0	38 *3	14	14	5.5	5.5	5.5	22	14	5.5	38 *3	14	14	2.0	2.0	2.0
	18.5	FRN0069E3■-2G	38 *3	14	14	-	22	14	8.0	8.0	8.0	38 *3	14	8.0	38 *3	22	14	2.0	2.0	2.0
	22	FRN0088E3■-2G	38 *6	22	14	60 *7	38 *6	22	8.0 *1	8.0 *1	8.0 *1	38 *6	22	14	60 *7	22	22	2.0	2.0	2.0
	30	FRN0115E3■-2G	60 *7	38 *6	22	-	60 *7	38 *6	14	14	14	60 *7	38 *6	22	-	38 *6	38 *6	2.0	2.0	2.0
Three-phase 400 V	0.75	FRN0002E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	1.1	FRN0004E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	2.2	FRN0006E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	3.0	FRN0007E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	5.5	FRN0012E3■-4G	2.0	2.0	2.0	3.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	7.5	FRN0022E3■-4G	2.0	2.0	2.0	5.5	2.0	2.0	2.0	2.0	2.0	3.5	2.0	2.0	3.5	2.0	2.0	2.0	2.0	2.0
	11	FRN0029E3■-4G	5.5	2.0	2.0	8.0	3.5	3.5	3.5	3.5	3.5	5.5	2.0	2.0	5.5	3.5	2.0	2.0	2.0	2.0
		FRN0029E3E-4G	5.5	2.0	2.0	6.0	3.5	3.5	3.5	3.5	3.5	5.5	2.0	2.0	5.5	3.5	2.0	2.0	2.0	2.0
	15	FRN0037E3■-4G	8.0	3.5*5	2.0	14	5.5	5.5	3.5 *5	3.5 *5	3.5 *5	8.0	5.5	3.5*5	14	5.5	3.5*5	2.0	2.0	2.0
		FRN0037E3E-4G	8.0	3.5	2.0	10	5.5	5.5	3.5 *5	3.5 *5	3.5 *5	8.0	5.5	3.5*5	14	5.5	3.5*5	2.0	2.0	2.0
	18.5	FRN0044E3■-4G	14	5.5	3.5*5	22	8.0	5.5	5.5	5.5	5.5	14	5.5	3.5*5	14	5.5	5.5	2.0	2.0	2.0
		FRN0044E3E-4G	10	5.5	3.5	10	8.0	5.5	5.5	5.5	5.5	14	5.5	3.5*5	14	5.5	5.5	2.0	2.0	2.0
	22	FRN0059E3■-4G	14	5.5	5.5	22	14	8.0 *1	5.5	5.5	5.5	14	8.0*1	5.5	22	8.0*1	5.5	2.0	2.0	2.0
	30	FRN0072E3■-4G	22	14	8.0 *1	38 *6	14	14	8.0 *1	8.0 *1	8.0 *1	22	14	8.0*1	38 *6	14	8.0*1	2.0	2.0	2.0
Single-phase 200 V	0.2	FRN0001E3■-7G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	0.4	FRN0002E3■-7G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	0.75	FRN0004E3■-7G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	1.1	FRN0006E3■-7G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	2.2	FRN0010E3■-7G	3.5	2.0	2.0	3.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	5.5	2.0	2.0	2.0	2.0	2.0
	3.0	FRN0012E3■-7G	5.5	3.5	2.0	5.5	3.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	8.0	3.5	2.0	2.0	2.0	2.0

*1 For compatible crimped terminals, please use model 8-L6 by JST Mfg. Co., Ltd. or equivalent.

*2 For compatible crimped terminals, please use model 22-S5 by JST Mfg. Co., Ltd. or equivalent.

*3 For compatible crimped terminals, please use model 38-S6 by JST Mfg. Co., Ltd. or equivalent.

*4 For compatible crimped terminals, please use model CB60-S6 by JST Mfg. Co., Ltd. or equivalent.

*5 For compatible crimped terminals, please use model R5.5-6 by JST Mfg. Co., Ltd. or equivalent.

*6 For compatible crimped terminals, please use model 38-6 by JST Mfg. Co., Ltd. or equivalent.

*7 For compatible crimped terminals, please use model 60-6 by JST Mfg. Co., Ltd. or equivalent.

*8 For compatible crimped terminals, please use model CB100-S8 by JST Mfg. Co., Ltd. or equivalent.

☐ Ambient temperature: 40°C (104°F) and below

Table 2.2-4 Wire sizes (Main power supply input and inverter output)

HHD: Heavy-duty load
HND: General load

HHD: Heavy-duty load

Power supply voltage	Standard applicable motors	Inverter type	Recommended wire size (mm^2)																	
			Main power supply input [L1/R], [L2/S], [L3/T]						Ground terminal			Inverter Output [U], [V], [W]			For DC reactor connection [P1], [P(+)]			For braking resistor connection [P(+)], [DB]		
			With DC reactor (DCR)			Without DC reactor (DCR)			Allowable temperature (Note 1)			Allowable temperature (Note 1)			Allowable temperature (Note 1)			Allowable temperature (Note 1)		
			Allowable temperature (Note 1)			Allowable temperature (Note 1)														
			60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F
Three-phase 200 V	0.1	FRN0001E3■-2G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	0.2	FRN0002E3■-2G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	0.4	FRN0004E3■-2G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	0.75	FRN0006E3■-2G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	1.5	FRN0010E3■-2G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	2.2	FRN0012E3■-2G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	3.7	FRN0020E3■-2G	2.0	2.0	2.0	3.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	5.5	FRN0030E3■-2G	2.0	2.0	2.0	5.5	3.5	2.0	3.5	3.5	3.5	3.5	2.0	2.0	3.5	2.0	2.0	2.0	2.0	2.0
	7.5	FRN0040E3■-2G	3.5	2.0	2.0	8.0	5.5	3.5	5.5	5.5	5.5	5.5	3.5	2.0	5.5	3.5	3.5	2.0	2.0	2.0
	11	FRN0056E3■-2G	8.0	5.5	3.5 *5	14	8.0	5.5	5.5	5.5	5.5	8.0	5.5	3.5 *5	14	5.5	5.5	2.0	2.0	2.0
	15	FRN0069E3■-2G	14	8.0	5.5	22	14	14	5.5	5.5	5.5	14	8.0	5.5	14	14	8.0	2.0	2.0	2.0
	18.5	FRN0088E3■-2G	14	14	8.0 *1	38 *6	22	14	8.0 *1	8.0 *1	8.0 *1	22	14	8.0 *1	22	14	14	2.0	2.0	2.0
	22	FRN0115E3■-2G	22	14	14	38 *6	22	14	8.0 *1	8.0 *1	8.0 *1	22	14	14	38 *6	22	14	2.0	2.0	2.0
Three-phase 400 V	0.4	FRN0002E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	0.75	FRN0004E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	1.5	FRN0006E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	2.2	FRN0007E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	3.7	FRN0012E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	5.5	FRN0022E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	7.5	FRN0029E3■-4G	2.0	2.0	2.0	3.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	11	FRN0037E3■-4G	2.0	2.0	2.0	5.5	3.5 *5	2.0	3.5 *5	3.5 *5	3.5 *5	3.5 *5	2.0	2.0	3.5 *5	2.0	2.0	2.0	2.0	2.0
	15	FRN0044E3■-4G	3.5 *5	2.0	2.0	8.0	5.5	3.5 *5	5.5	5.5	5.5	5.5	3.5 *5	2.0	5.5	3.5 *5	3.5 *5	2.0	2.0	2.0
	18.5	FRN0059E3■-4G	5.5	3.5 *5	3.5 *5	14	8.0 *1	5.5	5.5	5.5	5.5	5.5	3.5 *5	3.5 *5	8.0 *1	5.5	3.5 *5	2.0	2.0	2.0
	22	FRN0072E3■-4G	8.0 *1	5.5	3.5 *5	14	8.0 *1	5.5	5.5	5.5	5.5	8.0 *1	5.5	3.5 *5	14	5.5	5.5	2.0	2.0	2.0
Single-phase 200 V	0.1	FRN0001E3■-7G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	0.2	FRN0002E3■-7G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	0.4	FRN0004E3■-7G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	0.75	FRN0006E3■-7G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	1.5	FRN0010E3■-7G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	2.2	FRN0012E3■-7G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0

*1 For compatible crimped terminals, please use model 8-L6 by JST Mfg. Co., Ltd. or equivalent.

*2 For compatible crimped terminals, please use model 22-S5 by JST Mfg. Co., Ltd. or equivalent.

*3 For compatible crimped terminals, please use model 38-S6 by JST Mfg. Co., Ltd. or equivalent.

*4 For compatible crimped terminals, please use model CB60-S6 by JST Mfg. Co., Ltd. or equivalent.

*5 For compatible crimped terminals, please use model R5.5-6 by JST Mfg. Co., Ltd. or equivalent.

*6 For compatible crimped terminals, please use model 38-6 by JST Mfg. Co., Ltd. or equivalent.

*7 For compatible crimped terminals, please use model 60-6 by JST Mfg. Co., Ltd. or equivalent.

*8 For compatible crimped terminals, please use model CB100-S8 by JST Mfg. Co., Ltd. or equivalent.

HND: General load

Power supply voltage	Standard applicable motors (kW)	Inverter type	Recommended wire size (mm^2)																	
			Main power supply input [L1/R], [L2/S, [L3/T]						Ground terminal			Inverter Output [U], [V], [W]			For DC reactor connection[P1], [P(+)]			For braking resistor connection [P(+)], [DB]		
			With DC reactor (DCR)			Without DC reactor (DCR)														
			Allowable temperature (Note 1)			Allowable temperature (Note 1)			Allowable temperature (Note 1)			Allowable temperature (Note 1)			Allowable temperature (Note 1)			Allowable temperature (Note 1)		
			60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F
Three-phase 200 V	0.2	FRN0001E3■-2G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	0.4	FRN0002E3■-2G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	0.75	FRN0004E3■-2G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	1.5	FRN0006E3■-2G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	2.2	FRN0010E3■-2G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	3.0	FRN0012E3■-2G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	5.5	FRN0020E3■-2G	2.0	2.0	2.0	5.5	3.5	2.0	3.5	3.5	3.5	2.0	2.0	2.0	3.5	2.0	2.0	2.0	2.0	2.0
	7.5	FRN0030E3■-2G	3.5	3.5	2.0	8.0	5.5	3.5	5.5	5.5	5.5	3.5	3.5	2.0	5.5	3.5	3.5	2.0	2.0	2.0
	11	FRN0040E3■-2G	8.0	5.5	3.5	14	8.0	5.5	5.5	5.5	5.5	5.5	5.5	3.5	14	5.5	5.5	2.0	2.0	2.0
	15	FRN0056E3■-2G	14	8.0	5.5	22	14	14	5.5	5.5	5.5	14	8.0	5.5	14	14	8.0	2.0	2.0	2.0
	18.5	FRN0069E3■-2G	14	14	8.0	38 *3	22	14	8.0	8.0	8.0	14	14	8.0	22	14	14	2.0	2.0	2.0
	22	FRN0088E3■-2G	22	14	14	38 *6	22	14	8.0 *1	8.0 *1	8.0 *1	22	14	14	38 *6	22	14	2.0	2.0	2.0
	30	FRN0115E3■-2G	38 *6	22	22	60 *7	38 *6	38 *6	14	14	14	38 *6	22	22	60 *7	38 *6	22	2.0	2.0	2.0
Three-phase 400 V	0.75	FRN0002E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	1.1	FRN0004E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	2.2	FRN0006E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	3.0	FRN0007E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	5.5	FRN0012E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	7.5	FRN0022E3■-4G	2.0	2.0	2.0	3.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	11	FRN0029E3■-4G	2.0	2.0	2.0	5.5	3.5	2.0	3.5	3.5	3.5	3.5	2.0	2.0	3.5	2.0	2.0	2.0	2.0	2.0
	15	FRN0037E3■-4G	3.5 *5	2.0	2.0	8.0	5.5	3.5 *5	3.5 *5	3.5 *5	3.5 *5	5.5	3.5 *5	3.5 *5	5.5	3.5 *5	3.5 *5	2.0	2.0	2.0
	18.5	FRN0044E3■-4G	8.0	5.5	3.5 *5	14	8.0	5.5	5.5	5.5	5.5	8.0	5.5	3.5 *5	8.0	5.5	3.5 *5	2.0	2.0	2.0
		FRN0044E3E-4G	8.0	5.5	3.5	10	8.0	5.5	5.5	5.5	5.5	8.0	5.5	3.5*6	8.0	5.5	3.5*6	2.0	2.0	2.0
	22	FRN0059E3■-4G	8.0 *1	5.5	3.5 *5	14	8.0 *1	5.5	5.5	5.5	5.5	8.0 *1	5.5	3.5 *5	14	5.5	5.5	2.0	2.0	2.0
	30	FRN0072E3■-4G	14	8.0 *1	5.5	22	14	8.0 *1	8.0 *1	8.0 *1	8.0 *1	14	8.0 *1	5.5	14	14	8.0 *1	2.0	2.0	2.0
Single-phase 200 V	0.2	FRN0001E3■-7G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	0.4	FRN0002E3■-7G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	0.75	FRN0004E3■-7G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	1.1	FRN0006E3■-7G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	2.2	FRN0010E3■-7G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	3.0	FRN0012E3■-7G	3.5	2.0	2.0	3.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	5.5	3.5	2.0	2.0	2.0	2.0

*1 For compatible crimped terminals, please use model 8-L6 by JST Mfg. Co., Ltd. or equivalent.

*2 For compatible crimped terminals, please use model 38-S6 by JST Mfg. Co., Ltd. or equivalent.

*3 For compatible crimped terminals, please use model 38-S6 by JST Mfg. Co., Ltd. or equivalent.

*4 For compatible crimped terminals, please use model CB60-S6 by JST Mfg. Co., Ltd. or equivalent.

*5 For compatible crimped terminals, please use model R5.5-6 by JST Mfg. Co., Ltd. or equivalent.

*6 For compatible crimped terminals, please use model 38-6 by JST Mfg. Co., Ltd. or equivalent.

*7 For compatible crimped terminals, please use model 60-6 by JST Mfg. Co., Ltd. or equivalent.

*8 For compatible crimped terminals, please use model CB100-S8 by JST Mfg. Co., Ltd. or equivalent.

HD: Heavy duty load

Power supply voltage	Nominal applied motors (kW)	Inverter type	Recommended wire size (mm^2)																	
			Main power supply input [L1/R], [L2/S], [L3/T]						Ground terminal			Inverter Output [U], [V], [W]			For DC reactor connection [P1], [P(+)]			For braking resistor connection [P(+)], [DB]		
			With DC reactor (DCR)			Without DC reactor (DCR)														
			Allowable temperature (Note 1)			Allowable temperature (Note 1)			Allowable temperature (Note 1)			Allowable temperature (Note 1)			Allowable temperature (Note 1)			Allowable temperature (Note 1)		
			60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F
Three-phase 400 V	0.75	FRN0002E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	1.1	FRN0004E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	2.2	FRN0006E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	3.0	FRN0007E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	5.5	FRN0012E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	7.5	FRN0022E3■-4G	2.0	2.0	2.0	3.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	11	FRN0029E3■-4G	2.0	2.0	2.0	5.5	3.5	2.0	3.5	3.5	3.5	3.5	2.0	2.0	3.5	2.0	2.0	2.0	2.0	2.0
	15	FRN0037E3■-4G	3.5*5	2.0	2.0	8.0	5.5	3.5*5	5.5	5.5	5.5	5.5	3.5*5	3.5*5	5.5	3.5*5	3.5*5	2.0	2.0	2.0
	18.5	FRN0044E3■-4G	5.5	3.5*5	3.5*5	14	8.0	5.5	5.5	5.5	5.5	8.0	5.5	3.5*5	8.0	5.5	3.5*5	2.0	2.0	2.0
		FRN0044E3E-4G	5.5	3.5	3.5	10	8.0	5.5	5.5	5.5	5.5	8.0	5.5	3.5*5	8.0	5.5	3.5*5	2.0	2.0	2.0
	22	FRN0059E3■-4G	8.0*1	5.5	3.5*5	14	8.0*1	5.5	5.5	5.5	5.5	8.0*1	5.5	3.5*5	14	5.5	5.5	2.0	2.0	2.0
	30	FRN0072E3■-4G	14	8.0*1	5.5	22	14	8.0*1	8.0*1	8.0*1	8.0*1	14	8.0*1	5.5	14	14	8.0*1	2.0	2.0	2.0

ND: General load

Power supply voltage	Nominal applied motors (kW)	Inverter type	Recommended wire size (mm^2)																	
			Main power supply input [L1/R], [L2/S, [L3/T]						Ground terminal			Inverter Output [U], [V], [W]			For DC reactor connection [P1], [P(+)]			For braking resistor connection [P(+)], [DB]		
			With DC reactor (DCR)			Without DC reactor (DCR)														
			Allowable temperature (Note 1)			Allowable temperature (Note 1)			Allowable temperature (Note 1)			Allowable temperature (Note 1)			Allowable temperature (Note 1)			Allowable temperature (Note 1)		
			60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F	60 °C 140°F	75 °C 167°F	90 °C 194°F
Three-phase 400 V	0.75	FRN0002E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	1.5	FRN0004E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	2.2	FRN0006E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	3.0	FRN0007E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	5.5	FRN0012E3■-4G	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	11	FRN0022E3■-4G	2.0	2.0	2.0	5.5	3.5	2.0	3.5	3.5	3.5	2.0	2.0	2.0	3.5	2.0	2.0	2.0	2.0	2.0
	15	FRN0029E3■-4G	3.5	2.0	2.0	8.0	5.5	3.5	5.5	5.5	5.5	3.5	2.0	2.0	5.5	3.5	3.5	2.0	2.0	2.0
		FRN0029E3E-4G	3.5	2.0	2.0	-	5.5	3.5	5.5	5.5	5.5	3.5	2.0	2.0	5.5	3.5	3.5	2.0	2.0	2.0
	18.5	FRN0037E3■-4G	5.5	3.5*5	3.5*5	14	8.0	5.5	5.5	5.5	5.5	5.5	3.5*5	3.5*5	8.0	5.5	3.5*5	2.0	2.0	2.0
		FRN0037E3E-4G	5.5	3.5	3.5	-	8.0	5.5	5.5	5.5	5.5	5.5	3.5*5	3.5*5	8.0	5.5	3.5*5	2.0	2.0	2.0
	22	FRN0044E3■-4G	8.0	5.5	3.5*5	14	8.0	5.5	5.5	5.5	5.5	8.0	5.5	3.5*5	14	5.5	5.5	2.0	2.0	2.0
		FRN0044E3E-4G	8.0	5.5	3.5	-	8.0	5.5	5.5	5.5	5.5	8.0	5.5	3.5*5	14	5.5	5.5	2.0	2.0	2.0
	30	FRN0059E3■-4G	14	8.0*1	5.5	22	14	8.0*1	8.0*1	8.0*1	8.0*1	14	8.0*1	5.5	14	14	8.0*1	2.0	2.0	2.0
	37	FRN0072E3■-4G	14	14	8.0*1	38*6	14	14	8.0*1	8.0*1	8.0*1	14	14	8.0*1	22	14	14	2.0	2.0	2.0

*1 For compatible crimped terminals, please use model 8-L6 by JST Mfg. Co., Ltd. or equivalent.

*2 For compatible crimped terminals, please use model 22-S5 by JST Mfg. Co., Ltd. or equivalent.

*3 For compatible crimped terminals, please use model 38-S6 by JST Mfg. Co., Ltd. or equivalent.

*4 For compatible crimped terminals, please use model CB60-S6 by JST Mfg. Co., Ltd. or equivalent.

*5 For compatible crimped terminals, please use model R5.5-6 by JST Mfg. Co., Ltd. or equivalent.

*6 For compatible crimped terminals, please use model 38-6 by JST Mfg. Co., Ltd. or equivalent.

*7 For compatible crimped terminals, please use model 60-6 by JST Mfg. Co., Ltd. or equivalent.

*8 For compatible crimped terminals, please use model CB100-S8 by JST Mfg. Co., Ltd. or equivalent.

[4] Description of terminal functions (main circuit terminal)

Classification	Terminal symbol	Terminal name	Specification
Main circuit	[L1/R], [L2/S], [L3/T]	Main power supply input	Terminals to connect three-phase power source. (Three-phase models only)
	[L1/L], [L2/N]	Main power supply input	Terminals to connect single-phase power source. (Single-phase models only)
	[U], [V], [W]	Inverter output	Terminals to connect three-phase motors.
	[P1], [P(+)]	For direct current reactor connection	Terminals to connect DC reactor (DCR) (optional). Connect the DCR after removing the shorting bar between [P1] and [P(+)]. Do not remove the shorting bar if the DCR is not used.
	[P(+)], [N(-)]	For direct current bus connection	Terminals to connect direct current intermediate circuits of other inverters and PWM converters.
	[P(+)], [DB]	For braking resistor connection	Connect the terminals [P(+)] and [DB] of the braking resistor (DB) (option) (wiring length of 5 m or less).
	[⏚ G]	For inverter chassis (case) grounding	Grounding terminal for inverter chassis (case). Connect one terminal to the ground and the other to the motor grounding terminal. This terminal is made of two terminals.
	[R0], [T0]	Control power auxiliary input	When it is desired to retain the alarm signal for the activation of the protective function even when the inverter main power supply is shut off, or when continuous display of the keypad is desired, connect this terminal to the power supply (Types FRN0088 to 0115E3S/N-2G, FRN0059 to 0072E3S/E/N-4G).

Follow the sequence below when wiring.

(1) Inverter ground terminal [⏚ G]
(2) Inverter output terminals [U], [V], [W], motor ground terminal [⏚ G]
(3) Direct current reactor connection terminals [P1], [P(+)]*
(4) Braking resistor connection terminals [P(+)], [DB]*
(5) Direct current bus terminals [P(+)], [N(-)]*
(6) Main power supply input terminals [L1/R], [L2/S], [L3/T] (Three-phase input models) / [L1/L], [L2/N] (Single-phase input models)
(7) Control power auxiliary input terminals [R0], [T0]
(FRN0088 to 0115E3S/N-2G, FRN0059 to 0072E3S/E/N-4G)*

* Connect if necessary.

(1) Inverter ground terminal [⏚ G]

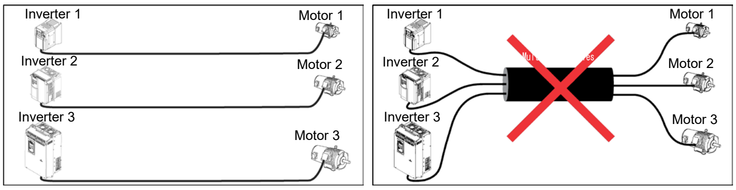
Be sure to ground grounding terminals to ensure safety, and as a noise countermeasure. In order to prevent accidents such as an electric shock or fire, users are obligated by the Electrical Equipment Technical Standards to carry out grounding work for the metal frames of electrical equipment.

Ground the inverter in compliance with the national or local electric code.

(2) Inverter output terminals [U], [V], [W], motor ground terminal [⏚ G]

1) Connect the three-phase motor terminals [U], [V], and [W] while matching the phase sequence.
2) Connect the ground line of the outputs [U], [V], [W] to the ground terminal [⏚ G].

Note When multiple combinations of inverters and motors exist, do not use multi-core cables for the purpose of bundling the various wires.



(3) Direct current reactor connection terminals [P1], [P(+)]

Connect the direct current reactor (DCR).

1) Remove the shorting bar from terminals [P1] and [P(+)].
2) Connect the [P1], [P(+)] terminals to the direct current reactor.

Note
- Keep the wiring length below 10 meters (32 feet).
- Do not remove the shorting bar if the direct current reactor is not used.
- Direct current reactors do not have to be connected when connecting PWM converters.

⚠WARNING
Always connect the direct current reactor (option) when the power supply transformer capacity is above 500 kVA and is over 10 times the rated capacity of the inverter. **Failure to observe this could result in fire.**

(4) Braking resistor connection terminals [P(+)], [DB]

1) Connect terminals [P(+)], [DB] of the inverter to braking resistor terminals.
2) Mount the inverter main body and the braking resistor such that the wiring length will be less than 5 m (16 ft) and route the two wires twisted or in contact with each other (parallel).
3) Change the DB resistor electronic thermal setting.

⚠WARNING
Do not connect to terminals other than [P(+)] and [DB] when connecting braking resistors. **Failure to observe this could result in fire.**

(5) Direct current bus terminals [P(+)], [N(-)]

The direct current intermediate circuit of other inverters and PWM converters can be connected.

Note Contact your Fuji Electric representative when using the direct current bus terminals [P(+)], [N(-)].

(6) Main power supply input terminals [L1/R], [L2/S], [L3/T] (three-phase input models) or [L1/L], [L2/N] (single-phase input models)

Connect a three-phase power supply to three-phase input models. Connect a single-phase power supply to single-phase input models.

1) For safety reasons, check in advance that the molded case circuit breaker (MCCB), residual-current-operated protective device (RCD) or magnetic contactor (MC) on the main power supply wiring is off.
2) Connect the power supply wires (L1/R, L2/S, L3/T) or (L1/L, L2/N) via an MCCB, residual-current-operated protective device (RCD), an earth leakage breaker (ELCB)* or, as necessary, an MC. There is no need to match the phases of the power supply wires and the inverter.
   *With overcurrent protection function

Tip It is recommended to connect an MC with which the power can be cut manually to prevent the spread of failures and damage by separating the inverter from the power supply when the inverter protective function is operating or in case of another emergency.

(7) Control power auxiliary input terminals [R0], [T0] (FRN0088 to 0115E3S/N-2G, FRN0059 to 0072E3S/E/N-4G)

The inverter can be operated without power input to the control power auxiliary input terminals. However, the inverter output signals and the keypad display will be shut off when the inverter main power is shut off and the control power source is lost.

When it is desired to retain the alarm signal for the activation of the protective function even when the inverter main power supply is shut off, or when continuous display of the keypad is desired, connect these terminals to the power supply. When the inverter input side has a magnetic contactor (MC), wire from the input (primary) circuit of the magnetic contactor (MC).

Terminal ratings:AC 200-240 V, 50/60 Hz, max. current 1.0 A
AC 380-480 V, 50/60 Hz, max. current 0.5 A

Note When using the earth leakage breaker, connect terminals [R0], [T0] to the output circuit of the earth leakage breaker. When connections are made to the input circuit of the earth leakage breaker, the earth leakage breaker will malfunction because the inverter input is three-phase and the terminals [R0], [T0] are single phase. When connecting terminals [R0], [T0] to the input circuit of the earth leakage breaker, make sure that the connection is done through an insulating transformer or, alternatively, through the auxiliary B contacts of the magnetic contactor as shown in the figure below.

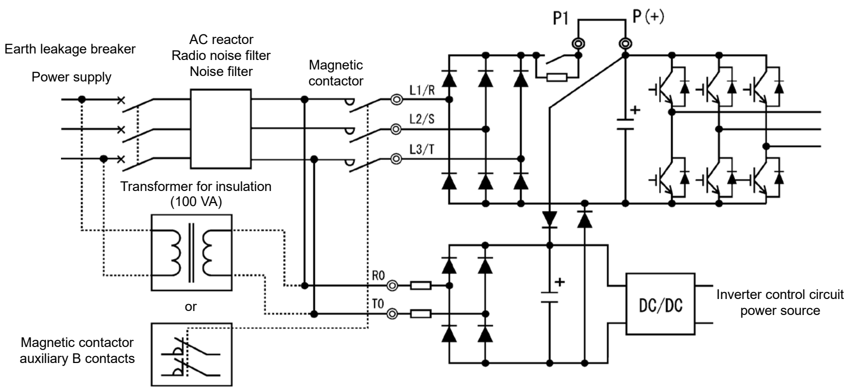


Figure 2.2-11 Connection of the earth leakage breaker

Note When connecting with the PWM converter, do not connect power source directly to the inverter's control power auxiliary input terminals ([R0], [T0]). Insert an insulating transformer or the auxiliary B contacts of a magnetic contactor on the power supply side.

For connection examples for the PWM converter side, refer to the instruction manual of the PWM converter.

Pay particular attention when replacing the inverters since the power supply may be directly connected to [R0], [T0] on previous models.

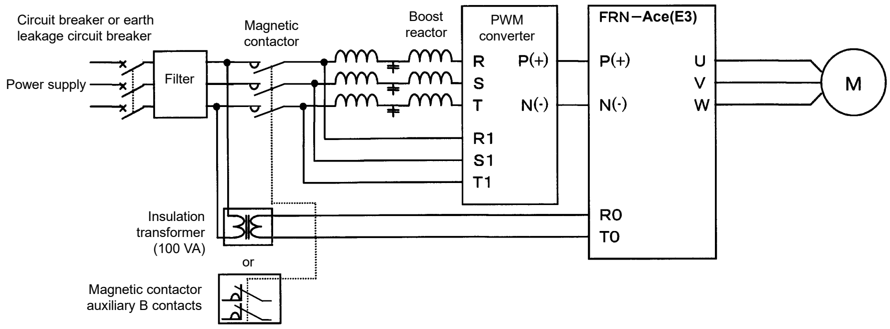


Figure 2.2-12 Example of connection of [R0], [T0] terminals in combination with PWM converter

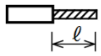
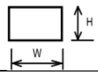
2.2.6 Control circuit terminals

[1] Recommended wire size (control circuit terminals)

The wire sizes to be used for control circuit wiring are shown below.

The control circuit terminal block is the same regardless of the inverter capacity.

Table 2.2-5 Recommended wire sizes

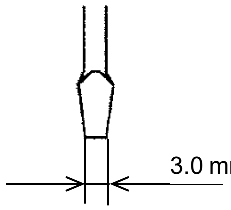
Common terminals	Allowable wire size	Recommended wire size	Screwdriver (shape of tip)	Removal size of wire cover 	Rod terminal*1 Terminal block opening dimensions 
Control circuit terminal	0.14 to 1.5 mm^2 (AWG26 to 16)	0.25 to 0.75 mm^2 (AWG24 to 18)	Flathead (0.5 mm×3.0 mm) (0.02×0.12 in.)	8 mm (0.31 in)	A1 *2 (2.35×1.45)

*1: Phoenix Contact products are recommended for the rod terminals. Refer to Table 2.2-6 below for more details.

*2 Defined according to IEC/EN 60947-1.

Table 2.2-6 Recommended rod terminals

Wire size	Type	
	With insulating collar 	Without insulating collar 
0.25 mm^2(AWG24)	AI 0.25-8 YE	-
0.34 mm^2(AWG22)	AI 0.34-8 TQ	-
0.5 mm^2(AWG20)	AI 0.5-8 WH	A 0.5-8
0.75 mm^2(AWG18)	AI 0.75-8 GY	A 0.75-8

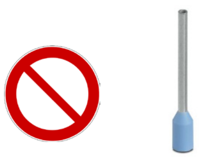


Width of the tip: 0.5 mm (0.02 in.)
screwdriver (shape of tip)

Note: If you use rod terminals other than those recommended above, you may be unable to remove the rod terminals from the terminal blocks, potentially damaging the terminal blocks.

Examples of terminals that cannot be used:

- Ferrule terminals with different sleeve lengths

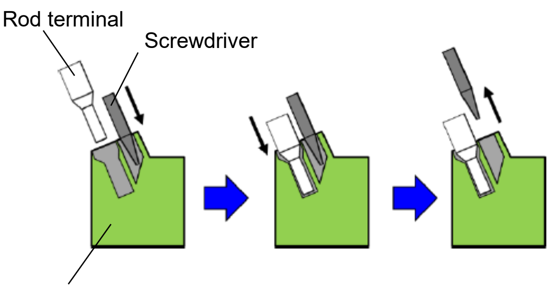


- Twin ferrule terminals for connecting 2 wires

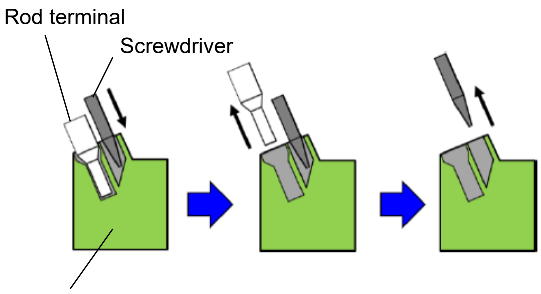
- Rod-shaped crimp terminals

Wiring procedure

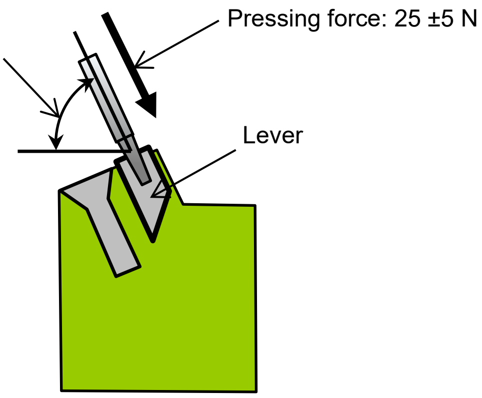
When inserting the wires



When removing the wires



Note When pressing the lever to insert or remove the rod terminal, refer to the figure below, pay attention to the angle of the screwdriver, and do not apply excessive force suddenly.



*Recommended insertion force by wire size:
0.25 mm^2 (AWG24) : 1.0 kgf
0.34 mm^2 (AWG22) : 1.1 kgf
0.5 mm^2 (AWG20) : 1.2 kgf
0.75 mm^2 (AWG18) : 1.5 kgf

[2] Terminal layout diagram (control circuit terminal) and switch layout diagram

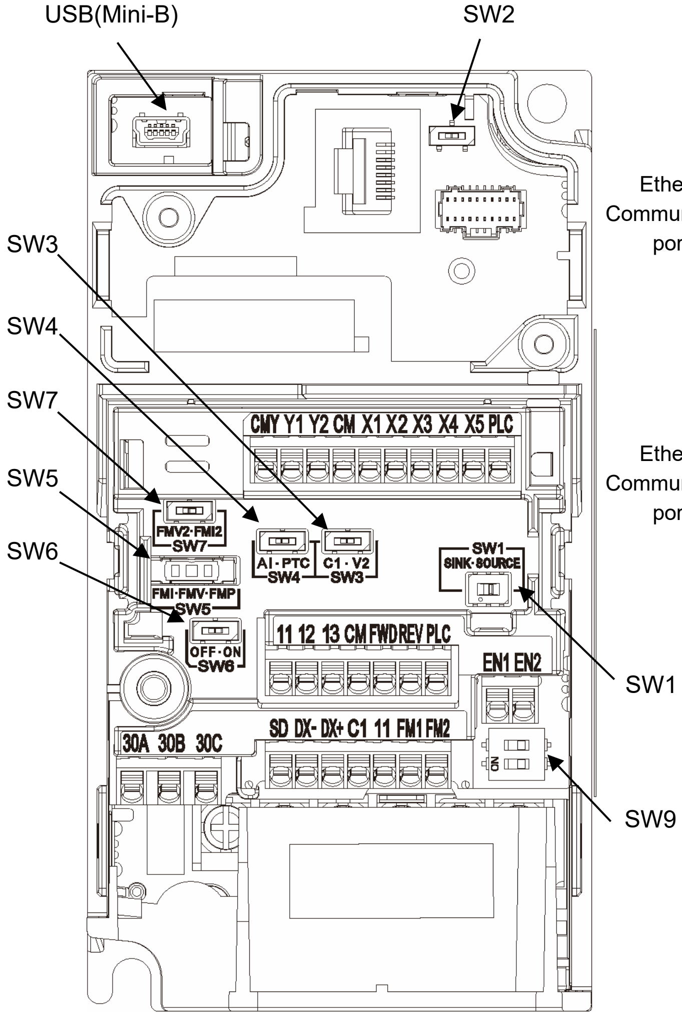


Figure 2.2-13 E3S and E3E terminal block and switches on PCB

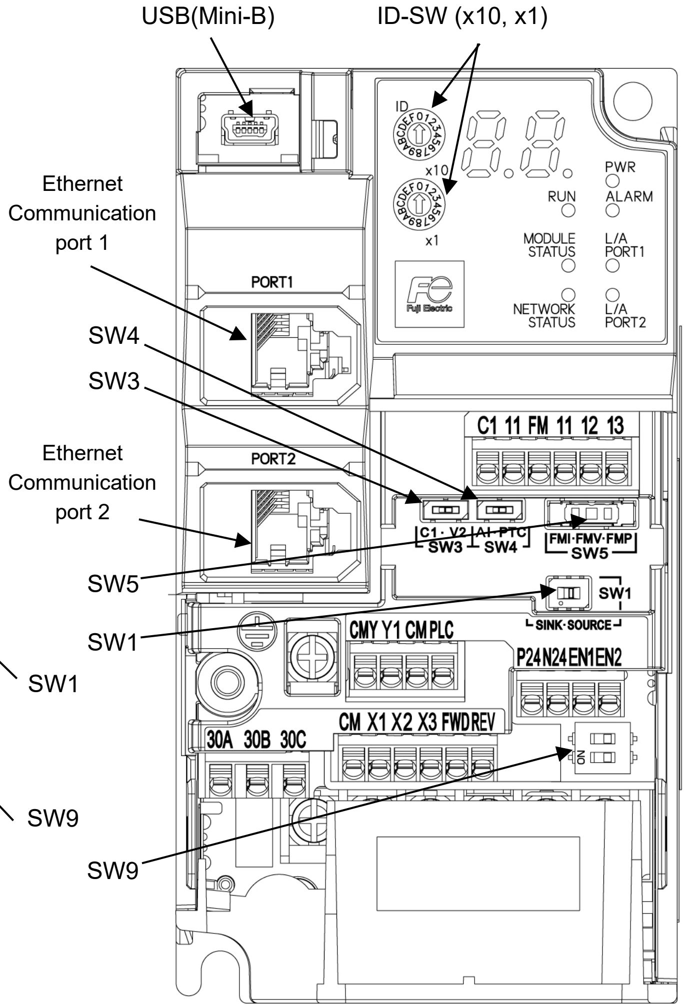


Figure 2.2-14 E3N terminal block and switches on PCB

⚠WARNING⚠

The following terminals will have high voltage when power is ON.

Control terminals: AUX-contact ([30A], [30B], [30C])

Insulation level

Contact output – Control circuit: Enhanced insulation (overvoltage category II, degree of contamination 2)

Failure to observe this could result in electric shock.

Note

- The control circuit terminal lines should be routed as far as possible from the main circuit routing. Malfunction may occur due to noise.
- To prevent direct contact with the main circuit live sections (such as the main circuit terminal block), route the control circuit wiring inside the inverter as bundles using cable ties.

⚠WARNING⚠

Generally, the insulation for control signal lines is not enhanced. When the control signal lines come into direct contact with the main circuit live section, the insulation cover may be damaged. In such a case, there is a danger that high voltage from the main circuit will be applied to the control signal lines, and therefore care should be taken to ensure that they do not come into contact with live parts of the main circuit.

Risk of accidents and risk of electric shock exist.

⚠CAUTION

Noise is generated by the inverter, motor, and wiring. Exercise caution to prevent malfunction of peripheral sensors and instruments.

Failure to observe this could result in an accident.

[3] Description of terminal functions (control circuit terminal)

Table below shows the functional explanations for the control circuit terminals. The connection method of the control circuit terminals differs depending on the functional code setting matching the purpose of inverter operation.

Properly route wires such that the impact of noise generated by the main circuit wiring is reduced.

Furthermore, the terminals installed on the FRENIC-Ace differ depending on the construction type.
Check the right-hand columns (E3S, E3E, E3N) in the table below to see which terminals are installed.

· Y: Installed
· N: Not installed

Additionally, option cards cannot be installed on the E3N type.

<u>Analog input terminal</u>

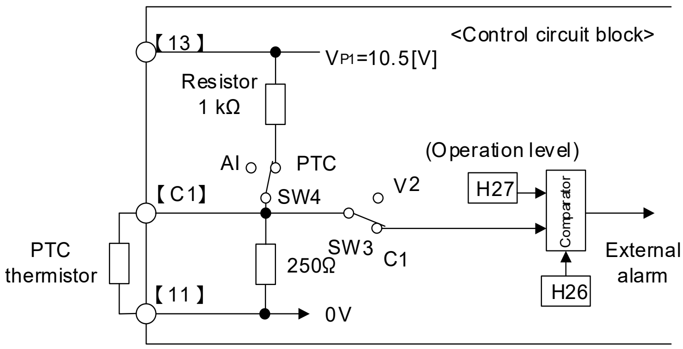
Table2.2-7 Functional descriptions of control circuit terminals

Classification	Terminal symbol	Terminal name	Functional description	E3S	E3E	E3N
Analog input	[13]	Power supply for the potentiometer	The terminal is used for the power supply (DC+10 V) for the external frequency command potentiometer (variable resistor: 1 to 5 kΩ). Connect variable resistors larger than 1/2 W.	Y	Y	Y
	[12]	Analog setup voltage input	(1) Frequency is set according to the external analog voltage input command value. • DC 0 to ±10 V/0 to 100 (%) (Normal operation) • DC +10 to 0 V/0 to 100 (%) (Reverse operation) (2) Besides the frequency settings by analog input, the terminal can be assigned to PID command, feedback signal of PID control, auxiliary frequency setup, ratio setup, torque limit setup, torque command value[*1,*2]/torque current command value[*1,*2], speed limit value, and analog input monitor. (3) Hardware specifications * Input impedance: 22 (kΩ) * Up to DC±15 V can be input. However, input exceeding DC±10 V will be recognized as DC±10 V. * To input bipolar (DC 0 to ±10 V) analog setup voltage to the terminal [12], set the function code C35 to "0".	Y	Y	Y

*1 This is a valid specification/function for sensorless vector control.

*2 This is a valid specification/function for vector control with sensor. The PG interface card (option) is required.

Table2.2-7 Functional descriptions of control circuit terminals (continued)

<table>
<tr><th>Classification</th><th>Terminal symbol</th><th>Terminal name</th><th>Functional description</th><th>E3S</th><th>E3E</th><th>E3N</th></tr>
<tr><td rowspan="3">Analog input</td><td rowspan="3">[C1]</td><td>Analog setup voltage input
(C1 function)</td><td>(1) Frequency is set according to the external analog voltage input command value.
SW3 and SW4 (refer to “2.2.7 Switching switches”) must be switched on the PCB.
• DC4 to 20 mA/0 to 100(%), DC0 to 20 mA/0 to 100 (%) (Normal operation)
• DC20 to 4 mA/0 to 100(%), DC20 to 0 mA/0 to 100 (%) (Reverse operation)
(2) Aside from the frequency setup by analog input, the terminal can be assigned to PID command, feedback signal of PID control, auxiliary frequency setup, ratio setup, torque limit setup, torque command value[*1,*2]/torque current command value[*1,*2], speed limit value, and analog input monitor.
(3) Hardware specifications
* Input impedance: 250 (Ω)
* Up to DC 30 mA can be input. However, input exceeding DC 20 mA will be recognized as DC 20 mA.</td><td>Y</td><td>Y</td><td>Y</td></tr>
<tr><td>Analog setup voltage input
(V2 function)</td><td>(1) Frequency is set according to the external analog voltage input command value.
SW3 and SW4 (refer to “2.2.7 Switching switches”) must be switched on the priPCB.
• DC0 to ±10 V/0 to 100 (%) (DC0 to +5 V/0 to 100%) (Normal operation)
• DC +10 to 0 V/0 to 100 (%) (Reverse operation)
(2) Aside from the frequency setup by analog input, the terminal can be assigned to PID command, feedback signal of PID control, auxiliary frequency setup, ratio setup, torque limit setup, torque command value[*1,*2]/torque current command value[*1,*2], speed limit value, and analog input monitor.
(3) Hardware specifications
* Input impedance: 22 (kΩ)
* Up to DC+15 V can be input. However, input exceeding DC+10 V will be recognized as DC+10 V.</td><td>Y</td><td>Y</td><td>Y</td></tr>
<tr><td>PTC thermistor input
(PTC function)</td><td>(1) PTC (Positive Temperature Coefficient) thermistor for motor protection can be connected. SW3 (C1/V2 Switch) and SW4 (PTC /AI Switch) (refer to “2.2.7 Switching switches”) must be switched on the PCB.
Figure 2.2-12 shows the internal circuit when SW3 and SW4 are set for PTC thermistor input. For details on SW3 and SW4, refer to “2.2.7 Switching switches”. When SW3 and SW4 are switched to the PTC side, function codes H26 and H27 also need to be changed.


</td><td>Y</td><td>Y</td><td>Y</td></tr>
</table>

*1 This is a valid specification/function for sensorless vector control.

*2 This is a valid specification/function for vector control with sensor. The PG interface card (option) is required.

Table2.2-7 Functional descriptions of control circuit terminals (continued)

Classification	Terminal symbol	Terminal name	Functional description	E3S	E3E	E3N
Analog input	[11]	Analog input common	The terminal is the common terminal for analog input signals (terminals [12], [13], [C1], [FM1], [FM2]). The terminal is insulated from terminals [CM], [CMY].	Y	Y	Y

Note

- Use shielded lines and keep the wiring to the minimum (below 20 meters (65 feet)) for control signals which are susceptible to external noise. Grounding the shielded lines is generally recommended, but if external induction noise is large, connecting to terminal [11] may reduce the noise. The shielded line increases the blocking effect. Always ground one end as shown in Figure 2.2-15.
- When inserting a relay contact for analog input signal lines, use the twin contacts relay for small signals. Also, do not insert a relay to terminal [11].
- When external analog signal generators are connected, the analog signal generator circuit may malfunction due to the noise created by the inverter. In these cases, connect ferrite core (toroidal shape or equivalent) to the output terminals of the analog signal generator or connect high frequency capacitors between the control signal lines, as shown in Figure 2.2-16.
- Do not apply a voltage of DC +7.5 V or more to the terminal [C1]. This will damage the internal circuit.

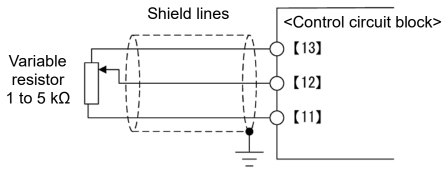


Figure 2.2-15 Connection diagram for shielded lines

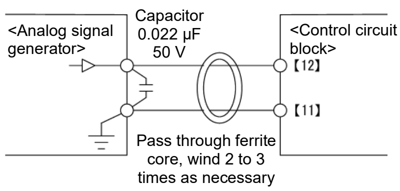


Figure 2.2-16 Example of noise countermeasures

*1 This is a valid specification/function for sensorless vector control.

*2 This is a valid specification/function for vector control with sensor. The PG interface card (option) is required.

Digital input terminal

Table 2.2-8 Functional descriptions of control circuit terminals

Classification	Terminal symbol	Terminal name	Functional description	E3S	E3E	E3N
Digital input	[X1]	Digital input 1	(1) Various signals (coast to a stop command, external alarm, multi-speed selection, etc) set up by function codes E01 to E05, E98, E99 can be set. For details, refer to Chapter 5 "FUNCTION CODES." (2) Input mode, SINK/SOURCE can be switched using SW1. (Refer to "2.2.7 Switching switches.") (3) The operating mode of the various digital input terminals when connected with terminal [CM] (SINK mode) / PLC (SOURCE mode) can be switched to "ON when shorted with CM/PLC (active ON)" or "OFF when shorted with CM/PLC (active OFF)." (4) Digital input terminal [X5] can be set up as a pulse train input terminal by changing the function code Maximum cable length: 20 m (65.6 ft) Maximum input pulse 30 kHz: When connected to open collector output pulse generator (A pull-up/pull-down resistor is required. Refer to "Note ■ Pulse train input with terminal [X5].") 100 kHz: When connected to complementary output pulse generator Refer to Chapter 5 "FUNCTION CODES" for function code settings.	Y	Y	Y
	[X2]	Digital input 2		Y	Y	Y
	[X3]	Digital input 3		Y	Y	Y
	[X4]	Digital input 4		Y	Y	N
	[X5]	Digital input 5		Y	Y	N
	[FWD]	Forward rotation/stop command Input		Y	Y	Y
	[REV]	Reverse rotation/stop command Input		Y	Y	Y

<Digital input circuit specification>

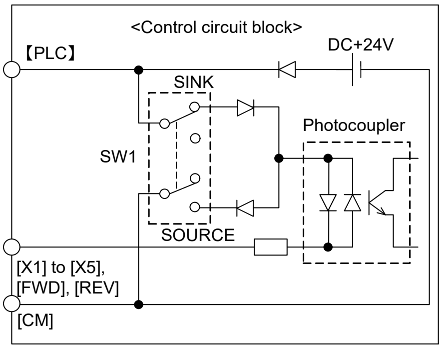


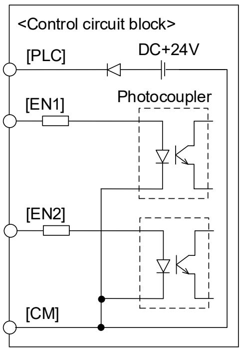
Figure 2.2-17 Digital input circuit

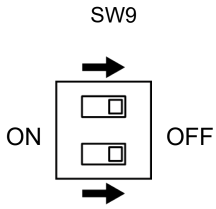
Table 2.2-9

Item		Minimum	Maximum
Operating voltage (SINK)	ON level	0 V	2 V
	OFF level	20 V	27 V
Operating voltage (SOURCE)	ON level	20 V	27 V
	OFF level	0 V	2 V
Operating current while ON (at input voltage 0 V) (In the case of [X5] input terminal)		2.5 mA (9.7 mA)	5 mA (16 mA)
Allowable leakage current while OFF		-	0.5 mA

Table 2.2-8 Functional descriptions of control circuit terminals (continued)

<table>
<tr><th>Classification</th><th>Terminal symbol</th><th>Terminal name</th><th>Functional description</th><th>E3S</th><th>E3E</th><th>E3N</th></tr>
<tr><td rowspan="2">Digital input</td><td>[EN1]
[EN2]</td><td>Enable input</td><td>(1) When terminals [EN1]-[PLC] or terminals [EN2]-[PLC] are OFF, the inverter output transistors stop switching (safe torque off: STO).
Be sure to operate terminals [EN1] and [EN2] simultaneously; otherwise an EcF alarm is issued and the operation of the inverter will be disabled.
(2) The input mode for terminals [EN1] and [EN2] is fixed to SOURCE. The mode cannot be switched to SINK.
(3) This function can be enabled and disabled with SW9. Set both SW9 switches to OFF when using this function.

<Terminals [EN1] and [EN2] circuit specification>




<table>
<tr><th colspan="2">Item</th><th>Minimum</th><th>Maximum</th></tr>
<tr><td rowspan="2">Operating voltage (SOURCE)</td><td>ON level</td><td>20 V</td><td>27 V</td></tr>
<tr><td>OFF level</td><td>0 V</td><td>2 V</td></tr>
<tr><td colspan="2">Operating current while ON (at input voltage 24 V)</td><td>–</td><td>4.5 mA</td></tr>
<tr><td colspan="2">Allowable leakage current while OFF</td><td>–</td><td>0.5 mA</td></tr>
</table></td><td>Y</td><td>Y</td><td>Y</td></tr>
<tr><td>[PLC]</td><td>Programmable controller signal power source</td><td>(1) Connects to the programmable controller output signal power source.
(Rated voltage of DC +24 V (power source voltage variation range: DC +20.4 to +27 V), 100 mA max.)
(2) The terminal can also be used as the power supply for loads connected to transistor outputs.
For details, refer to the page on “Transistor outputs.”</td><td>Y</td><td>Y</td><td>Y</td></tr>
</table>

Table 2.2-8 Functional descriptions of control circuit terminals (continued)

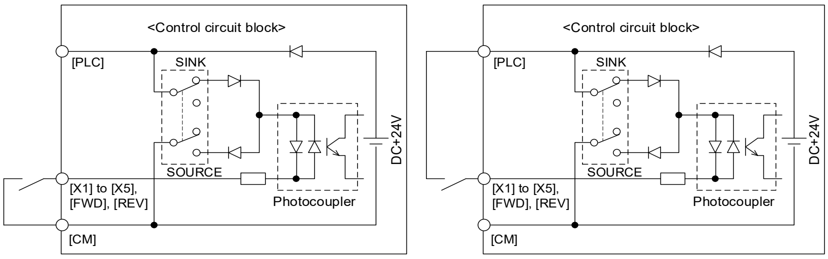
Classification	Terminal symbol	Terminal name	Functional description	E3S	E3E	E3N
Digital input	[CM]	Digital input common	This terminal is the common terminal for digital input signals. This terminal is insulated from terminals [11] and [CMY].	Y	Y	Y

Tip

■ **When turning terminals [FWD], [REV], [X1] to [X5] ON and OFF using relay contacts**

Figure 2.2-18 shows an example of the circuit configuration using relay contact. Circuit (a) shows the circuit configuration when the switch (SW1) is on the SINK side and circuit (b) shows the circuit configuration when the switch is on the SOURCE side.

Caution: Use a relay which will not have contact failures (high contact reliability).
(Fuji Electric’s control relay type: HH54PW)



(a) Switch on SINK side (b) Switch on SOURCE side

Figure 2.2-18 Circuit configuration example using relay contact

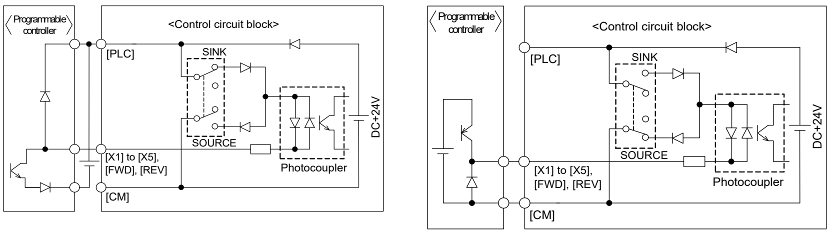
Tip

■ **When turning terminals [FWD], [REV], [X1] to [X5] ON and OFF using the programmable controller**

Figure 2.2-19 shows an example of the circuit configuration using the programmable controller. Circuit (a) shows the circuit configuration when the switch (SW1) is on the SINK side and circuit (b) shows the circuit configuration when the switch is on the SOURCE side.

In circuit (a), terminals [FWD], [REV], [X1] to [X5] can be turned ON/OFF by shorting/opening the open collector transistor output of the programmable controller using the external power supply. Follow the instructions below when using this type of circuit.

• Connect the + side of the external power supply which is insulated from the programmable controller power supply to terminal [PLC].
• Do not connect the inverter’s [CM] terminal and the common terminal of the programmable controller.



(a) Switch on SINK side (b) Switch on SOURCE side

Figure 2.2-19 Circuit configuration example using the programmable controller

📖 Refer to “2.2.7 Switching switches” for more information on the switches.

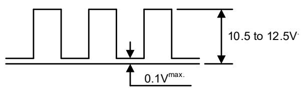
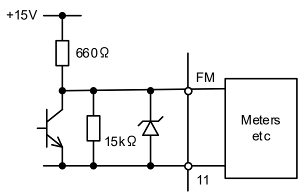
Note

■ **Pulse train input with terminal [X5]**

When connected to an open collector output pulse generator, the input pulse may not be correctly recognized due to the wiring stray capacitance. To solve this issue, you may connect a pull-up resistor between the open collector output signal (terminal [X5]) and the power supply (terminal [PLC]) when the switch is on the SINK side, or connect a pull-down resistor between the open collector output signal (terminal [X5]) and the digital common (terminal [CM)] when the switch is on the SOURCE side. 1 kΩ, 2 W is recommended for the pull-up/pull-down resistors. Since the wiring stray capacitance greatly differs depending on the wire type and installation method, check that the pulse train input is correctly recognized.

Analog output/Pulse output/Transistor output/Contact output terminals

Table 2.2-10 Functional descriptions of control circuit terminals

Classification	Terminal symbol	Terminal name	Functional description	E3S	E3E	E3N
Analog output/pulse output	[FM1] *1	Analog input monitor (FMV function) (FMI function)	This terminal outputs an analog direct current voltage DC0 to 10 V or analog direct current DC4 to 20 mA (DC0 to 20mA) monitor signal. The output form [FM1] *1 (FMP) can be switched using SW5 on the PCB and function code F29. The signal content can be chosen in the function code F31 data setting. * Allowable impedance for connection: Min. 5 kΩ (at DC to 10 V output) (up to 2 analog volt meters (DC 0 to 10 V, input impedance 10 kΩ) can be connected.) * Allowable impedance for connection: Max 500 Ω (at DC 4 to 20 mA/DC0 to 20 mA) * Gain adjustable range: 0 to 300%	Y	Y	Y
		Pulse monitor (FMP function)	The terminal output pulse signal. Signal content can be chosen in the same way as for the FMV function by function code F31 setting. The output form [FM1] *1 (FMP) can be switched using SW5 on the PCB and function code F29. * Allowable impedance for connection: Min. 5 kΩ (up to 2 analog volt meters (DC 0 to 10 V, input impedance 10 kΩ) can be connected.) (If using as the average voltage output, set F34 to between 1 and 300%.) * Pulse duty: Approx. 50% Pulse rate: 25 to 32000 p/s (at full scale) <Voltage waveform specification> • Pulse output waveform  Fig. 2.2-20 • FMP output circuit  Fig. 2.2-21	Y	Y	Y
	[FM2]	Analog input monitor (FMV function) (FMI function)	This terminal outputs an analog direct current voltage DC 0 to 10 V or analog direct current DC 4 to 20 mA (DC0 to 20mA) monitor signal. The output form [FM2] (FMV2/FMI2) can be switched using SW7 on the PCB and function code F32. The signal content can be chosen in the function code F35 data setting among the same items as [FM] (F31). * Allowable impedance for connection: Min. 5 kΩ (at DC to 10 V output) (up to 2 analog volt meters (DC 0 to 10 V, input impedance 10 kΩ) can be connected.) * Allowable impedance for connection: Max 500 Ω (at DC 4 to 20 mA/DC 0 to 20 mA) * Gain adjustable range: 0 to 300%	Y	Y	N
	[11]	Analog input common	This terminal is the common terminal for analog input and analog/pulse output signals. The terminal is insulated from terminals [CM], [CMY].	Y	Y	Y

*1 For the Ethernet built-in type (E3N), this terminal symbol is [FM].

Table 2.2-10 Functional descriptions of control circuit terminals (continued)

<table>
<tr><th>Classification</th><th>Terminal symbol</th><th>Terminal name</th><th>Functional description</th><th>E3S</th><th>E3E</th><th>E3N</th></tr>
<tr><td rowspan="4">Transistor outputs</td><td>[Y1]</td><td>Transistor output 1</td><td rowspan="2">(1) Various signals (running signal, frequency reached signal, overload forecast signal, etc) set up by function code E20, E21 can be output. For details, refer to Chapter 5 “FUNCTION CODES.”
(2) The operating mode of the transistor output terminals [Y1], [Y2] and [CMY] can be switched to “ON (active ON) at signal output” or “OFF (active OFF) at signal output.”

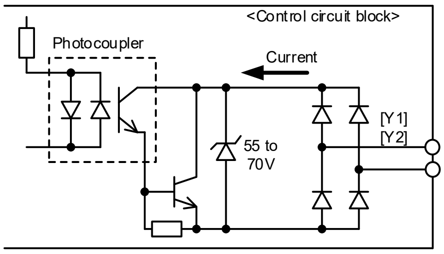
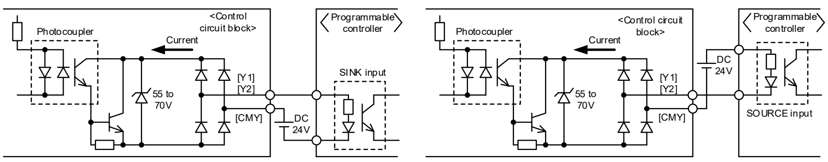
<Transistor output circuit specifications>


Figure 2.2-22 Transistor output circuit

Table 2.2-11
<table><tr><th colspan="2">Item</th><th>Maximum</th></tr><tr><td rowspan="2">Operating voltage</td><td>ON level</td><td>2 V</td></tr><tr><td>OFF level</td><td>48 V</td></tr><tr><td colspan="2">Max load current at ON</td><td>50 mA</td></tr><tr><td colspan="2">Leak current at OFF</td><td>0.1 mA</td></tr></table>
Figure 2.2-23 shows an example of the configuration of a circuit connected to a programmable controller.

Note
• Connect a surge absorbing diode between both terminals of the excitation coil when connecting control relays.
• When a power source is needed for the circuit to be connected, terminal [PLC] can be used as a power source terminal. In this case, terminal [CMY] must be shorted to terminal [CM].</td><td>Y</td><td>Y</td><td>Y</td></tr>
<tr><td>[Y2]</td><td>Transistor output 2</td><td>Y</td><td>Y</td><td>N</td></tr>
<tr><td>[CMY]</td><td>Transistor output common</td><td>This terminal is the common terminal for transistor output signals.
This terminal is insulated from terminals [CM] and [11].</td><td>Y</td><td>Y</td><td>Y</td></tr>
<tr><td colspan="3">Tip
■ When connecting the programmable controller to terminals [Y1], [Y2]
The circuit configuration example for connecting the inverter transistor output to the programmable controller is shown in Figure 2.2-23. Circuit (a) shows the programmable controller input circuit as SINK input and circuit (b) shows as SOURCE input.


(a) Connection diagram for SINK input type programmable controller
(b) Connection diagram for SOURCE input type programmable controller
Figure 2.2-23 Example of connection circuit configuration with the programmable controller</td><td></td><td></td><td></td></tr>
</table>

Table 2.2-10 Functional descriptions of control circuit terminals (continued)

Classification	Terminal symbol	Terminal name	Functional description	E3S	E3E	E3N
Contact output	[30A] [30B] [30C]	Batch alarm output	(1) When the inverter stops due to an alarm, output is generated on the relay contact (1C). Contact rating: AC250 V 0.3 A cosφ = 0.3, DC48 V 0.5 A (2) With the function code E27, you can select and output the same signals as with the terminal [Y1]. (3) Terminals can be switched to "Terminals [30A] to [30C] shorted (excitation: active ON) at ON signal output" or "Terminals [30A] to [30C] open (non-excitation: active OFF) at ON signal output."	Y	Y	Y
Communication	[DX+] [DX-] [SD]	RS-485 communications Port 2	(1) Can be used to connect a computer, programmable controller, etc by RS-485 communication. (For details on terminating resistor, refer to "2.2.7 Switching switches.") (For details on recommended rod terminals, refer to "2.2.6 [1] Recommended wire size (control circuit terminals).")	Y	Y	N
Grounding		Grounding terminal for Ethernet	To be connected to the [G] terminal of the inverter to connect the shield of the Ethernet communication cable to FG. Use a cable as short as possible.	N	N	Y

External power supply input terminals

Table 2.2-12 Functional descriptions of control circuit terminals

Classification	Terminal symbol	Terminal name	Functional description	E3S	E3E	E3N
External power supply	[P24]	DC 24 V power supply input	(1) Power supply input to establish Ethernet communication. It is possible to establish Ethernet communication using this power supply input even if the inverter main power supply is shut off. Input voltage range: DC +22 to +26 V Consumption current: 200 mA max. Note: It cannot be used for backup purposes as a control power auxiliary input, as with USB port bus power. Since the same precautions as with the bus power apply, refer to the Precautions in section 2.4 .	N	N	Y
	[N24]	DC 24 V power supply common	Common terminal for terminal [P24].	N	N	Y

RS-485 communication connector

Table 2.2-13 Functional descriptions of control circuit terminals

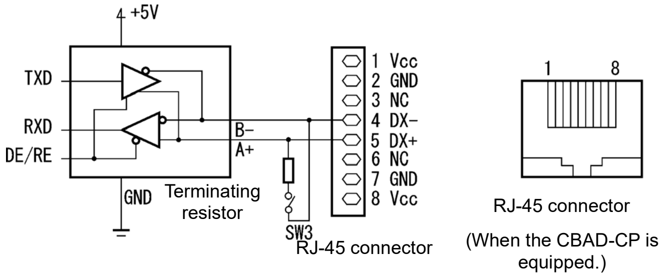
<table>
<tr><th>Classification</th><th>Terminal symbol</th><th>Terminal name</th><th>Functional description</th><th>E3S</th><th>E3E</th><th>E3N</th></tr>
<tr><td rowspan="3">Communication</td><td>RJ-45 connector for keypad connection</td><td>RS-485 communication port 1 (for keypad connection)</td><td>The keypad relay adapter CBAD-CP (optional) becomes RS-485 communication port 1 when installed, and can be used for the following purposes.
(1) It can be used for remote connection to the keypad. The keypad power is supplied from the inverter via an extension cable for remote operation. When using an extension cable, set the SW2 terminating resistor to ON.
(2) It can be used to connect to a PC, programmable controller, etc. for RS-485 communication. (For details on terminating resistors, refer to "2.2.7 Switching switches.")


Figure 2.2-24 RJ-45 connector pin configuration
(When CBAD-CP is equipped)

Note
• Pins 1, 2, 7, and 8 are assigned as the power supply sources for the keypad.
When connecting this RJ-45 connector to other devices, do not use these pins.
• Do not connect PC LAN ports, Ethernet hubs, or telephone lines to the RJ-45 connector. Otherwise, it may damage the inverter and the connected device.
Failure to observe this could result in fire.</td><td>Y</td><td>Y</td><td>N</td></tr>
<tr><td>USB connector</td><td>USB port</td><td>This is a USB connector (Mini-B specification) for connecting to a computer. It can be used to edit, transfer, and verify function codes, perform test runs for the inverter, and monitor the inverter states using the inverter support loader (FRENIC Loader).

*For more details, refer to Chapter 9 "9.2 FRENIC Loader Overview."</td><td>Y</td><td>Y</td><td>Y</td></tr>
<tr><td>RJ-45 connector for Ethernet connection</td><td>Ethernet communication
Port 1
Port 2</td><td>This is an input terminal to connect a programmable controller or another device using Ethernet communication.</td><td>N</td><td>N</td><td>Y</td></tr>
</table>

Note

- The control circuit terminal lines should be routed as far as possible from the main circuit routing. Malfunction may occur due to noise.
- To prevent direct contact with the main circuit live sections (such as the main circuit terminal block), route the control circuit wiring inside the inverter as bundles using cable ties.

2.2.7 Switching switches

WARNING

Switching the various switches should be conducted after more than 5 minutes has elapsed since power is shut off. Confirm that the LED monitor and the charge lamp are turned off, and that the direct current intermediate circuit voltage between the main circuit terminals [P(+)]-[N(-)] is below the safe voltage (below DC+25 V) with a tester before switching the switches.

Failure to observe this could result in electric shock.

The I/O terminal specifications can be changed, such as switching the analog output form, by switching the switches on the PCB (Figure 2.2-13 and Figure 2.2-14 Switch locations).

To switch the switches, remove the front cover so that the control PCB is visible.

Refer to “2.2.2 Removal and attachment of the front cover and wiring guide” to remove the front cover and to open/close the keypad case.

Functional descriptions of the switches are explained in Table 2.2-14.

Table 2.2-14 Functional descriptions of switches Y: Equipped; N: Not equipped

<table>
<tr><th>Switch Symbol</th><th>Functional description</th><th>E3S</th><th>E3E</th><th>E3N</th></tr>
<tr><td>SW1</td><td><Digital input terminal SINK/SOURCE switch>
• This is the switch used to switch between the SINK/SOURCE sides of the digital input terminals [X1] to [X5], [FWD], and [REV].
• The switch is set to SINK by default. In this manual, explanations are given assuming that the switch is set to SINK unless otherwise mentioned.</td><td>Y</td><td>Y</td><td>Y</td></tr>
<tr><td>SW2</td><td><Switch to change the RS-485 communication port 1 terminating resistor (RS-485 communication port (on the control PCB))>
• With RS-485 communication, move the switch to the ON position when the inverter is located at either end of the communication network.</td><td>Y</td><td>Y</td><td>N</td></tr>
<tr><td>SW3
SW4</td><td><Switch to change terminal [C1] input setting to current/voltage/PTC thermistor>
This switch changes the input type for terminal [C1].
<table>
<tr><th>Input type</th><th>SW3</th><th>SW4</th><th>H26</th></tr>
<tr><td>Current input (factory default)</td><td>C1 side</td><td>AI side</td><td>0</td></tr>
<tr><td>Voltage input</td><td>V2 side</td><td>AI side</td><td>0</td></tr>
<tr><td>PTC thermistor input</td><td>C1 side</td><td>PTC side</td><td>1 (OH4 trip)
2 (“THM” output, continuous running)</td></tr>
</table></td><td>Y</td><td>Y</td><td>Y</td></tr>
<tr><td>SW5</td><td><Switch to change terminal [FM1] *1 output setting to current/voltage/pulse>
This switch changes the output type for terminal [FM1] *1. When operating this switch, also change function code F29.
Table 2.2-15
<table>
<tr><th>Output type</th><th>SW5</th><th>F29</th></tr>
<tr><td>Current output</td><td>FMI side</td><td>1 (4 to 20 mA)
2 (0 to 20 mA)</td></tr>
<tr><td>Voltage output (factory default)</td><td>FMV side</td><td>0</td></tr>
<tr><td>Pulse output</td><td>FMP side</td><td>3</td></tr>
</table></td><td>Y</td><td>Y</td><td>Y</td></tr>
</table>

<table>
<tr><th>Switch Symbol</th><th>Functional description</th><th>E3S</th><th>E3E</th><th>E3N</th></tr>
<tr><td>SW6</td><td><Switch to change the RS-485 communication port 2 terminating resistor (RS-485 communication port (on the terminal board))>
Move the switch to the ON position when the inverter is located at either end of the communication network.</td><td>Y</td><td>Y</td><td>N</td></tr>
<tr><td>SW7</td><td><Switch to change terminal [FM2] output setting to voltage/current>
This switch changes the output type for terminal [FM2]. When operating this switch, also change function code F32.

Table 2.2-16
<table>
<tr><th>Output type</th><th>SW7</th><th>F32 data</th></tr>
<tr><td>Voltage output (factory default)</td><td>FMV2 side</td><td>0</td></tr>
<tr><td>Current output</td><td>FMI2 side</td><td>1 (4 to 20 mA)
2 (0 to 20 mA)</td></tr>
</table></td><td>Y</td><td>Y</td><td>N</td></tr>
<tr><td>SW9
(bipolar)</td><td><EN signal disabling switch>
This is the switch to disable/enable the terminals [EN1] and [EN2]. When using the functional safety input terminals [EN1] and [EN2], always set both the upper and lower poles of this switch to the OFF side.
Caution: When the logic differs on the upper and lower poles of the switch, the ECF alarm will occur and the inverter will not be able to operate.
Table 2.2-17
<table>
<tr><th rowspan="2">Input type</th><th colspan="2">SW9</th></tr>
<tr><th>Lower [EN1]</th><th>Upper [EN2]</th></tr>
<tr><td>Disable terminals [EN1] and [EN2]</td><td>ON side</td><td>ON side</td></tr>
<tr><td>Enable terminals [EN1] and [EN2]</td><td>OFF side</td><td>OFF side</td></tr>
</table></td><td>Y</td><td>Y</td><td>Y</td></tr>
<tr><td>ID SW
x10
x1</td><td><IP address configuration switches>
These are rotary switches for configuring the IP address.
For details, refer to Chapter 9 “9.3.4 [1] Configuring the IP address.”</td><td>N</td><td>N</td><td>Y</td></tr>
</table>

*1 For the Ethernet built-in type (E3N), this terminal symbol is [FM].

For the switch locations on the control PCB, refer to “Figure 2.2-13 E3S/E3E terminal block and switches on PCB” and “Figure 2.2-14 E3N terminal block and switches on PCB.”

Table 2.2-18 Switching positions and default settings of the switches

	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW9
Variation range	SINK SOURCE	OFF ON	C1 V2	AI PTC	FMI FMV FMP	OFF ON	FMV2 FMI2	ON OFF
Factory default	SINK *1	OFF	C1	AI	FMV	OFF	FMV2	ON

(*1) The factory default setting for SW1 of FRN****E3E-4G is “SOURCE”.

Note Use a pair of tweezers or another tool with a thin tip to set the switches and pay attention not to touch other electronic parts. The switches are in the open position when the slider is in the middle, so make sure the switches are securely set to one extremity.

2.3 Attachment and Connection of Keypad

2.3.1 Parts required for connection

The following parts are necessary when attaching the keypad to locations other than the inverter main body.

Part name	Type	Remarks
Keypad extension cable (Note 1)	CB-5S, CB-3S, CB-1S	Three lengths available (5 m, 3 m, 1 m) (3.3 ft, 9.8 ft, 16.4 ft)
Keypad fixing screws	M3×□ (Note 2)	2 screws are required.
Keypad relay adapter, Rear mounting adapter	CBAD-CP	

(Note 1) When using commercially available LAN cable, use 10BASE-T/100BASE-TX straight cables (below 20 m) which meet the U.S. standards for ANSI/TIA/EIA-568A category 5.

Recommended LAN cable

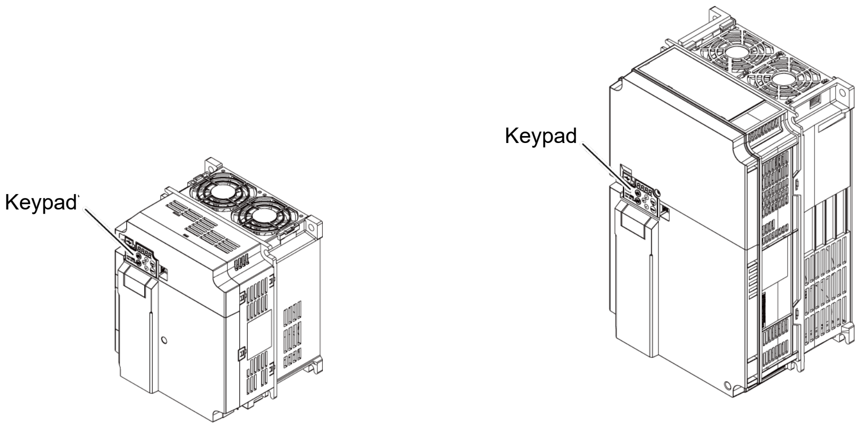
Manufacturer: Sanwa Supply, Inc.
Type: KB-10T5-01K (for 1 meter (3feet))
KB-STP-01K (for 1 meter (3feet)) (shielded cable when conforming to EMC directive)

(Note 2) When attaching to paneling, use a fixing screw of appropriate length to the panel thickness.

2.3.2 Attachment procedure

The keypad can be attached in the following ways.

- ■ Attach to the inverter main body (refer to Figure 2.3-1 (a), (b))
- ■ Attach to the paneling (refer to Figure 2.3-2)
- ■ Operate the keypad remotely, by hand (refer to Figure 2.3-3)



(a) FRN0069E3S-2G (b) FRN0072E3S-4G

Figure 2.3-1 Attaching the keypad to the inverter main body

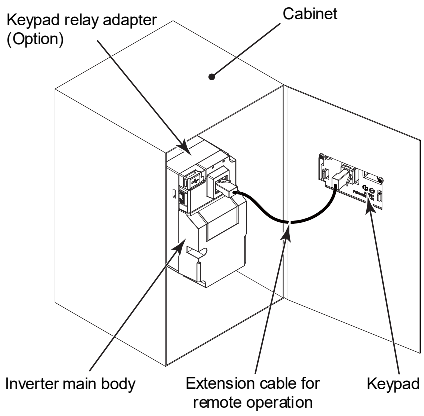


Figure 2.3-2 Attaching the keypad on the Paneling

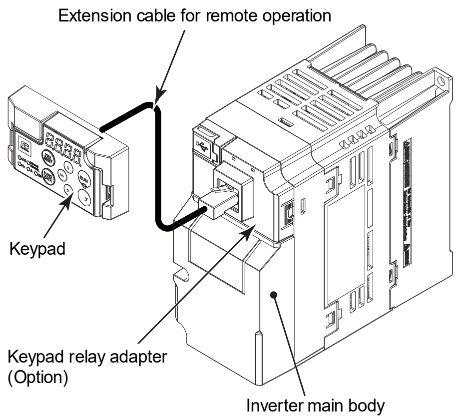


Figure 2.3-3 Operating the keypad remotely, by hand

■ **Attachment to the paneling**

(1) Squeeze the hooks (2) shown in Figure 2.3 4 and pull the keypad towards you to remove it.

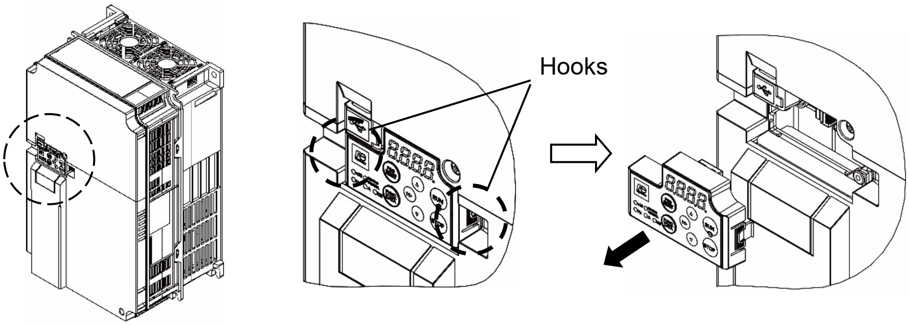


Figure 2.3-4 Removal of the keypad

(2) Attach the relay connector of the CBAD-CP to the inverter main body. (Refer to Figure 2.3 5.)

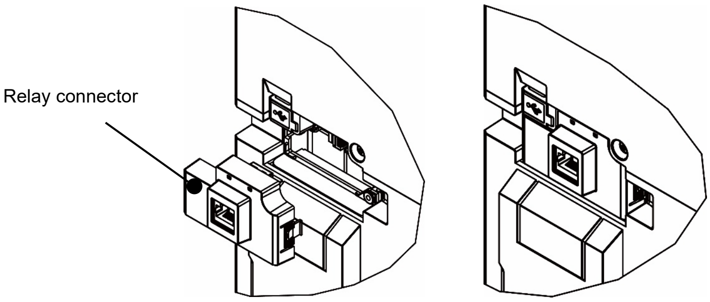


Figure 2.3 5 Attachment of the relay connector

(3) Attach the rear mounting adapter of the CBAD-CP to the keypad main body.

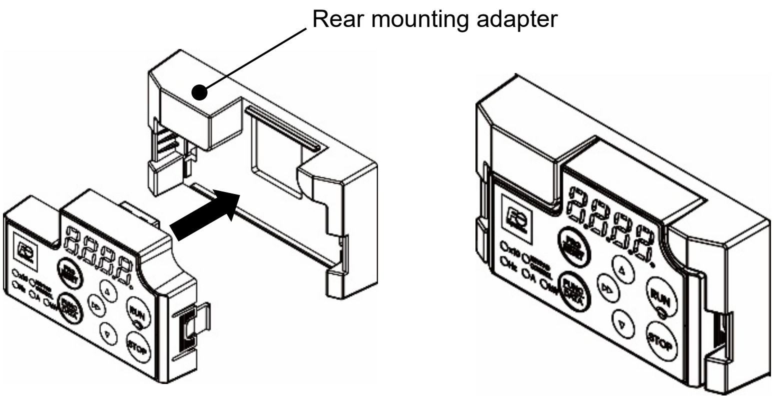
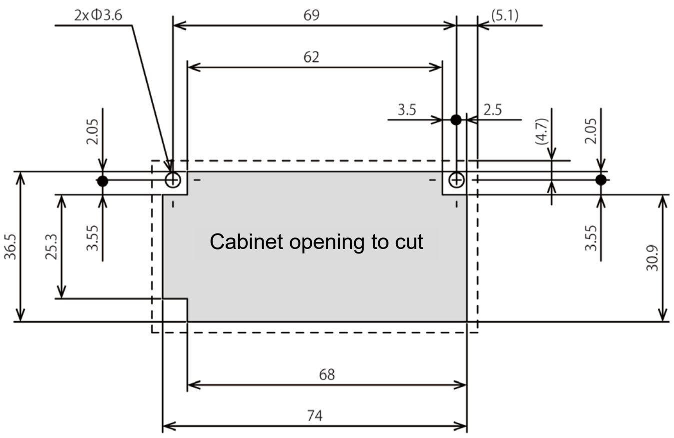


Figure 2.3-6 Attachment of the keypad

(4) Cut the paneling to attach the keypad, as shown in Figure 2.3-7.

(Unit: mm)



Cabinet cut dimensions (arrow A)

Figure 2.3-7 Fixing screw positions and the dimensions of the paneling to cut

(5) Fix the keypad to the cabinet using 2 keypad rear cover fixing screws. (Refer to Figure 2.3-8) (tightening torque: 0.7 N•m (6.2 lb-in))

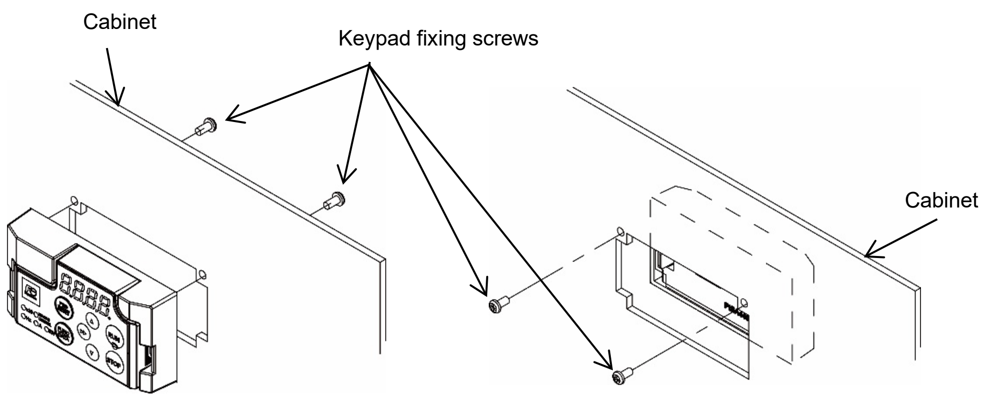


Figure 2.3-8 Attachment of the keypad

(6) Connect the extended cable for remote operation (CB-5S, CB-3S, CB-1S) or the commercially available LAN cable (straight) to the keypad RJ-45 connector and the inverter main body RJ-45 connector (modular jack). (Refer to Figure 2.3-9.)

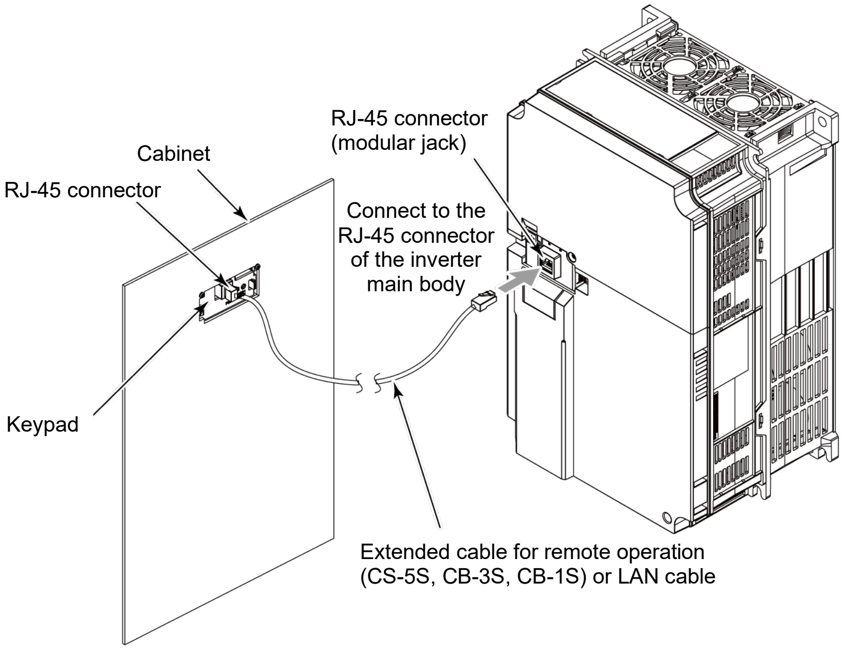


Figure 2.3-9 Connection of the extension cable or the commercially available LAN cable between the keypad and the inverter main body

⚠CAUTION
Do not connect the inverter to PC LAN ports, Ethernet hubs, or telephone lines. The inverter and the connected instrument may be damaged. **Risk of fire and risk of accidents exist**

■ Operating remotely, by hand

Connect following the procedure "■ Attachment to the paneling" in (1) to (3) and (6).

■ Removing the keypad from the rear mounting adapter

Insert a flathead screwdriver into the hook section of the keypad, tilt the screwdriver, and remove the keypad. (Refer to Figure 2.3-10.)

Recommended flathead screwdriver blade tip shape: 0.7 mm × 3.5 mm (0.03 × 0.14 inches)

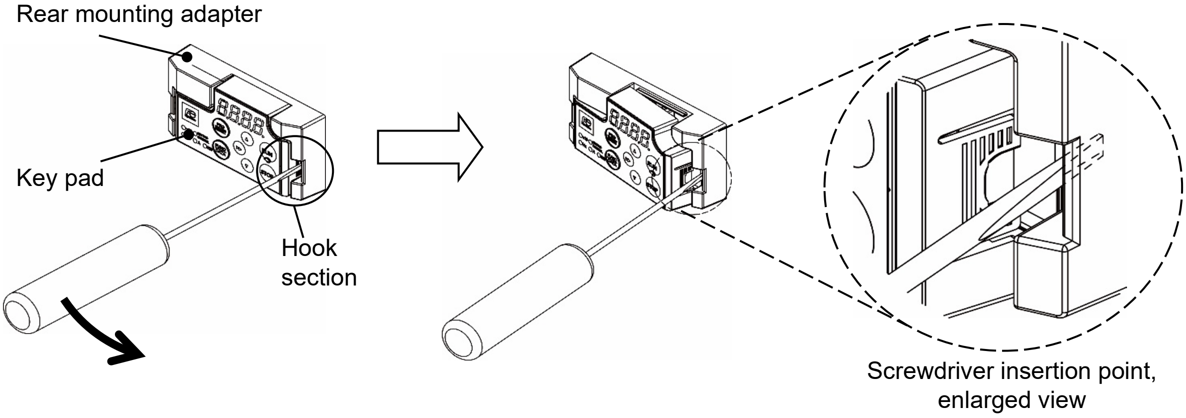
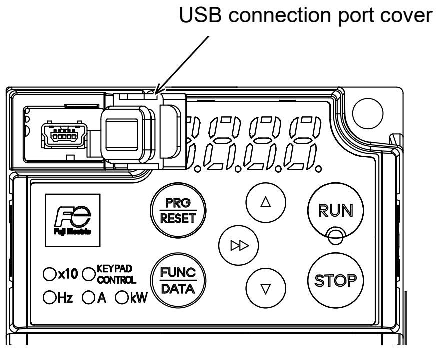


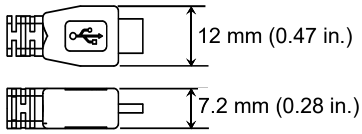
Figure 2.3-10 Removal of the keypad

2.4 USB port

There is a port (Mini-B) for USB cable connection on the surface of the inverter. Open the port cover as shown in the figure below to connect a USB cable.



Note USB cable
Use a cable with a connector of 12 mm (0.47 in.) or less in width and 7.2 mm (0.28 in.) or less in length.



By connecting the inverter directly to a PC with a USB cable, you will be able to use the FRENIC Loader to edit, check, and manage inverter function codes, monitor data during operation, acquire traceback data, carry out remote operations such as running and stopping, and monitor data such as the maintenance data and alarms.

Refer to the FRENIC Loader Instruction Manual for how to use the FRENIC Loader.

The following operations are also possible using bus power from the USB port when the inverter main power supply is shut off.

- Reading and writing of function codes using the keypad, checking of alarm history and other information, and data copying (a keypad supporting data copy (option) is required.)
- Editing, checking, and management of function codes, and acquisition of traceback data using the FRENIC loader

Note The operation of functions that use the main power supply (restart after momentary power failure, lifetime measurement, etc.) may vary depending on the availability of USB port bus power. Test runs should be performed with the same conditions as in normal operation.

Note USB port bus power cannot be used for backup purposes as a control power auxiliary input. When only bus power is used to supply power, the following specific restrictions apply.

- When the keypad is used to change the function code settings, set “2” for the communication data storage selection (y97) and save the function code setting to nonvolatile memory (all save). (After saving all data, the y97 data returns to 1.)
- If the bus power is shut off while changing or operating the function code settings, the Er1 or ErF alarm may occur. In this case, the initialization of all data in H03=1 is required. For details, refer to Chapter 6 “TROUBLESHOOTING.”
- The inverter monitor values (current, voltage, temperature, etc.) are set to “0” or “undefined.”
- The digital and analog input terminals do not operate and are handled as open.
- The digital and analog output terminals do not operate.
- RS-485 communication (Ch2) cannot be used.
- The option card does not operate.

Chapter 3
OPERATION USING THE KEYPAD

This chapter describes inverter keypad operation.

In addition to the keypad attached to the inverter main body (TP-M3), the optional remote operation keypad (TP-E2) and multi-function keypad (TP-A2SW) may also be used. Unless otherwise noted, this manual describes the operation of the keypad attached to the inverter main body. For details on the remote operation and multi-function keypads, refer to their respective instruction manuals.

Note The Ethernet built-in type (E3N) is not equipped with a keypad (and cannot be connected to the remote operation or multi-function keypads). For details on the monitor display content, refer to Chapter 9 "9.3.8 About the display content of Ethernet built-in type (E3N)."

Contents

3.1 Names and Functions of Keypad Components

The keypad allows you to run and stop the inverter, display various data, configure function code data, and monitor I/O signal states, maintenance information and alarm information.

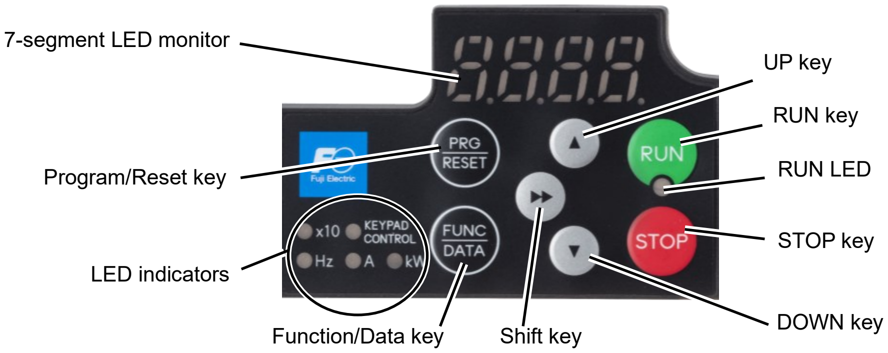


Figure 3.1-1 Keypad external appearance and name of each part

Table 3.1-1 Names of each keypad component and overview of functions

Item	LED Indicator and Keys	Functions
Data display		This is a 4-digit, 7-segment LED monitor. Displays the following contents based on the operation mode. ■ In Running mode: Running status information (e.g., output frequency, current, and voltage) When a warning occurs, the warning code (refer to Section 3.3.2 is displayed. ■ In Programming mode: Menus, function codes and their data ■ In Alarm mode: Alarm code, which identifies the alarm factor that has activated the protective function.
Operation keys	PRG RESET	Switches operation modes. ■ In Running mode: Pressing this key switches the inverter to Programming mode. (Holding down the key brings back the initial display.) ■ In Programming mode: Pressing this key switches the inverter to Running mode. ■ In Alarm mode: Pressing this key after removing the alarm factor resets the alarm and switches back to Running mode.
	FUNC DATA	Performs the following operations. ■ In Running mode: Pressing this key switches the information to be displayed concerning the status of the inverter (output frequency (Hz), output current (A), output voltage (V), etc.). ■ In Programming mode: Pressing this key displays the function code or confirms the data. ■ In Alarm mode: Pressing this key displays the details of the problem indicated by the alarm code that has come up on the LED monitor.
	RUN	Press this key to run the motor (when performing keypad operation).
	STOP	Press this key to stop the motor (when performing keypad operation).
	▲/▼	Press these keys to select the setting items and change the function code data displayed on the LED monitor.

<table>
<tr><th>Item</th><th>LED Indicator and Keys</th><th>Functions</th></tr>
<tr><td></td><td></td><td>■ In Running mode: Functions assigned with function code E70 can be used.
Hold down (for 1 second) to turn the function ON and OFF
The function is always OFF when the power is turned ON.
For details, refer to “3.3.7 Switching between remote and local modes”.
■ In Programming mode
While menu is displayed: Jumps to the next menu number.
While function code is displayed: Jumps to the displayed number +10.
While setting numerical values: Moves the cursor digit to the right.
■ In Alarm mode: The alarm detailed information number shifts +10.</td></tr>
<tr><td rowspan="5">LED Indicators</td><td>RUN
(green)</td><td>Lights up when running with a run command entered by the RUN key, by terminal command “FWD” or “REV”, or through the communications link.</td></tr>
<tr><td>KEYPAD CONTROL
(green)</td><td>The keypad RUN key lights up when activated as a run command.
In Alarm mode, however, pressing the key cannot run the inverter even if this indicator is lit.
Blinks every second in local mode.</td></tr>
<tr><td rowspan="2">Unit LEDs
(3 red LEDs)</td><td>Hz, A, kW, r/min, m/min:
These three LED indicators identify the unit of the numerals displayed on the LED monitor in Running mode by combination of their lit and unlit states. For details, refer to “3.3.1 Running status monitoring.”</td></tr>
<tr><td>PRG. MODE:
While the inverter is in Programming mode, the LEDs for Hz and kW light up.
(●Hz ○A ●kW)</td></tr>
<tr><td>x10 LED
(red)</td><td>Lights when the data to display exceeds 9999. When this LED lights, the actual value is “the displayed value x 10.”
Example: If data is “12,345,” the LED monitor displays 1234 and the x10 LED lights up, meaning that “1,234 x 10 = 12,340.”</td></tr>
</table>

■ LED monitor

In Running mode, the LED monitor displays running status information (output frequency, current or voltage); in Programming mode, it displays menus, function codes and their data; and in Alarm mode, it displays an alarm code which identifies the alarm factor that has activated the protective function.

If one of LED4 through LED1 is blinking, it means that the cursor is at this digit, allowing you to change it.

If the decimal point of LED1 is blinking, it means that the currently displayed data is a PID command value, not the frequency data usually displayed.

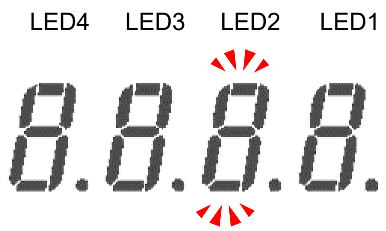


Figure 3.1-2 7-segment LED monitor (LED 2 is blinking)

Table 3.1-2 7-segment LED monitor display

Character	LED indicator	Character	LED indicator	Character	LED indicator	Character	LED indicator
0	0	9	9	I *	I or I	R	r
1	1	A	A	J	J	S	S
2	2	B	b	K	K	T *	T or t
3	3	C *	C or c	L	L	U *	U or u
4	4	D	d	M	M	V *	U or u
5	5	E	E	N	n	W	W
6	6	F	F	O *	O or o	X	X
7	7	G *	G or 9	P	P	Y	y
8	8	H *	H or h	Q	q	Z	Z
Special characters and symbols (minus and underscore) display							
-	-	_	_	[	[	]	]
%	% or L						

*Upper case or lower case letters are used depending on the display content.

3.2 Overview of Operation Modes

The FRENIC-Ace features the following three operation modes.

Table 3.2-1 Operation modes

Operation mode	Description
Running mode	When powered ON, the inverter automatically enters this mode. This mode allows you to specify the reference frequency, PID command value, etc., and run/stop the motor with the RUN/STOP keys. It is also possible to monitor the running status in real time. If a warning occurs, the warning code (refer to Section 3.3.2 appears on the LED monitor.
Programming mode	This mode allows you to configure function code data and check a variety of information relating to the inverter status and maintenance. * The operation continues even if the mode is changed to the Programming mode with the PRG/RESET key during operation. The inverter can also be run or stopped while in the Programming mode.
Alarm mode	If an alarm condition arises, the inverter automatically enters Alarm mode in which you can view the corresponding alarm code* and its related information on the LED monitor. * Indicates the alarm condition. For details, first refer to "Table 6.1-1 Error detection (alarms/warnings)" in Chapter 6 "6.1 Protective Function," and then read the troubleshooting of each alarm.

Figure 3.2-1 shows the status transition of the inverter between these three operation modes.

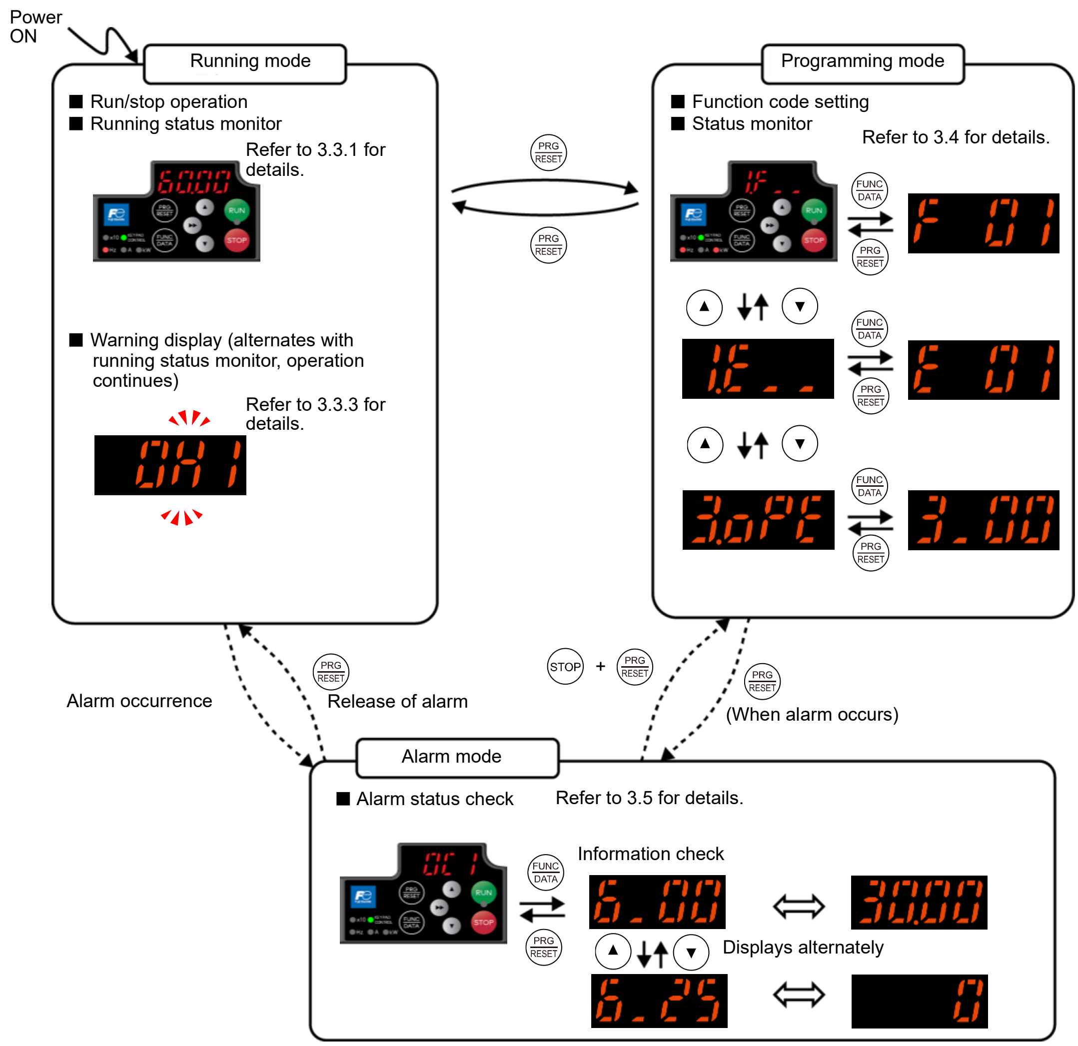


Figure 3.2-1 Status transition between operation modes

Tip **Simultaneous keying**

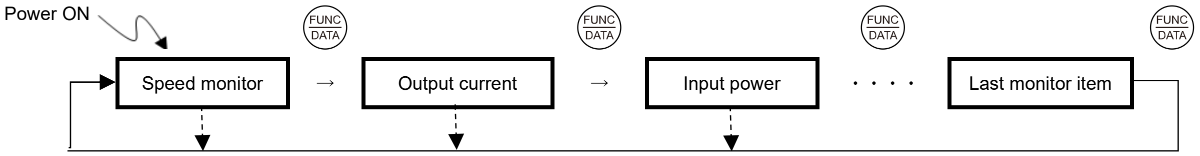
Simultaneous keying means pressing two keys at the same time. The simultaneous keying operation is expressed by a "+" letter between the keys throughout this manual.

For example, the expression "STOP and PRG/RESET keys" stands for pressing the STOP key with the PRG/RESET key held down .

3.3 Running mode

3.3.1 Running status monitoring

In Running mode, the 17 items listed below in Table 3.3-1 can be monitored. Immediately after the inverter is turned on, the monitor item specified by function code E43 is displayed. Press the FUNC/DATA key to switch between monitor items.



Tip: Holding down the FUNC/DATA key brings back the initial display (the monitor items set with function code E43).

Table 3.3-1 Monitor items

Monitor items	Display sample on the LED monitor	LED indicator	Unit	Meaning of displayed value	Function code E43 data
Speed monitor	Function code E48 specifies what to be displayed on the LED monitor and LED indicators.				0
Output frequency 1	50.00	●Hz ○A ○kW	Hz	Output frequency (before slip compensation) (Hz)	(E48=0)
Output frequency 2	50.00	●Hz ○A ○kW	Hz	Output frequency (after slip compensation) (Hz)	(E48=1)
Reference frequency	50.00	●Hz ○A ○kW	Hz	Reference frequency (Hz)	(E48=2)
Motor speed	1500	●Hz ●A ○kW	r/min	Output frequency (Hz) × $\frac{120}{P01}$	(E48=3)
Load rotation speed	300.0	●Hz ●A ○kW	r/min	Output frequency (Hz) x E50/E39	(E48=4)
Feed speed (Line speed)	300.0	○Hz ●A ●kW	m/min	Output frequency (Hz) x E50/E39	(E48=5)
Constant feed time	50	○Hz ○A ○kW	min	$\frac{E50}{\text{Output frequency (Hz)} \times E39}$	(E48=6)
Speed (%)	50.0	○Hz ○A ○kW	%	$\frac{\text{Output frequency (Hz)}}{\text{Max.frequency}} \times 100$	(E48=7)
Output current	12.34	○Hz ●A ○kW	A	Current output from the inverter in RMS	3
Input power	10.25	○Hz ○A ●kW	kW	Input power to the inverter	9
Calculated torque (Note 1)	50	○Hz ○A ○kW	%	Motor output torque (Calculated value)	8
Output voltage (Note 2)	200U	○Hz ○A ○kW	V	Voltage output from the inverter in RMS	4
Motor output (Note 3)	9.85	○Hz ○A ●kW	kW	Motor output (kW)	16
Load factor (Note 4)	50L	○Hz ○A ○kW	%	Load factor of the motor in % with the rated output being at 100%	15
PID command value (Note 5) (Note 6)	10.00.	○Hz ○A ○kW	–	PID command/feedback amount converted to physical quantities of the object to be controlled (e.g. temperature) Refer to function codes J106 and J107 for details.	10
PID feedback value (Note 5) (Note 7)	9.00.	○Hz ○A ○kW	–		12
PID deviation (Note 5) (Note 7)	1.00.	○Hz ○A ○kW	–	PID command value and PID feedback value deviation converted into physical quantities of the object to be controlled	29
PID output (Note 5) (Note 6)	100.0.	○Hz ○A ○kW	%	PID output in % with the maximum frequency (F03) being at 100%	14
Timer (Note 10)	50	○Hz ○A ○kW	s	Remaining time for timer operation (when C21 =3)	13

● ON, ○ OFF

Table 3.3-1 Monitor items (continued)

Monitor items	Display sample on the LED monitor	LED indicator	Unit	Meaning of displayed value	Function code E43 data
Analog input monitor (Note 8)	82.00	○Hz ○A ○kW	–	An analog input to the inverter in a format suitable for a desired scale. Refer to the following function codes. Terminal [12]: C59, C60 Terminal [C1] (C1 function): C65, C66 Terminal [C1] (V2 function): C71, C72	17
Current position (Note 11)	765 4321.	○Hz ○A ○kW	–	Upper (with sign) and lower 4 digits are displayed alternately.	21
Positioning deviation (Note 11)	765 4321.	○Hz ○A ○kW	–	Upper (with sign) and lower 4 digits are displayed alternately.	22
Stop target position (Note 11)	765 4321.	○Hz ○A ○kW	–	Stop target position indicated with the user value. Upper (with sign) and lower 4 digits are displayed alternately.	28
Torque current (Note 9)	48	○Hz ○A ○kW	%	Torque current command value or calculated torque current	23
Magnetic flux command (Note 9)	50	○Hz ○A ○kW	%	Magnetic flux command value	24
Integral power consumption	100.0	○Hz ○A ○kW	kWh	$\frac{\text{Input watt-hour (kWh)}}{100}$	25
Torque bias	25	○Hz ○A ○kW	%	Torque bias value display	30
Customizable logic output (Note 13)	82.00	○Hz ○A ○kW	–	Display of output content for specific customizable logic step For details, refer to function codes U98 and U99.	32

● ON, ○ OFF

(Note 1) Calculated torque 100% is equal to the motor rated torque. For the calculation formula of the motor rated torque, refer to D.2 “Calculation formulas" (1) in Appendix D "Conversion to Non-SI Units.”

(Note 2) When the output voltage is displayed, U is displayed as the lowest digit on the LED monitor, standing for the unit symbol V (volt).

(Note 3) When the LED monitor displays the motor output, the unit LED indicator “kW” blinks.

(Note 4) When the LED monitor displays the load factor,; is displayed as the lowest digit on the LED monitor, standing for “%.”

(Note 5) These PID-related items appear only when performing PID control.

(Note 6) When the LED monitor displays a PID command or its output amount, the dot (decimal point) attached to the lowest digit of the 7-segment letter blinks.

(Note 7) When the LED monitor displays a PID feedback amount, the dot (decimal point) attached to the lowest digit of the 7-segment letter lights up.

(Note 8) The analog input monitor appears only when the analog input monitor function is assigned to one of the analog input terminals by one of function codes E61 to E63 or E66. Specify the unit with C58, C64, C70 and C84.

(Note 9) 0 (zero) appears under the V/f control.

(Note 10) During timer operation, only the function code C21 = 3 is displayed.

(Note 11) Displayed when position control is enabled.

(Note 13) Displayed only when U00 = 1 and U98 ≠ 0.

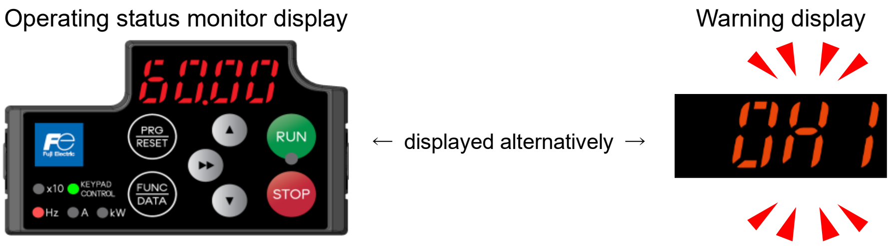
Tip The monitoring signals for the monitor items such as output frequency and output current can be filtered with function code E42 (LED display filter). Increase the E42 settings if the monitored values are unstable and unreadable due to load fluctuation, etc.
(Function code E42)

3.3.2 Monitoring warnings

When the inverter identifies abnormal states, alarms are separated into alarms, with which the inverter immediately trips, and warnings, with which the operation continues and a warning is output (display and general-purpose output terminal). When a warning occurs, the running status monitor (frequency, etc.) and the warning code* are displayed alternatively on the LED monitor.

It is necessary to set the warning (“L-ALM”) targets with the function codes H81, H82, and H83. Assigning the L-ALM (= 98) to any one of the general-purpose output terminals enables the inverter to output the “L-ALM” signal on that terminal upon occurrence of a warning.

Example: “OH1” is displayed when cooling fin overheat OH1 has been assigned to a warning.



For details on the warning targets, refer to Chapter 6 "TROUBLESHOOTING."

■ How to check past warning contents

Warning contents can be checked with 5_37 (warning contents (last)) to 5_39 (warning contents (third last)), 5_64 (warning contents (fourth last)) and 5_65 (warning contents (fifth last)).

For details on the menu transition in “Maintenance Information,” refer to “3.4.5 Reading maintenance information: “Maintenance Information: 5.CHE .”

■ How to reset a warning

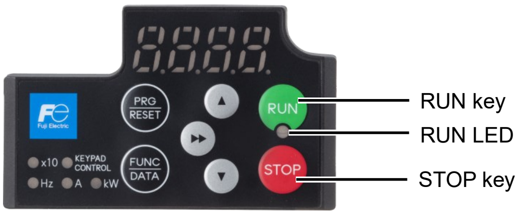
Use the function codes H81, H82, or H83 or refer to Chapter 6 "6.4 If a Warning Code Appears on the LED Monitor" to remove the warning condition.
When the warning condition has been removed, the warning will no longer be displayed and “L-ALM” also turns off on the general-purpose output.

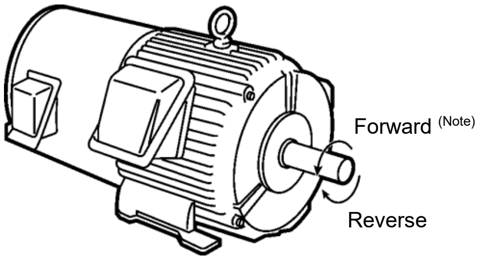
3.3.3 Running or stopping the motor with the keypad

By factory default, pressing the (RUN) key starts running the motor in the forward direction and pressing the (STOP) key decelerates the motor to stop. The (RUN) key is enabled only in Running mode.

When the inverter is running, the RUN LED lights up.

To run the motor in the reverse direction or for reversible operation, change the data of function code F02.





Note: The rotation direction of IEC-compliant motors is opposite to the one shown above.

Table 3.3-2 Relationship Between the Function Code F02 "Run/Operation" and the (RUN) Key

Function code F02 data	Motor rotation direction
0	In the direction commanded by terminal [FWD] or [REV]
1	Disable (The motor is driven by terminal [FWD] or [REV] command)
2	In the forward direction
3	In the reverse direction

Tip: During a test run from the Loader, the test run can be stopped using the (STOP) key. Set y99 again to resume the test run after it has been stopped.

3.3.4 Setting the reference frequency from the keypad

You can set the desired reference frequency with the (▲)/(▼) keys on the keypad. It is also possible to set the reference frequency as load rotation speed, motor speed or speed (%) by setting function code E48.

Using the keypad to set the frequency (F01 = 0 (factory default) or 8)

(1) Set function code F01 to "0" (keypad operation using (▲)/(▼) keys) or "8" (keypad operation using (▲)/(▼) keys, balanceless-bumpless). When the keypad is set to Programming or Alarm mode, the reference frequency cannot be set using the (▲)/(▼) keys. You need to switch to Running mode to enable frequency setting with the (▲)/(▼) keys.

(2) Press the (▲)/(▼) key to display the current reference frequency. The lowest digit blinks.

(3) To change the reference frequency, press the (▲)/(▼) key again. The new setting can be saved into the inverter's internal memory.

Tip
- To set the reference frequency, first press the ▲/▼ key once. When the last digit blinks, each time the ▸▸ key is pressed, the cursor moves to the next higher digit where data can be changed. This cursor movement allows you to easily move the cursor to the desired digit and change the data of large values.
- Holding down the ▲/▼ key changes data from the last digit, and the data to be changed moves along to the highest digit.
- The reference frequency can be saved either automatically by turning the main power OFF or simply by pressing the FUNC/DATA key. You can choose either way using function code E64. The factory default is "0" (Automatic saving when main power is turned OFF).
- If you have set function code F01 to "0" or "8" but have selected a setting method other than Frequency setting 1 (i.e., Frequency setting 2, frequency command via communication, multistep frequency command, etc.), then you cannot use the ▲/▼ keys to change the current frequency setting even in Running mode.
- Setting F01 data to "8" (Keypad operation using ▲/▼ keys, balanceless-bumpless) enables balanceless-bumpless switching.

  Balanceless-bumpless switching refers to the function that makes the inverter inherit the current frequency that had been applied before the frequency setting source was switched to the keypad from any other source, providing smooth switching and shockless running.

3.3.5 Setting up PID commands from the keypad

You can set the desired PID commands with the ▲/▼ keys on the keypad.

[1] Settings under PID process control

To enable the PID process control, you need to set the J01 data to "1" or "2."

In the PID process control mode, the content that can be specified and checked using the ▲/▼ keys changes depending on the LED monitor content. If the LED monitor is set to the speed monitor, the item accessible is a manual speed command (reference frequency); if it is set to any other, the item is a PID process command.

Setting the PID process command with ▲/▼ keys

(1) Set the J02 data to "0" (▲/▼ keys on keypad).

(2) Set the LED monitor to something other than the speed monitor (E43=0) when the keypad is in Running mode. When the keypad is in Programming or Alarm mode, you cannot modify the PID process command with the ▲/▼ keys. To enable the PID process command to be modified with the ▲/▼ keys, first switch to Running mode.

(3) Press the ▲/▼ keys to display the PID process command. The lowest digit and its decimal point blink on the LED monitor.

(4) To change the PID process command, press the ▲/▼ keys again. The new setting can be saved into the inverter's internal memory.

Tip
- The PID process command can be saved either automatically by turning the main power OFF or simply by pressing the FUNC/DATA key. You can choose either way using function code E64.
- Even if multistep frequency is selected as a PID command ("PID-SS1 or PID-SS2" = ON), it is possible to set a PID command using the keypad.
- When function code J02 is set to any value other than "0," pressing the ▲/▼ keys displays, on the LED monitor, the PID command currently selected, but does not allow any change.
- On the LED monitor, the decimal point of the lowest digit is used to discriminate the PID-related data from the reference frequency. The decimal point blinks or lights when a PID command or PID feedback amount is displayed, respectively.

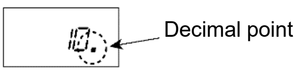


Table 3.3-3 PID process command manually set with ▲/▼ keys and requirements

PID control (Operation mode selection) J01	PID control (Remote command) J02	LED monitor E43	Multistep frequency "PID-SS2", "PID-SS2"	Display when ▲/▼ keys are on
1 or 2	0	Other than 0	ON or OFF	PID process command by keypad
	Other than 0			PID process command currently selected

Setting up the reference frequency with ▲/▼ keys under PID process control

When function code F01 is set to "0" (▲/▼ keys on keypad) and Frequency setting 1 is selected as a manual speed command (when disabling the frequency setting command via communications link, multistep frequency command, and PID control), switching the LED monitor to the speed monitor in Running mode enables you to modify the reference frequency with the ▲/▼ keys.

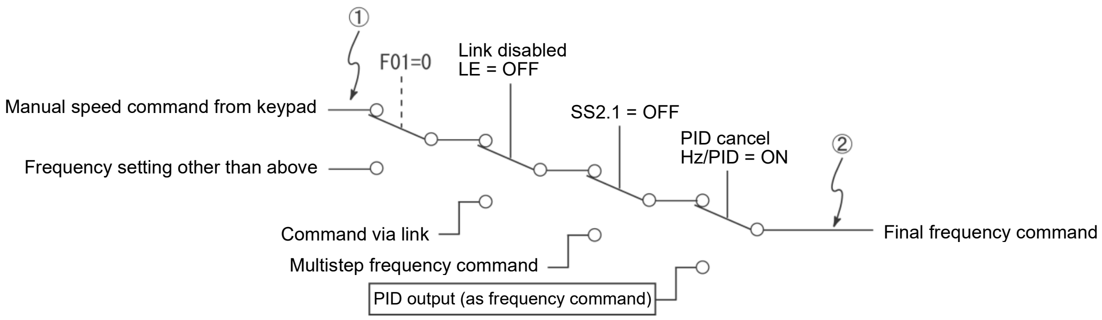
In Programming or Alarm mode, the ▲/▼ keys cannot be used to modify the reference frequency. You need to switch to Running mode to enable frequency setting with the ▲/▼ keys. Refer to Table 3.3-4 or the figure below. Table 3.3-4 "Manual speed command (frequency) and necessary settings for using the ▲/▼ keys" illustrates how the manual speed command entered via the keypad is translated to the final frequency command.

The setting procedure is the same as that for setting of a usual reference frequency.

Under other conditions that those mentioned above, the display changes as shown below when pressing the ▲/▼ keys.

Table 3.3-4 Manual speed command (frequency) and necessary settings for using the ▲/▼ keys

PID control (Operation mode selection) J01	LED Monitor E43	Frequency setting 1 F01	Multistep frequency "SS2"	Multistep frequency "SS1"	Link operation selection "LE"	Cancel PID control "Hz/PID"	Display with the ▲/▼ keys
1 or 2	0	0	OFF	OFF	OFF	ON (PID disabled)	Manual speed command (frequency) set by keypad
		Other than the above					Manual speed command (frequency) currently selected
		Don't care				OFF (PID enabled)	PID output (as final frequency command)



[2] Settings under PID (dancer) control

To enable the PID (dancer) control, you need to set the J01 data to "3."

In the PID control mode, the content that can be specified and checked using the ▲/▼ keys changes depending on the LED monitor content.

When the LED monitor displays the speed monitor, the item accessible is the primary (frequency) setting; if it is set to any other, the item is the PID dancer position set point.

<u>Setting the PID dancer position set point with the ▲/▼ keys</u>

(1) Set the J02 data to "0" (▲/▼ keys on keypad).

(2) Set the LED monitor to something other than the speed monitor (E43=0) when the inverter is in Running mode. When the keypad is in Programming or Alarm mode, you cannot modify the PID dancer position set point with the ▲/▼ keys. To enable the PID dancer position set point to be modified with the ▲/▼ keys, first switch to Running mode.

(3) Press the ▲/▼ keys to display the PID dancer position set point. The lowest digit and its decimal point blink on the LED monitor.

(4) To change the PID dancer position set point, press the ▲/▼ keys again. The command you have specified will be automatically saved into the inverter's internal memory as function code J57 data. It is retained even if you temporarily switch to another PID command source and then go back to the via-keypad PID command. Furthermore, you can directly configure the settings with function code J57.

Tip

- Even if multistep frequency is selected as a PID command ("PID-SS1 or PID-SS2" = ON), it is possible to set a PID command using the keypad.
- When function code J02 is set to any value other than "0," pressing the ▲/▼ keys displays, on the LED monitor, the PID command currently selected, but does not allow any change.
- On the LED monitor, the decimal point of the lowest digit is used to discriminate the PID related data from the reference frequency. The decimal point blinks or lights up when a PID command or PID feedback amount is displayed, respectively.

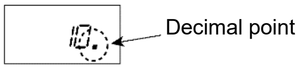


Table 3.3-5 PID commands using the ▲/▼ keys and necessary settings

PID control (Operation mode selection) J01	PID control (Remote command) J02	LED monitor E43	Multistep frequency "PID-SS2", "PID-SS2"	Display when ▲/▼ keys are on
3	0	Other than 0	ON or OFF	PID command by keypad
	Other than 0			PID command currently selected

Setting up the primary frequency setting with ▲/▼ keys under PID dancer control

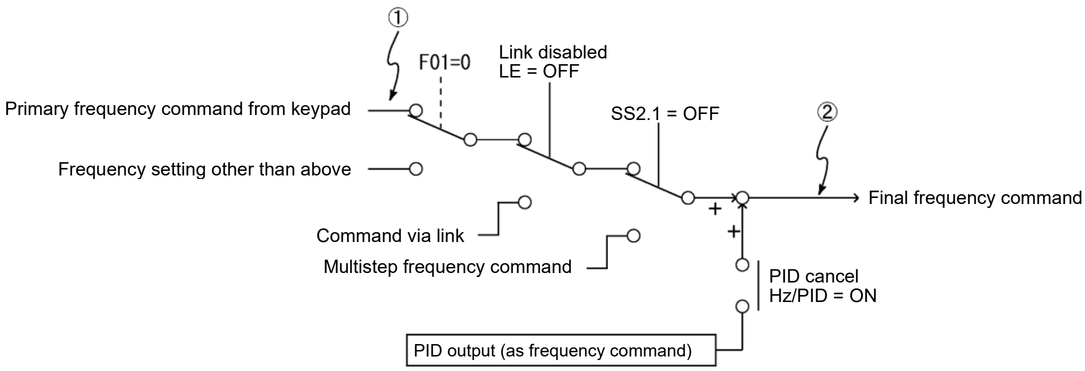
When function code F01 is set to “0” (▲/▼ keys on keypad) and Frequency setting 1 is selected as a primary frequency setting (when disabling the frequency setting via communications link, multistep frequency setting, and PID control), switching the LED monitor to the speed monitor in Running mode enables you to modify the primary frequency setting with the ▲/▼ keys. In Programming or Alarm mode, these cannot be used to modify the primary frequency setting. You need to switch to Running mode. Refer to the Table 3.3-6 or the figure below. Table 3.3-6 lists the combinations of the commands. The figure illustrates how the primary frequency setting entered via the keypad is translated to the final frequency command.

The setting procedure is the same as that for setting of a usual reference frequency.

Under other conditions that those mentioned above, the display changes as shown below when pressing the ▲/▼ keys.

Table 3.3-6 Primary (frequency) setting specified with ▲/▼ keys and necessary settings

<table>
<tr><th>PID control (Operation mode selection) J01</th><th>LED Monitor E43</th><th>Frequency setting 1 F01</th><th>Multistep frequency “SS2”</th><th>Multistep frequency “SS1”</th><th>Link operation selection "LE"</th><th>Cancel PID control “Hz/PID”</th><th>Display with the ▲/▼ keys</th></tr>
<tr><td rowspan="3">3</td><td rowspan="3">0</td><td>0</td><td>OFF</td><td>OFF</td><td>OFF</td><td rowspan="2">ON
(PID disabled)</td><td>Primary frequency setting from keypad
(Frequency setting)</td></tr>
<tr><td colspan="4">Other than the above</td><td>Primary (frequency) setting currently selected</td></tr>
<tr><td colspan="4">Don't care</td><td>OFF
(PID enabled)</td><td>PID output (as final frequency command)</td></tr>
</table>



3.3.6 Performing jogging operations with the keypad

This section provides the procedure for jogging the motor using the keypad.

Note If operation is set by external signal (function code F02 = 1), jogging cannot be performed using the keypad. When performing jogging using external signal input, assign the input terminal command “JOG” to terminals [X1] to [X5], then turn “JOG” ON and input a run command. For details, refer to the descriptions of function codes E01 to E05 in Chapter 5 “5.3.2 E codes (Extension terminal functions).”

(1) Make the inverter ready to jog by following the steps below. (LED monitor should display JoG)

- Enter Running mode. (Refer to “3.2 Overview of Operation Modes.”)
- Press the “STOP and ▲” keys simultaneously. The LED monitor displays the jogging frequency for approximately one second and then displays JoG again.

Tip

- The frequency during the jogging operation is based on the function code C20 setting. Function codes H54 and H55 specify the acceleration/deceleration time, respectively. These function codes are only for the jogging operation. Enable them according to your needs.
- Alternatively, using the input terminal command “JOG” (“Ready for jogging”) switches between the normal operation state and ready-to-jog state. For details, refer to the descriptions of function codes E01 to E05 in Chapter 5 “5.3.2 E codes (Extension terminal functions).”
- Switching between the normal operation state and read-to-jog state with the (STOP and ▲) keys is possible only when the inverter is stopped.

(2) Jogging the motor.

- Hold down the RUN key while the motor jogs. To decelerate and stop the motor, release the RUN key.

(3) Exit the ready-to-jog state and return to the normal operation state.

- Press the “STOP and ▲” keys simultaneously.

3.3.7 Switching between remote and local modes

During normal operation, the inverter operates under remote mode and uses the operation method set to the inverter. During maintenance mode, the mode switches to local mode and the inverter is operated using the keypad. In local mode, the inverter is separated from the control system and all operations required to operate the inverter are performed from the keypad.

- Remote mode: Run and frequency commands are selected by function codes or source switching signals except "LOC" (Select local (keypad) command).
- Local mode: The command source is the keypad, regardless of the settings specified by function codes. The keypad takes precedence over the settings specified by communications link operation signals. In local mode, the KEYPAD CONTROL LED blinks every second.

The table below shows the input procedures of run commands from the keypad in the local mode.

Data for F02	Operation command setting method
0: Keypad operation (Rotation direction input: Terminal block)	The inverter can be run or stopped using the keypad RUN/STOP keys. The rotational direction is specified with the terminals [FWD] and [REV].
1: External signal	The inverter can be run or stopped using the keypad RUN/STOP keys. Rotation direction command is unnecessary. However, the inverter operates only in the forward direction, not in the reverse direction.
2 : Keypad operation (forward rotation)	
3: Keypad operation (reverse rotation)	The inverter can be run or stopped using the keypad RUN/STOP keys. Rotation direction command is unnecessary. However, the inverter operates only in the reverse direction, not in the forward direction.

The two following methods are available to switch between remote mode and local mode.

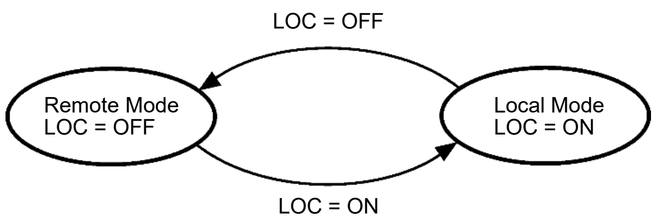
1. Assign data=35 "LOC" to the function code E70 and hold down the » key of the keypad.
2. To enable the switching, you need to assign "LOC" to any of the function codes E01 to E09, E98, or E99, and turn on the applicable digital input terminal.

Switching from remote to local mode automatically inherits the frequency settings used in remote mode.

If the motor is running at the time of the switching from remote to local, the keypad Run command will be automatically turned ON so that all the necessary data settings will be carried over.

If, however, there is a discrepancy between the settings used in remote mode and ones made on the keypad (e.g., switching from the reverse rotation in remote mode to the forward rotation only in local mode), the inverter automatically stops.

The transition paths between remote and local modes depend on the current mode and the value (ON/OFF) of "LOC," as shown in the status transition diagram given in the figure below. Also, refer to above table for details.



Transition between remote and local modes by LOC

3.3.8 Shift key function assignment

In Running mode, various functions can be assigned to the Shift key, as with the digital input terminals, based on the function code E70 setting. One of these functions is the switching function between remote and local modes mentioned above.

The factory default setting value is 100 (no function).

For details, refer to the descriptions of function code E70 in Chapter 5 "5.3.2 E codes (Extension terminal functions)."

3.4 Programming mode

The Programming mode provides you with the following functions--setting and checking function code data, monitoring maintenance information and checking input/output (I/O) signal status. The functions can be easily selected with the menu-driven system. Table 3.4-1 below lists menus available in Programming mode. The leftmost digit (numerals) of each letter string on the LED monitor indicates the corresponding menu number and the remaining three digits indicate the menu contents.

When the inverter enters Programming mode from the second time on, the menu selected last in Programming mode will be displayed.

Table 3.4-1 Menus Available in Programming Mode

Menu No.	Menu	LED monitor display	Main functions		Refer to:
1	Data Setting	1.F - -	F codes (Fundamental functions)	Selecting each of these function codes enables its data to be displayed/ changed. (Note 1)	Section 3.4.1
		1.E - -	E codes (Extension terminal functions)		
		1.C - -	C codes (Control functions)		
		(Omitted)			
		1.o2 -	o2 codes (Optional functions)		
		1.K - -	K code (Keypad functions)		
2	Data Checking	2.rEP	Displays only function codes that have been changed from their factory defaults. You can refer to or change those function code data. (Note 1)		Section 3.4.2
3	Drive Monitoring	3.oPE	Displays the running information required for maintenance or test running.		Section 3.4.3
4	I/O Checking	4. I_o	Displays external interface information.		Section 3.4.4
5	Maintenance Information	5.CHE	Displays maintenance information including cumulative run time.		Section 3.4.5
6	Alarm Information	6.AL	Displays the most recent four alarm codes. You can refer to the running information at the time when each alarm occurred.		Section 3.4.6
7	Data copying	7.CPY	Allows you to read or write function code data, as well as verify it. Available when the optional remote keypad TP-E2 is connected.		Section 3.4.7
8	Destination	8.dES	Setting the shipping destination region.		Section 4.4
9	Communication monitor	9.S - - 9.Add 9.dAt	Communication commands and monitor codes with the host device can be monitored.		Section 3.4.8
0	Favorites	0.Fnc	It is possible to display and change only the function codes registered as favorites by the user.*1		Section 3.4.9

(Note 1) The data cannot be changed when a decimal point "." is display after the last digit on the LED monitor. (Protected with a password.)

For details, refer to the descriptions of function code H99, H197, H198, and H199 in Chapter 5 "5.3.5 H codes (High-performance Functions)."

Tip Enter Programming mode to display menus. While cycling through the menus with the ▲/▼ keys, select the desired menu item with the FUNC/DATA key. Once the entire menu has been cycled through, the display returns to the first menu item.
Jump to the next menu number with the ⏩ key.

3.4.1 Setting function codes: "Data Setting: 1.F _ _ through 1.P _ _"

Menu number 1 "Data Setting" (1.F _ _ through 1.P _ _) in Programming mode allows you to configure all function codes.

Figure 3.4-1 shows the Menu transition and function code data change procedure in "Data Setting" menu.

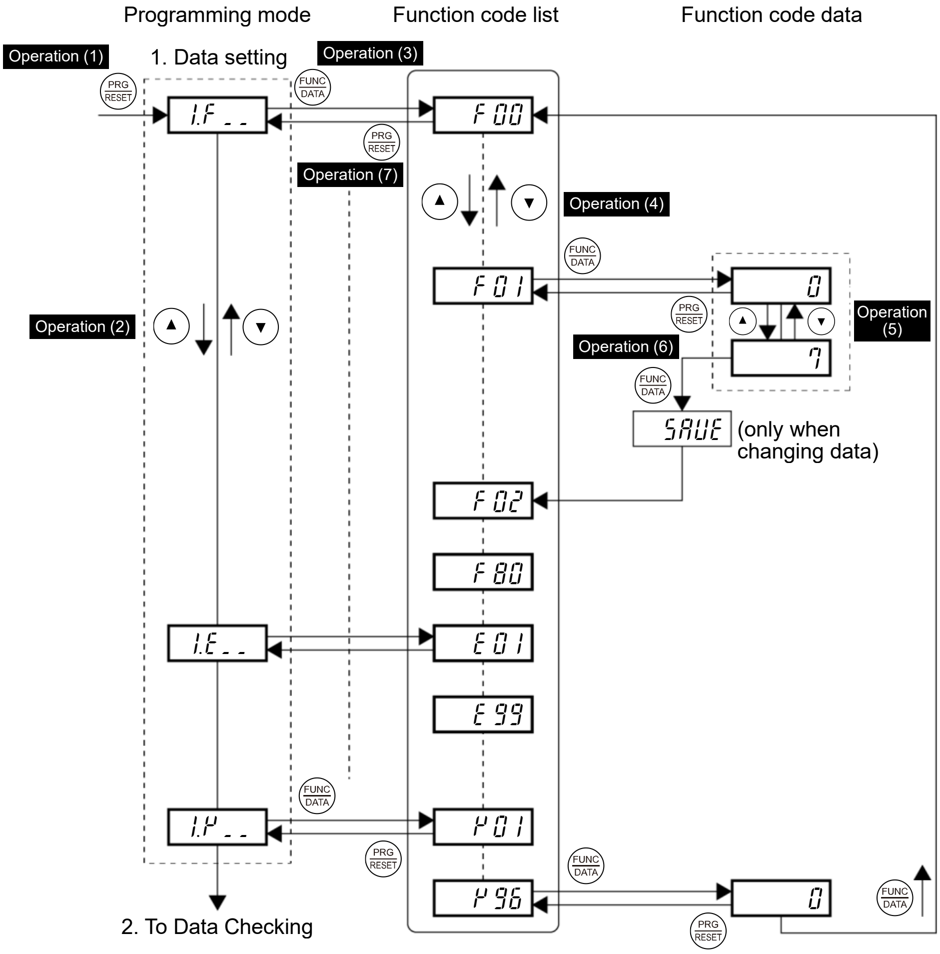


Figure 3.4-1 Menu transition and function code data change procedure in "Data Setting" menu

<u>Basic key operation</u>

Operation (1) Turn the inverter ON. It automatically enters Running mode. In that mode, press the PRG/RESET key to switch to Programming mode. The function selection menu appears.

Operation (2) Use the ▲/▼ keys to select the desired function code group from the choices 1.F _ _ through 1.P _ _.
Jump to 2. "Data Checking" by pressing the ►► key.

Operation (3) Press the FUNC/DATA key to proceed to the list of function codes for the selected function code group.

Operation (4) Use the ▲/▼ keys to display the desired function code, then press the FUNC/DATA key.
The data of the relevant function code appears.
Use the ►► key to skip 10 function code numbers. You return to the beginning of the same function code group after you reach the end.

Operation (5) Change the function code data using the ▲/▼ keys.

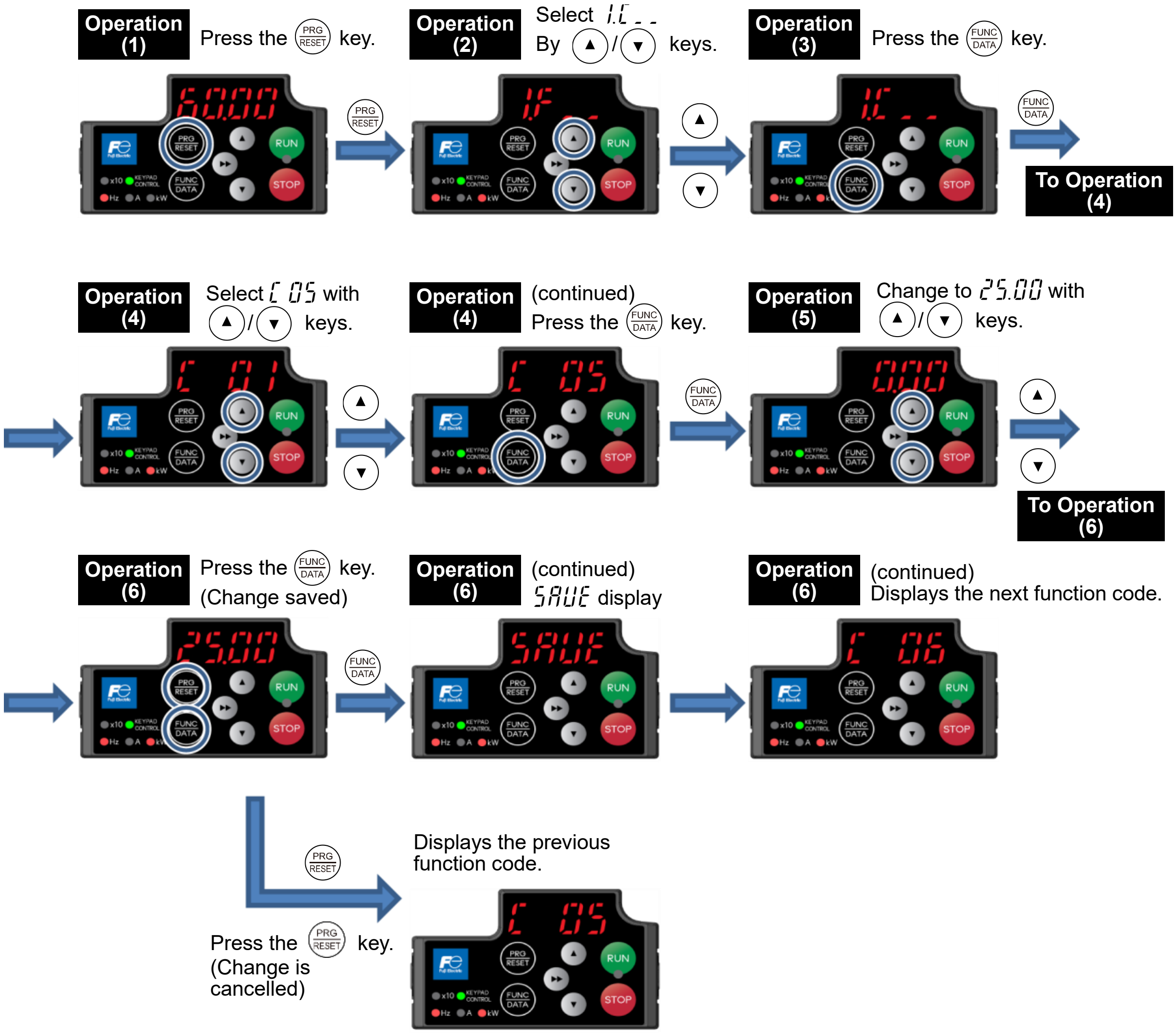
Operation (6) Press the FUNC/DATA key to confirm the function code data.
SAVE appears and the data will be saved in the memory inside the inverter. After that, the display will return to the function code list and then move to the next function code.
Pressing the FUNC/DATA key instead of the PRG/RESET key cancels the change made to the data.

Operation (7) Press the PRG/RESET key to return to the menu from the function code list.

Tip When changing function code data, press the ▶▶ key once the lowest digit blinks. After that, each time the ▶▶ key is pressed, the cursor moves to the next higher digit where data can be changed. This cursor movement allows you to easily move the cursor to the desired digit and change the data in higher digits.

You can register frequently used function codes as favorites. For details, refer to section 3.4.9 "Setting favorites function codes data: "Favorites: 0.Fnc ".

Operation example: The procedure when changing C05 (Multistep frequency 1) from 0.00 to 25.00 is shown in the figure below in relation to the **Operation (1)** to **Operation (6)** above.



3.4.2 Checking changed function codes: "Data Checking: 2.rEP"

Menu number 2 "Data Checking" (2.rEP) in Programming mode allows you to check function codes that have been changed. Only the function codes whose data has been changed from the factory defaults are displayed on the LED monitor. You can refer to the function code data and change it again if necessary.

The menu transition in "Data Checking" is the same as the one in Menu number 1 "Data Setting."

3.4.3 Monitoring the running status: "Drive Monitoring: 3.oPE"

Menu number 3 "Drive Monitoring" (3.oPE) is used to monitor the running status during maintenance and test running.

Table 3.4-2 "Drive Monitoring" display items

Monitor No.	Item	Unit	Description
3_00	Output frequency 1	Hz	Output frequency before slip compensation
3_01	Output frequency 2	Hz	Output frequency after slip compensation
3_02	Output current	A	Output current
3_03	Output voltage	V	Output voltage
3_04	Calculated torque	%	Motor output torque (Calculated value)
3_05	Reference frequency	Hz	Reference frequency
3_06	Rotation direction	N/A	Rotation direction of current output F: forward, r: reverse, ----: stop
3_07	Running status	N/A	Displays the running status. For details, refer to "■ Displaying the running status (3_07) and running status 2 (3_23)".
3_08	Motor speed	r/min	Display value=120×$\frac{\text{(Output frequency Hz)}}{\text{(No. of motor poles)}}$
3_09	Load rotation speed	r/min	Display value=(Output frequency Hz)×$\frac{\text{Function code E50}}{\text{Function code E39}}$
3_10	PID command value	N/A	Virtual physical value (e.g., temperature or pressure) of the object to be controlled, which is converted from the PID command value using function code J106 and J107 data (PID display Maximum scale/ minimum scale) Display value = (PID command value (%)) / 100 * (Max. scale - Min. scale) + Min. scale If PID control is disabled, "----" appears.
3_11	PID feedback value	N/A	Virtual physical value (e.g., temperature or pressure) of the object to be controlled, which is converted from the PID feedback amount using function codeJ106 and J107 data (PID display Maximum scale/ minimum scale). Display value = (PID feedback value (%)) / 100 * (Max. scale - Min. scale) + Min. scale If PID control is disabled, "----" appears.
3_12	Torque limit value A	%	Driving torque limit value A (based on motor rated torque)
3_13	Torque limit value B	%	Braking torque limit value B (based on motor rated torque)
3_14	Ratio setting	%	When this setting is 100%, the LED monitor shows 1.00. If no ratio setting is selected, "----" appears.
3_15	Line speed	m/min	Display value=(Output frequency Hz)×$\frac{\text{Function code E50}}{\text{Function code E39}}$
3_17	Stop target position	N/A	For details, refer to Chapter 5 "5.3.9 [7] Position control."
3_18	Current position	N/A	
3_19	Positioning deviation	N/A	
3_20	Positioning status monitor	N/A	
3_21	PID output value	%	Displays the PID output value (100% at the maximum frequency). If PID control is disabled, "----" appears.

Table 3.4-2 “Drive Monitoring” display items (continued)

Monitor No.	Item	Unit	Description
3_22	Flux command	%	Displays the flux command value.
3_23	Running status 2	N/A	For details, refer to “■ Displaying the running status (3_07) and running status 2 (3_23)”.
3_25	SY synchronization deviation	deg	Displays the positioning deviation (angle) for master-follower operation.
3_29	PG feedback value	Hz	Shows the frequency detected by the PG in Hz regardless of the control method.
3_32	Torque bias command	%	Displays the selected torque bias command value.
3_50	Command (master) side A/B phase pulse rate	kp/s	Displays the pulse rate input into the A/B phase of the PG used for the command (master) side.
3_51	Command (master) side Z phase pulse rate	p/s	Displays the pulse rate input into the Z phase of the PG used for the command (master) side.
3_52	Feedback (follower) side A/B phase pulse rate	kp/s	Displays the pulse rate input into the A/B phase of the PG used for the feedback (follower) side.
3_53	Feedback (follower) side Z phase pulse rate	p/s	Displays the pulse rate input into the Z phase of the PG used for the feedback (follower) side.

■ Displaying the running status (3_07) and running status 2 (3_23)

To display the running status and running status 2 in 4-digit hexadecimal format, each state has been assigned to bits 0 to 15 as listed in Table 3.4-3 and Table 3.4-4 respectively. Table 3.4-5 shows the relationship between each of the status assignments and the LED monitor display.

Table 3.4-6 gives the conversion table from binary to hexadecimal.

Table 3.4-3 Running status (3_07) bit assignment

Bit	Symbol	Content	Bit	Symbol	Content
15	BUSY	“1” when function code data is being written.	7	VL	“1” under voltage limiting control.
14	WR	Fixed at 0	6	TL	“1” under torque limiting control.
13		Fixed at 0	5	NUV	“1” when the DC link bus voltage is higher than the undervoltage level.
12	RL	“1” when communication is enabled (when ready for run and reference frequency are commanded via communications link).	4	BRK	“1” during braking.
11	ALM	“1” when an alarm has occurred.	3	INT	“1” when the inverter output is shut down.
10	DEC	“1” during deceleration.	2	EXT	“1” during DC braking.
9	ACC	“1” during acceleration.	1	REV	“1” during running in the reverse direction.
8	IL	“1” under current limiting control.	0	FWD	“1” during running in the forward direction.

Table 3.4-4 Running status 2 (3_23) bit assignment

Bit	Symbol	Content	Bit	Symbol	Content
15	-	Driving motor type 0000: Induction motor 1000: Permanent magnet synchronous motor (PMSM)	7	-	1 when performing speed control (during torque control)
14			6	-	(Not used.)
13			5	-	Motor selection 00: Motor 1 01: Motor 2
12			4		
11	-	(Not used.)	3	-	Inverter drive control 0000: V/f control with slip compensation inactive 0001: Dynamic torque vector control 0010: V/f control with slip compensation active 0011: V/f control with speed sensor 0100: Dynamic torque vector control with sensor 0101: Sensorless vector control 0110: Vector control with sensor 1010: Torque control (Sensorless vector control) 1011: Torque control (Vector control with sensor)
10	-	1 if the alarm information at the start of the retry was recorded when an alarm occurred after a retry failure (used only with alarm information 6_22)	2		
9	-	1 when an alarm occurred after a retry failure 0 clear by resetting the alarm	1		
8	-	1 when performing rotational direction limitation	0		

Table 3.4-5 Running status (3_07) display

LED No.		LED4				LED3				LED2				LED1			
Bit		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Symbol		BUSY	WR	RL		ALM	DEC	ACC	IL	VL	TL	NUV	BRK	INT	EXT	REV	FWD
Example	Binary	1	0	0	0	0	0	1	1	0	0	1	0	0	0	0	1
	Hexadecimal LED Monitor	LED4 LED3 LED2 LED1 8.3.2.1.															

Table 3.4-6 Running status 2 (3_23) display

(When the PMSM is assigned to motor 1 and operating with vector control with sensor)

LED No.		LED4				LED3				LED2				LED1			
Bit		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Symbol		-				-				-	-	-		-			
Example	Binary	1	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0
	Hexadecimal LED Monitor	LED4 LED3 LED2 LED1 8.0.3.6.															

■ Hexadecimal expression

A 4-bit binary number can be expressed in hexadecimal. Table 3.4-6 shows the correspondence between the two notations.

Table 3.4-6 Binary and hexadecimal conversion

Binary				Hexadecimal	Binary				Hexadecimal
0	0	0	0	0	1	0	0	0	8
0	0	0	1	1	1	0	0	1	9
0	0	1	0	2	1	0	1	0	A
0	0	1	1	3	1	0	1	1	b
0	1	0	0	4	1	1	0	0	c
0	1	0	1	5	1	1	0	1	d
0	1	1	0	6	1	1	1	0	E
0	1	1	1	7	1	1	1	1	F

3.4.4 Checking I/O signal status: "I/O Checking: 4.i_o"

Using Menu number 4 "I/O Checking" (4.i_o) displays the I/O status of external signals including digital and analog I/O signals without using a measuring instrument.

Table 3.4-7 lists I/O check items. Figure 3.4-2 shows Menu transition in Menu number 4 "I/O Checking"

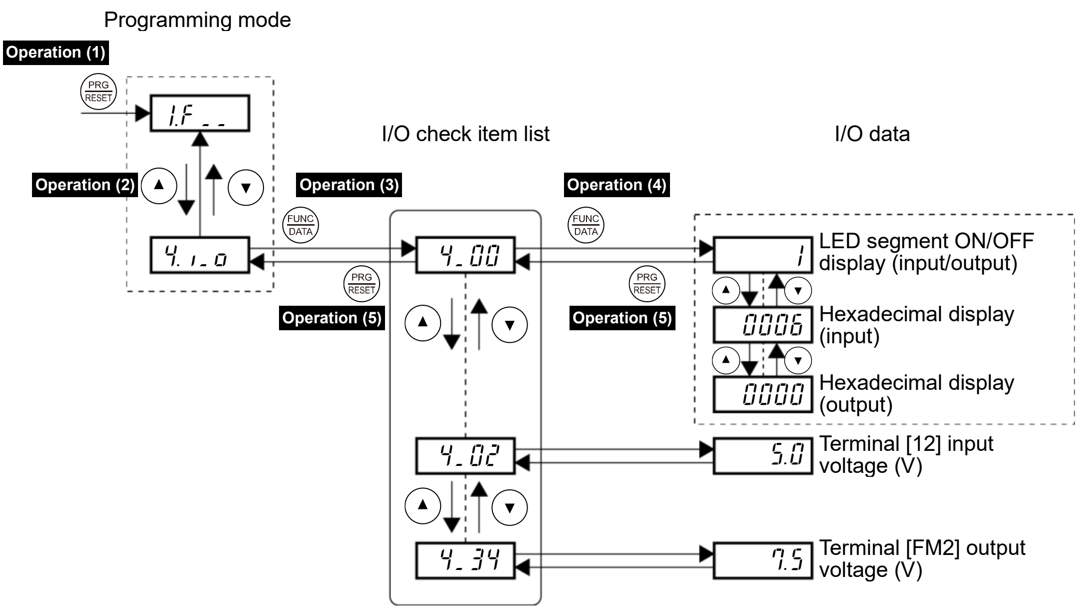


Figure 3.4-2 Menu transition in Menu number 4 "I/O Checking"

Basic key operation

Operation (1) Turn the inverter ON. It automatically enters Running mode. In that mode, press the PRG/RESET key to switch to Programming mode. The function selection menu appears.

Operation (2) Use the ∧/∨ keys to display "I/O Checking" (4.i_o).
Use the ≫ key to skip menus by menu number.

Operation (3) Press the FUNC/DATA key to proceed to a list of I/O check items (e.g. 4_00).

Operation (4) Use the ∧/∨ keys to display the desired I/O check item, then press the FUNC/DATA key.
Use the ≫ key to skip 10 I/O check items. You return to the beginning of the same function code group after you reach the end.
The corresponding I/O check data appears. For the items 4_00 or 4_01, using the ∧/∨ keys switches the display method between the segment display (refer to Table 3.4-8 and Table 3.4-9) and hexadecimal display.

Operation (5) Press the PRG/RESET key to return to the list of I/O check items. Press the PRG/RESET key again to return to the menu.

Table 3.4-7 I/O check items

Monitor No.	Item	Unit	Description
4_00	Control circuit terminal (input/output)	–	Shows the ON/OFF state of the digital I/O terminals. For details, refer to "■ I/O display for control circuit terminals terminals."
4_01	Communications control signal (input/output)	–	Shows the ON/OFF state of the digital I/O terminals that received a command via RS-485 or field bus option. For details, refer to "■ I/O display for control circuit terminals terminals" and "■ Displaying control I/O signal terminals under communications control."
4_02	Input voltage on terminal [12]	V	Shows the input voltage (with sign) on terminal [12] in volts (V).
4_03	Input current on terminal [C1] (C1 function)	mA	Shows the input current on terminal [C1] (C1 function) in milliamperes (mA).
4_04	Output voltage on terminal [FM1]	V	Shows the output voltage on terminal [FM1] in volts (V). (with symbol)
4_05	Output voltage on terminal [FM2]	V	Shows the output voltage on terminal [FM2] in volts (V).
4_06	Output frequency on terminal [FM1]	p/s	Shows the output pulse rate per unit of time on terminal [FM1] (FMP function) in (p/s).
4_07	Input voltage on terminal [C1] (V2 function)	V	Shows the input voltage on terminal [C1] (V2 function) in volts (V) (with symbol).
4_08	Output current on terminal [FM1]	mA	Shows the output current on terminal [FM1] in milliamperes (mA).
4_09	Output current on terminal [FM2]	mA	Shows the output current on terminal [FM2] in milliamperes (mA).
4_10	Option control circuit terminal (input/output)	–	Shows the ON/OFF state of the digital I/O terminals on the digital input and output interface card (DIO options). For details, refer to "■ Displaying control I/O signal terminals on optional digital input and output interface card."
4_11	Terminal [X5] pulse input monitor	kp/s	Shows the pulse rate of the pulse train signal on terminal [X5].
4_15	PG pulse rate (Ch1 A/B phase)	kp/s	Shows the pulse rate (p/s) of the A/B phase signal fed back from the reference PG.
4_16	PG pulse rate (Ch1 Z phase)	p/s	Shows the pulse rate (p/s) of the Z phase signal fed back from the reference CH1 PG.
4_17	PG pulse rate (Ch2 A/B phase)	kp/s	Shows the pulse rate (p/s) of the A/B phase signal fed back from the follower PG.
4_18	PG pulse rate (Ch2 Z phase)	p/s	Shows the pulse rate (p/s) of the Z phase signal fed back from the follower CH2 PG.
4_20	Input voltage on terminal [32]	V	Shows the input voltage on terminal [32] on the analog interface card (AIO option) in volts (V).
4_21	Input current on terminal [C2]	mA	Shows the input current on terminal [C2] on the analog interface card (AIO option) in milliamperes (mA).
4_22	Output voltage on terminal [AO]	V	Shows the output voltage on terminal [AO] on the analog interface card (AIO option) in volts (V).
4_23	Output current on terminal [CS]	mA	Shows the output current on terminal [CS] on the analog interface card (AIO option) in milliamperes (mA).
4_24	Customizable logic timer monitor	–	Monitors the timer or counter value in the customizable logic specified by U91.
4_36	PTC terminal input voltage	V	Shows the input voltage to terminal [V2] (PTC function) in volts (V).
4_37	Relay option output	–	Shows the ON/OFF state of the output terminal on the relay output interface card (option). For details, refer to "■ Displaying the optional relay output interface card output."

Monitor No.	Item	Unit	Description
4_43	Bus option command	–	Shows the input state of the dedicated command via the field bus option. bit0: Q_STOP (force to stop) command bit1: BX (coast to stop) command

■ I/O display for control circuit terminals terminals

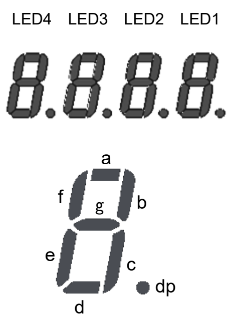
The status of control circuit terminal I/O signals can be displayed in two ways: with "• Displaying the I/O signal status with ON/OFF of each LED segment" and "• Displaying I/O signal status in hexadecimal".

• Displaying the I/O signal status with ON/OFF of each LED segment

As shown in Table 3.4-8 and the figure below, each of segments "a" to "dp" on LED1 and LED2 lights up when the corresponding digital input terminal circuit ([FWD], [REV], [X1] to [X5], [EN1] and [EN2]) is closed (ON); it goes OFF when it is open (OFF). Segment "a" or "b" on LED3 lights up when the circuit between output terminal [Y1] or [Y2] and terminal [CMY] is closed, respectively; it goes OFF when the circuit is open. Segment "a" on LED4 is for terminals [30A/B/C] and lights when the circuit between terminals [30C] and [30A] is short-circuited (ON) and goes OFF when it is open.

Tip If all terminal signals are OFF (open), segment "g" on all of LED1 to LED4 will light ("- - - -").

Table 3.4-8 Segment display of external signal information



Segment	LED4	LED3	LED2	LED1
a	[30A/B/C]	[Y1-CMY]	—	[FWD]
b	—	[Y2-CMY]	—	[REV]
c	—	—	—	[X1]
d	—	—	[EN1]	[X2]
e	—	—	[EN2]	[X3]
f	—	—	(XF) *	[X4]
g	—	—	(XR) *	[X5]
dp	—	—	(RST) *	—

–: No corresponding control circuit terminal exists

* (XF), (XR), and (RST) are assigned for communications control. For details, refer to "■ Displaying control I/O signal terminals under communications control".

• Displaying I/O signal status in hexadecimal

Each I/O terminal is assigned to bit 15 through bit 0. An unassigned bit is interpreted as "0." Allocated bit data is displayed on the LED monitor as four hexadecimal digits (0 to F).

On the FRENIC-Ace, digital input terminals [FWD] and [REV] are assigned to bits 0 and 1, respectively. Terminals [X1] through [X5] are assigned to bits 2 through 10. The bit is set to "1" when the corresponding input terminal is short-circuited (ON), and it is set to "0" when the terminal is open (OFF). For example, when [FWD] and [X1] are ON (short-circuited) and all the others are OFF (open), 0005 is displayed on LED4 to LED1.

Digital output terminals [Y1] and [Y2] are assigned to bits 0 to 1. Each bit is set to "1" when the output terminal [Y1] or [Y2] is short-circuited with [CMY] (ON), and "0" when it is open (OFF). The status of the relay contact output terminals [30A/B/C] is assigned to bit 8. It is set to "1" when the circuit between output terminals [30A] and [30C] is closed, and "0" when the circuit between [30A] and [30C] is open. For example, if [Y1] is ON, [Y2] is OFF, and the circuit between [30A] and [30C] is closed, then "0101" is displayed on the LED4 to LED1.

The terminals assigned to bits 0 to 15 and the Display of I/O signal status in hexadecimal (example) are shown in Table 3.4-9.

Table 3.4-9 Display of I/O signal status in hexadecimal (example)

LED No.	LED4				LED3				LED2				LED1			
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Input terminal	(RST) *	(XR) *	(XF) *	EN2	EN1	—	—	—	—	X5	X4	X3	X2	X1	REV	FWD
Output terminal	—	—	—	—	—	—	—	30A/B/C	—	—	—	—	—	—	Y2	Y1
Example: Binary	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Example: Hexadecimal LED Monitor																

–: No corresponding control circuit terminal exists

* (XF), (XR), and (RST) are assigned for communications control. For details, refer to "■ Displaying control I/O signal terminals under communications control" given below.

■ Displaying control I/O signal terminals under communications control

Under communications control, input commands (function code S06) sent via RS-485 or other optional communications can be displayed in two ways: "with ON/OFF of each LED segment" and "in hexadecimal." The content to be displayed is basically the same as that for the control I/O signal terminal status display; however, (XF), (XR), and (RST) are added as inputs. Note that under communications control, the I/O display is in normal logic (using the original signals not inverted).

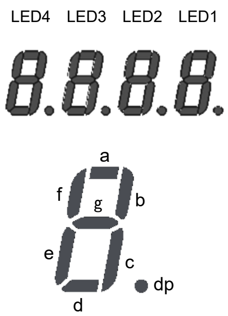
📖 For details about input commands sent through the communications link, refer to the "RS-485 Communication User's Manual" or the instruction manual of communication-related options as well.

■ Displaying control I/O signal terminals on optional digital input and output interface card

The LED monitor can also show the signal status of the terminals on the optional digital input and output interface card, same as the signal status of the control circuit terminals.

Table 3.4-10 lists the assignment of digital I/O signals to the LED segments.

Table 3.4-10 Display of I/O signal status with ON/OFF of each LED segment (Digital input and output interface card)



Segment	LED4	LED3	LED2	LED1
a	—	O1	I9	I1
b	—	O2	I10	I2
c	—	O3	I11	I3
d	—	O4	I12	I4
e	—	O5	I13	I5
f	—	O6	—	I6
g	—	O7	—	I7
dp	—	O8	—	I8

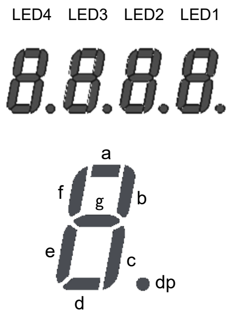
LED No.	LED4				LED3				LED2				LED1			
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Input terminal	—	—	—	I13	I12	I11	I10	I9	I8	I7	I6	I5	I4	I3	I2	I1
Output terminal	—	—	—	—	—	—	—	—	O8	O7	O6	O5	O4	O3	O2	O1

■ Displaying the optional relay output interface card output

The LED monitor can also show the status of the output terminal on the relay output interface card, in addition to the status of the control circuit terminals.

Table 3.4-11 lists the assignment of digital I/O signals to the LED segments.

Table 3.4-11 Segment display of external signal information (relay output interface card)



Segment	LED4	LED3	LED2	LED1
a	—	Y6A/C	—	—
b	—	Y7A/C	—	—
c	—	Y8A/C	—	—
d	—	—	—	—
e	—	—	—	—
f	—	—	—	—
g	—	—	—	—
dp	—	—	—	—

LED No.	LED4				LED3				LED2				LED1			
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Output terminal	—	—	—	—	—	—	—	—	—	—	—	—	—	Y8A/C	Y7A/C	Y6A/C

3.4.5 Reading maintenance information: "Maintenance Information: 5.CHE"

Menu number 5 "Maintenance Information: 5.CHE" contains information necessary for performing maintenance on the inverter. The menu transition in "Maintenance Information" is same as that in Menu number 3 "Drive Monitoring." (Refer to 3.4.3 .)

<u>Basic key operation</u>

(1) Turn the inverter ON. It automatically enters Running mode. In that mode, press the PRG/RESET key to switch to Programming mode. The function selection menu appears.

(2) (2) Use the ▲/▼ keys to display "Maintenance Information" (5.CHE).
Use the ▸▸ key to skip menus by menu number.

(3) Press the FUNC/DATA key to proceed to the list of maintenance items (e.g. 5_00).

(4) Use the ▲/▼ keys to display the desired maintenance item, then press the FUNC/DATA key.
The data of the corresponding maintenance item appears.
Use the ▸▸ key to skip 10 maintenance information items. You return to the beginning of the maintenance items after you reach the end.

(5) Press the PRG/RESET key to return to the list of maintenance items. Press the PRG/RESET key again to return to the menu.

Table 3.4-12 Display items in "Maintenance Information"

Monitor No.	Item	Description
5_00	Cumulative run time	Shows the content of the cumulative power-ON time counter of the inverter. Counter range: 0 to 65,535 hours Display: Upper 2 digits and lower 3 digits are displayed alternately. Example 0 ⇔ 535h (535 hours) 65 ⇔ 535h (65,535 hours) The lower 3 digits are displayed with h (h). When the count exceeds 65,535, the counter will be reset to "0" and start over again.
5_01	DC link bus voltage	Shows the DC link bus voltage of the inverter main circuit when alarm occurred. Display unit: V (volt)
5_02	Max. temperature inside the inverter	Shows the maximum temperature inside the inverter for every hour. Display unit: °C (Temperatures below 20°C are displayed as 20°C.)
5_03	Max. temperature of heat sink	Shows the maximum temperature of the inverter heat sink for every hour. Display unit: °C (Temperatures below 20°C are displayed as 20°C.)
5_04	Max. effective output current	Shows the maximum current in RMS for every hour. Display unit: A (ampere)
5_05	Capacitance of the DC link bus capacitor	Shows the current capacitance of the DC link bus capacitor (reservoir capacitor) in %, based on the capacitance when shipping as 100%. For details, refer to Chapter 7 "MAINTENANCE AND INSPECTION." Display: %
5_06	Cumulative run time of electrolytic capacitors on the PCB	Shows the content of the cumulative run time counter of the electrolytic capacitors on the printed circuit boards, which is calculated by multiplying the cumulative run time count by the coefficient based on the surrounding temperature condition. Counter range: 0 to 99,990 hours Display: 0 to 9999 x10 LED turns ON (Actual cumulative run time of electrolytic capacitors on the printed circuit boards (hours) = Displayed value x 10) When the count exceeds 99,990 the counter stops and the LED monitor sticks to 9999.
5_07	Cumulative run time of the cooling fan	Shows the content of the cumulative run time counter of the cooling fan. This counter does not work when the cooling fan ON/OFF control (function code H06) is enabled and the fan stops. The display method is the same as for 5_06 above.

Table 3.4-12 Display items in “Maintenance Information” (continued)

Monitor No.	Item	Description
5_08	Number of startups for motor 1	Shows the content of the motor 1 startup counter (i.e., the number of run commands issued). Counter range: 0 to 65,530 times Display: 0 to 9999 If the count exceeds 10,000, the x10 LED turns ON and the LED monitor shows one-tenth of the value. When the count exceeds 65,530, the counter will be reset to “0” and start over again.
5_09	Input watt-hour	Shows the input watt-hour of the inverter. Display: 0.001 to 9999 Displayed value = Input watt-hour kWh × 0.01 To reset the integrated input watt-hour and its data, set function code E51 to “0.000.” When the input watt-hour exceeds 999,900 kWh, the counter will be reset to “0.”
5_10	Input watt-hour data	Shows the value expressed by “input watt-hour kWh × function code E51 data. The function code E51 setting range is 0.000 to 9999. Unit: None (Display range: 0.001 to 9999. The count cannot exceed 9999. (It will be fixed at 9,999 once the calculated value exceeds 9999.)) Depending on the value of integrated input watt-hour data, the decimal point on the LED monitor shifts to show it within the LED monitors’ resolution. To reset the integrated input watt-hour data, set function code E51 to “0.000.”
5_11	Number of RS-485 communications errors (COM port 1)	Shows the total number of errors that have occurred in RS-485 communication (COM port 1, connection to keypad) after the power is turned ON. Once the count exceeds 9999, the counter will be reset to “0.”
5_12	Content of RS-485 communications error (COM port 1)	Shows the latest error that has occurred in RS-485 communication (COM port 1) in decimal. For error contents, refer to the “RS-485 Communication User’s Manual.”
5_13	Number of option errors	Shows the total number of errors that have occurred in the option. Once the count exceeds 9999, the counter will be reset to “0.”
5_14	Inverter ROM version	Shows the inverter's ROM version as a 4-digit code.
5_15	Inverter's ROM version Sub CPU	Shows the inverter's Sub CPU ROM version as a 4-digit code. Displayed when FRN0001 to 0020E3□-2G/7G / FRN0002 to 0012E3□-4G. “----” is displayed when FRN0030E3□-2G / FRN0022E3□-4G or higher.
5_16	Keypad ROM version	Shows the keypad's ROM version as a 4-digit code.
5_17	Number of RS-485 communications errors (COM port 2)	Shows the total number of errors that have occurred in RS-485 communication (COM port 2, connection to terminal block) after the power is turned ON. Once the count exceeds 9999, the counter will be reset to “0.”
5_18	Content of RS-485 communications error (COM port 2)	Shows the latest error that has occurred in RS-485 communication (COM port 2, connection to terminal block) in decimal. For error contents, refer to the “RS-485 Communication User’s Manual.”
5_19	Optional ROM version 1	Shows the ROM version of the option as a 4-digit code. If the option has no ROM, “----” appears on the LED monitor.

Table 3.4-12 Display items in "Maintenance Information" (continued)

Monitor No.	Item	Description
5_23	Cumulative run time of motor 1	Shows the content of the cumulative power-ON time counter of motor 1. Counter range: 0 to 99,990 hours Display: 0 to 9999 (x10 LED turns ON) Actual cumulative motor run time (hours) = Displayed value x 10 When the count exceeds 99,990, the counter will be reset to "0" and start over again.
5_24	Temperature inside the inverter (real-time value)	Shows the current temperature inside the inverter. Display unit: °C "- - - -" is displayed with FRN0001 to 0069E3□-2G/7G / FRN0002 to 0044E3□-4G models since they are not equipped with internal temperature sensors.
5_25	Temperature of heat sink (real-time value)	Shows the current temperature of the inverter heat sink. Display unit: °C
5_26	Lifetime of DC link bus capacitor (elapsed hours)	Shows the cumulative time during which a voltage is applied to the DC link bus capacitor. When the main power is shut down, the inverter automatically measures the discharging time of the DC link bus capacitor and corrects the elapsed time. The display method is the same as for 5_06 above.
5_27	Lifetime of DC link bus capacitor (remaining hours)	Shows the time remaining before the end of the service life of the DC link bus electrolytic capacitor. The value is the lifetime (10 years) to which the elapsed time has been subtracted. The display method is the same as for 5_06 above.
5_28	Cumulative run time of motor 2	Shows the content of the cumulative power-ON time counter of motor 2. The display method is the same as for 5_23 above.
5_31	Remaining hours before the next maintenance 1	Shows the hours remaining before the next maintenance, which is estimated by subtracting the cumulative run time of motor 1 from the maintenance interval specified by (H78). (This function applies to motor 1 only.) Display: 0 to 9999 x10 LED turns ON Actual remaining hours before maintenance = Displayed value x 10
5_32	Number of startups for motor 2	Shows the content of the motor 2 startup counter (i.e., the number of run commands issued). The display method is the same as for 5_08 above.
5_35	Remaining startup times before the next maintenance 1	Shows the startup times remaining before the next maintenance, which is estimated by subtracting the number of startups from the preset startup count for maintenance specified by (H79). (This function applies to motor 1 only.) The display method is the same as for 5_08 above.
5_36	Warning factor (Latest)	Shows the factor of the latest warning as an alarm code. For details, refer to Chapter 6, "6.1 Protective Function."
5_37	Warning (last)	Shows the factor of the last warning as an alarm code. For details, refer to Chapter 6, "6.1 Protective Function."
5_38	Warning (second last)	
5_39	Warning (third last)	
5_40	Option error Content	Shows the factor of the error that has occurred in the option being connected to the option port.
5_47	Option A type	Shows the type of the option mounted to port A. For the display content, refer to Table 3.4-13.

Table 3.4-12 Display items in “Maintenance Information” (continued)

Monitor No.	Item	Description
5_50	Regenerative load factor maximum value	Shows the maximum value of 5_51 when the inverter is on. The value returns to 0 when the inverter power is turned off.
5_51	Regenerative load factor	Shows the regeneration load factor during 100 s. The value is calculated and refreshed every 100 s when the inverter in on.
5_54	Braking resistor thermal calculation value	Shows the current thermal calculation value as a percentage. The dbH alarm occurs at 100%.
5_55	Inverter thermal calculation value 1	Shows the current IGBT junction temperature calculation value 1 as a percentage. The OLU alarm occurs at 100%.
5_56	Inverter thermal calculation value 2	Shows the current IGBT junction temperature calculation value 2 as a percentage. The OLU alarm occurs at 100%.
5_58	IGBT lifetime	Shows the estimated remaining time for the IGBT lifetime after a change in the IGBT temperature. It can be displayed and output as a warning iGb or LiF. A warning occurs when it decreases below 10%. Display: 0 to 100%
5_59	IP address	Displays the following information items when connected with Ethernet (equipped with OPC-CP-ETM (option)): ・IP address ・Subnet mask ・Default gateway Use the ▲/▼ keys to switch the 4 digits displayed .
5_60	Subnet mask	
5_61	Default gateway	
5_64	Warning factor (fourth last)	Shows the factor of the fourth and fifth last warnings as codes. For details, refer to Chapter 6 “6.1 Protective Function.”
5_65	Warning factor (fifth last)	
5_70	Control power supply state	Shows the connected power supply for control. bit0: Main power supply/auxiliary power supply bit1: USB bus power

Table 3.4-13 Display list by option type

Displayed content	Option type
- - - -	No connection
dio	OPC-DIO
Aio	OPC-AIO
PdP	OPC-PDP3
dEU	OPC-DEV
CoP	OPC-COP2
CCL	OPC-CCL
EtN	OPC-CP-ETM

3.4.6 Reading alarm information: "Alarm Information: 6.AL"

Menu number 6 "Alarm Information" (6.AL) shows the causes of the past 10 alarms with an alarm code. Further, it is also possible to display alarm information for the past 4 alarms, indicating the status of the inverter when each alarm occurred. Menu transition in Menu number 6 "Alarm Information" is shown in Figure 3.4-3 and Display items in "Alarm Information" is shown in Table 3.4-14.

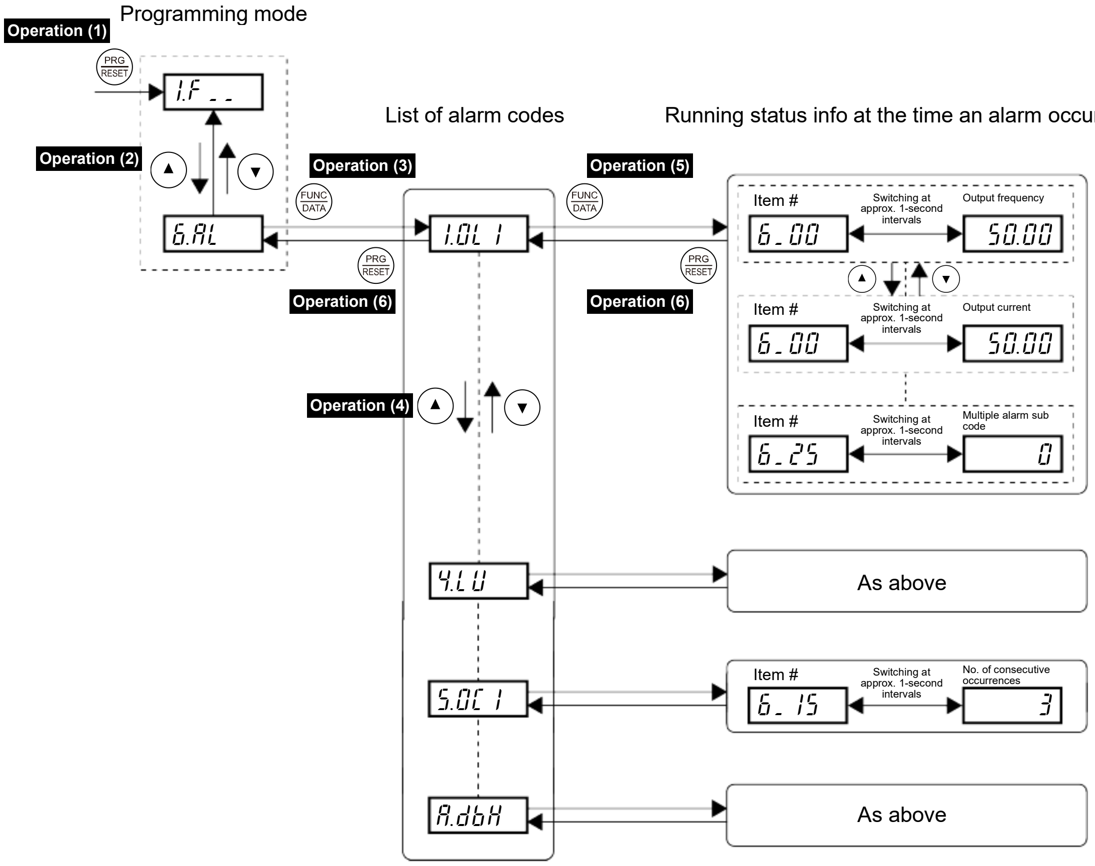


Figure 3.4-3 Menu transition in Menu number 6 "Alarm Information"

Basic key operation

Operation (1) Turn the inverter ON. It automatically enters Running mode. In that mode, press the PRG/RESET key to switch to Programming mode. The function selection menu appears.

Operation (2) Use the ▲/▼ key to display "Alarm Information" (6.AL).
Use the ▸▸ key to skip menus by menu number.

Operation (3) Press the FUNC/DATA key to proceed to the list of alarm codes (e.g. 1.OL 1).
In the list of alarm codes, the alarm information for the last 10 alarms is saved as an alarm history.

Operation (4) Each time the ▲/▼ key is pressed, the last 4 alarms are displayed beginning with the most recent one in the order of "1.", "2.", "3." and "4.". Press the ▸▸ key to return to the last alarm history.

Operation (5) Press the FUNC/DATA key with an alarm code being displayed. The item number (e.g. 6_00) and the inverter status information (e.g. Output frequency) at the time of the alarm occurrence alternately appear at approx. 1-second intervals. With the ▲/▼ keys, you can display a different item number (e.g. 6_01) and data item (e.g. output current) for the corresponding alarm.
In this case, press the FUNC/DATA key to switch the item number and symbol.

Operation (6) Press the PRG/RESET key to return to the list of alarm codes. Press the PRG/RESET key again to return to the menu.

Table 3.4-14 Display items in "Alarm Information"

Monitor No.	Description	Description
6_00	Output frequency	Output frequency before slip compensation
6_01	Output current	Output current Display unit: A (ampere)
6_02	Output voltage	Output voltage Display unit: V (volt)
6_03	Calculated torque	Calculated torque
6_04	Reference frequency	Reference frequency
6_05	Rotation direction	Shows the current rotation direction when alarm occurred. F: forward, r: reverse, ----: stop
6_06	Running status	Running status when alarm occurred as four hexadecimal digits. For details, refer to "■ Displaying the running status (3_07) and running status 2 (3_23)" in 3.4.3 Monitoring the running status: "Drive Monitoring: 3.oPE
6_07	Cumulative run time	Shows the content of the cumulative power-ON time counter of the inverter when alarm occurred. Counter range: 0 to 65,535 hours Display: Upper 2 digits and lower 3 digits are displayed alternately. Example 0 ⇔ 535h (535 hours) 65 ⇔ 535h (65,535 hours) The lower 3 digits are displayed with h (h). When the count exceeds 65,535, the counter will be reset to "0" and start over again.
6_08	No. of startups	Shows the content of the motor startup counter (i.e., the number of run commands issued) when alarm occurred. Counter range: 0 to 65,535 times Display: 0 to 9999 If the count exceeds 10,000, the x10 LED turns ON and the LED monitor shows one-tenth of the value. When the count exceeds 65,535, the counter will be reset to "0" and start over again.
6_09	DC link bus voltage	Shows the DC link bus voltage of the inverter main circuit when alarm occurred. Display unit: V (volt)
6_10	Temperature inside the inverter	Shows the temperature inside the inverter when alarm occurred. Display unit: °C
6_11	Max. temperature of heat sink	Shows the temperature of the inverter heat sink. Display unit: °C
6_12	Terminal I/O signal status (Displaying the I/O signal status with ON/OFF of each LED segment)	For details, refer to "Table 3.4-8 Segment display of external signal information" and "Table 3.4-9 Display of I/O signal status in hexadecimal (example)" in 3.4.4 Checking I/O signal status: "I/O Checking: 4.i_o
6_13	Terminal input signal status (in hexadecimal)	
6_14	Terminal output signal status (in hexadecimal)	

Table 3.4-14 Display items in “Alarm Information” (continued)

<table>
<tr><th>Monitor No.</th><th>Description</th><th>Description</th></tr>
<tr><td>6_15</td><td>No. of consecutive occurrences</td><td>Shows how many times the same alarm has occurred consecutively.</td></tr>
<tr><td>6_16</td><td>Multiple alarm 1</td><td>Simultaneously occurring alarm code (1) (“ - - -” is displayed if no alarm has occurred.)</td></tr>
<tr><td>6_17</td><td>Multiple alarm 2</td><td>Simultaneously occurring alarm code (2) (“ - - -” is displayed if no alarm has occurred.)</td></tr>
<tr><td>6_18</td><td>Terminal I/O signal status under communications control (displayed with the ON/OFF of LED segments)</td><td rowspan="3">Shows the ON/OFF state of the digital I/O terminals under RS-485 communications control when alarm occurred.
For details, refer to “■ Displaying control I/O signal terminals under communications control” in “3.4.4 Checking I/O signal status: “I/O Checking: 4.I_o .”</td></tr>
<tr><td>6_19</td><td>Terminal input signal status under communications control (in hexadecimal)</td></tr>
<tr><td>6_20</td><td>Terminal output signal status under communications control (in hexadecimal)</td></tr>
<tr><td>6_21</td><td>Error sub code</td><td>Secondary error code for an alarm.</td></tr>
<tr><td>6_22</td><td>Running status 2</td><td>Running status 2 when alarm occurred as four hexadecimal digits.
For details, refer to “Table 3.4-4 Running status 2 (3_23) bit assignment” in “3.4.3 Monitoring the running status: “Drive Monitoring: 3.oPE .”</td></tr>
<tr><td>6_23</td><td>Detected speed</td><td>Displays the detected speed value with hexadecimal number.
The speed + 100% is expressed as the standard value + 20000 (4E20).
<table>
<tr><th>Display Example</th><th>Decimal</th><th>Speed%</th><th>Rotation direction</th></tr>
<tr><td>4E20</td><td>+20000</td><td>+100%</td><td>Forward rotation</td></tr>
<tr><td>0000</td><td>0</td><td>0%</td><td>Stop</td></tr>
<tr><td>FF38</td><td>-200</td><td>-1.00%</td><td rowspan="2">Reverse rotation</td></tr>
<tr><td>b1E0</td><td>-20000</td><td>-100%</td></tr>
</table></td></tr>
<tr><td>6_24</td><td>Running status 3</td><td>Running status 3 when alarm occurred as four hexadecimal digits.
For details, refer to “Table 3.4-15 Running status 3 (6_24) bit assignment.” given below.</td></tr>
<tr><td>6_25</td><td>Multiple alarm sub code</td><td>Secondary error code for a multiple alarm.</td></tr>
</table>

Note When the same alarm occurs repeatedly in succession, the alarm information for the first and the most recent occurrences will be preserved and the information for other occurrences in-between will be discarded. The number of consecutive occurrences will be preserved as the first alarm information.

Table 3.4-15 Running status 3 (6_24) bit assignment.

Bit	Symbol	Content	Bit	Symbol	Content
15	-	Fixed at 0	7	FAN	“1” when the fan is in operation.
14	ID2	“1” when current 2 is detected.	6	KP	“1” during keypad operation.
13	IDL	“1” when low current is detected.	5	OL	“1” when a motor overload early warning is issued.
12	ID	“1” when current is detected.	4	IPF	“1” during auto-restarting after momentary power failure.
11	OLP	“1” under overload prevention control.	3	SWM2	“1” when motor 2 is selected.
10	LIFE	“1” when a lifetime early warning is issued.	2	RDY	“1” when the inverter is ready to run.
9	OH	“1” when a heat sink overheat early warning is issued.	1	FDT	“1” when frequency is detected.
8	TRY	“1” during auto-resetting.	0	FAR	“1” when a frequency arrival signal is issued.

3.4.7 Copying data: "Data Copying: 7.CPY"

Note

- Data copying can only be performed when the remote operation keypad TP-E2 or the multi-function keypad TP-A2SW are connected. (When neither of these are connected, this menu is not displayed.) **This section describes operation using the TP-E2.** If using the TP-A2SW, refer to the TP-A2SW instruction manual.
- For the Ethernet built-in type (E3N), use FRENIC-Loader to copy data.

The data copying functions read function code data from the inverter, and save it on the remote operation keypad TP-E2 or the multi-function keypad TP-A2SW. These functions can be used in the following situations.

- When writing function code data to another inverter
- When verifying (comparing) function code data stored on the keypad with that set on the inverter

In addition, the keypad serves as a temporary storage medium, allowing you to store the inverter running status, connect the keypad to a PC running FRENIC-Loader, and check the inverter running status from an office or other off-site location.

To store the inverter running status information into the keypad, use "Read data" (rEAd) or "Read inverter running information" (CHEC) function. For details on how to connect the keypad to a PC and check the inverter running status information stored in the keypad, refer to the FRENIC Loader Instruction Manual.

Figure 3.4-4 Menu transition in Menu number 7 "Data Copying" shows the menu transition in Menu number 7 "Data Copying." The keypad can hold function code data for a single inverter.

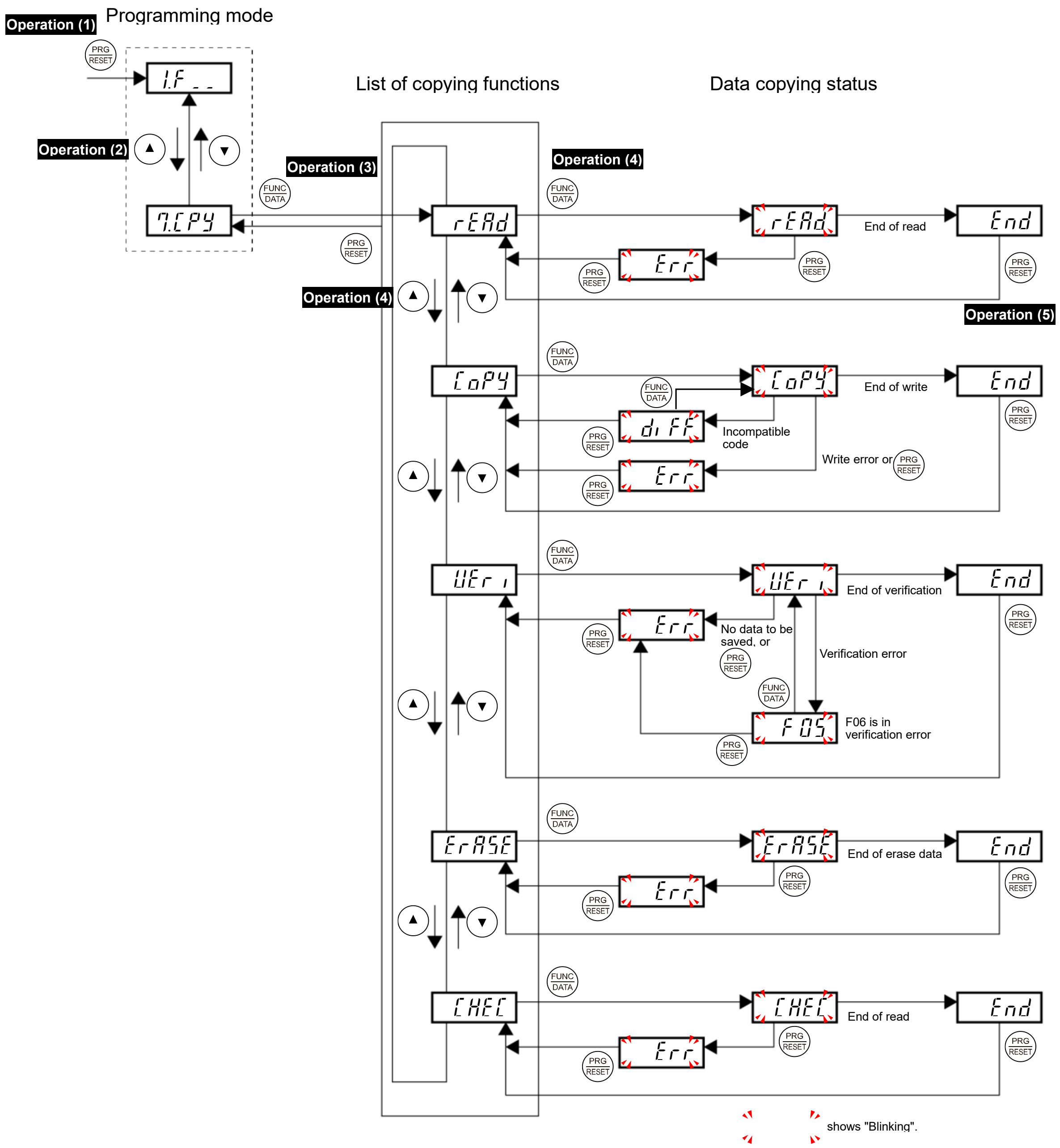


Figure 3.4-4 Menu transition in Menu number 7 "Data Copying"

Refer to "■ When you cannot perform the copy operation" if Err or diFF is displayed.

Basic key operation (when using TP-E2)

Operation (1) Turn the inverter ON. It automatically enters Running mode. In that mode, press the PRG/RESET key to switch to Programming mode. The function selection menu appears.

Operation (2) Use the ▲/▼ keys to display "Data Copying" (7.CPY).
Use the M/► key to skip menus by menu number.

Operation (3) Press the FUNC/DATA key to proceed to the list of data copying functions (e.g. rEAd).

Operation (4) Use the ▲/▼ keys to select the desired function, then press the FUNC/DATA key to execute the selected function.
(e.g. rEAd will blink.)

Operation (5) When the selected function has been completed, End appears. Press the PRG/RESET key to return to the list of data copying functions. Press the PRG/RESET key again to return to the menu.

Table 3.4-16 List of data copying functions (when using TP-E2)

LED indicator	Function	Description
rEAd	Read data	Reads the function code data out of the inverter's memory and stores it into the keypad memory. Also reads out inverter's current running status information which can be checked by FRENIC Loader, such as information of I/O, system, alarm, and running status. Pressing the PRG/RESET key during a read operation (when rEAd is blinking) immediately aborts the operation and displays Err (blinking). If this happens, the entire contents of the memory of the keypad will be completely cleared.
CoPY	Write data	Writes data stored in the keypad memory into the inverter's memory. If you press the PRG/RESET key during a write operation (when CoPY is blinking), the write operation that is under way will be aborted and Err will appear (blinking). If this happens, the contents of the inverter's memory (i.e., function code data) have been partly updated and remain partly old. Therefore, do not operate the inverter. Instead, perform initialization or rewrite the entire data. If this function does not work, refer to "■ When you cannot perform the copy operation." After the copy is completed, the inverter verifies data automatically. Displays the function code that was not been copied when copying in case that the model and voltage capacity is different.
UEri	Verify data	Verifies (compares) the data stored in the keypad memory with that in the inverter's memory. If any mismatch is detected, the verify operation will be aborted, with the function code that differs displayed blinking. Pressing the FUNC/DATA key again causes the verification to continue from the next function code. Pressing the PRG/RESET key during a verify operation (when UEri is blinking) immediately aborts the operation and displays Err (blinking). Err appears blinking also when the keypad does not contain any valid data.
ErASE	Erase data	Erase all data stored in the keypad internal memory. It does not affect the function code data of the inverter.
CHEC	Read inverter running information	Reads out inverter's current running status information that can be checked by FRENIC Loader, such as information of I/O, system, alarm, and running status,excluding function code data. To be used to keep the past setting information without overwriting the function code data saved in the keypad. Pressing the PRG/RESET key during a read operation (when CHEC is blinking) immediately aborts the operation and displays Err (blinking).
Prot	Data protection	Shows that the keypad internal memory is protected. It is not possible to read the data from the inverter or erase the keypad data. Data can be written and verified, and the inverter running information can be read. Err is immediately displayed when the FUNC/DATA key is pressed.

Tip If Err is blinking, press the PRG/RESET key to clear the error.
If diFF is blinking, operation can be continued by pressing the FUNC/DATA key but the data of the extended function code is not changed.

■ Data protection

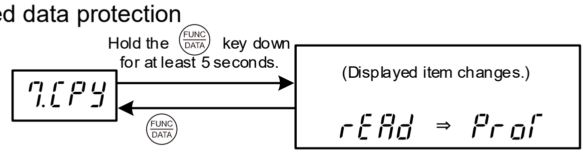
You can protect data saved in the keypad from unexpected modifications. Enabling the data protection changes the display on the "Data Copying" function list from "rEAd", "ErASE" to "Prot", and disables to read data from the inverter.

To enable or disable the data protection, follow the next steps.

(1) Select the "Data Copying" (7.CPY) on the function selection menu in Programming mode.
(2) When the (7.CPY) is displayed, holding the FUNC/DATA key down for at least 5 seconds alternates data protection status between enabled or disabled.

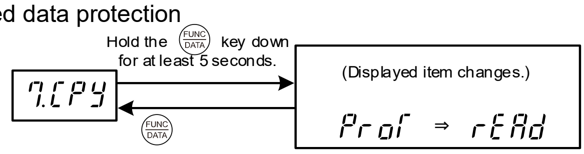
Note For switching the data protection status, be sure to hold the FUNC/DATA key down for at least 5 seconds. If the key is released within 5 seconds, press the PRG/RESET key to go back to the 7.CPY display and perform the keying operation again.

• Disabling the enabled data protection



While (7.CPY) is displayed, holding down the FUNC/DATA key for at least 5 seconds shows rEAd for 5 seconds and then switches to Prot, enabling the data protection.

• Disabling the enabled data protection



While (7.CPY) is displayed, holding down the FUNC/DATA key for at least 5 seconds shows rEAd for 5 seconds and then switches to Prot, disabling the data protection.

The following are restrictions and special notes concerning "Data Copying."

■ When you cannot perform the copy operation

Check if Err or diFF is blinking.

(1) If Err is blinking (writing error), the following factors should be considered.
   • There is not data saved in the keypad memory. (No data has been read since the shipment or the data reading process has been cancelled.)
   • There is a problem with the data saved in the keypad memory.
   • The inverter model differs.
   • Data writing has been performed during the inverter operation.
   • The data is protected in the inverter (function code F00=1).
   • The allow function code editing command "WE-KP" is off.
   • The reading operation has been performed with the protection enabled.
(2) If diFF is blinking, the following factors should be considered.
   • When the inverter type is the same:

   diFF is displayed if there is no data compatibility when data of a new ROM version has been written to an inverter with an old ROM version. (This does not occur when data of an old ROM version is written to an inverter with a new ROM version.) You can continue the copy process by pressing the FUNC/DATA key. In this case, the function codes added in the version upgrade are not copied but the existing function codes are copied and their compatibility is preserved.
   • When the inverter type differs, such as with special specification products:

   Do not perform copy since the compatibility will not be preserved.

3.4.8 Checking the status of communication with the host device: "Communication monitor: 9.S_ _ to 9.dAt"

You can check the communication commands with the host equipment and the monitor codes with Menu number 9 "Communication monitor: 9.S_ _ to 9.dAt".

Displayed number	Item	Display/Setting content
9.S_ _	Communication command (S code)*1	Shows the communication command (S code) value from the host equipment. Press the (FUNC/DATA) key, display the S code number you want to check with the (▲)/(▼) keys, and then press the (FUNC/DATA) key again to check the data. After checking the data, press the (PRG/RESET) key.
9.Add	Communication monitor (Address)*2	Enter the address of the function code you want to monitor. Press the (FUNC/DATA) key, enter a hexadecimal number, and then press the (FUNC/DATA) key to confirm.
9.dAt	Communication monitor (Data)*3*4	Displays the data of the function code set in 9.Add. After entering an address in 9.Add, press the (FUNC/DATA) key while in 9.dAt to display the data. You can display the data in two forms, in hexadecimal and in the decimal system as an integer or a fractional value. When you press the (▲) key: The data is displayed in hexadecimal. When you press the (▼) key: The data is displayed in the decimal system as an integer or a fractional value. After checking the data, press the (PRG/RESET) key.

*1 For details, refer to the RS-485 Communications User's Manual, "Command data."

*2 For details, refer to the RS-485 Communications User's Manual, "Monitor data 1" and following pages.

<About the address calculation formula>

1) Select the group number (in hexadecimal) of the function code you want to monitor from the table below and enter the two first digits.

Function code	Group number (hexadecimal)	Function code	Group number (hexadecimal)
M **	08_H	W3 **	18_H
M1 **	23_H	X **	10_H
W **	$0F_H$	X1 **	19_H
W1 **	16_H	Z **	11_H
W2 **	17_H		

2) Convert the xx number of the function code you want to monitor into hexadecimal and enter the last two digits.

Example 1: In the case of M10 (input power), M code = 08_H, number 10 = $0A_H$ → 080A

Example 2: In the case of W169 (IGBT lifetime), W1 code = 16_H, number 69 = 45_H → 1645

*3 About the data display form

If you want to display the data of the function code M10 (input power)

Enter the M10 address "080A" (hexadecimal) in 9.Add. (Refer to *2)

Then, press the (FUNC/DATA) key in 9.dAt to display "76.54". (When the input power = 76.54%)

Press the (▲) key in this state to display "1dE6" in hexadecimal.

Press the (▼) key to return to "76.54" in the decimal system.

*4 The data format of the hexadecimal display varies depending on the function code number.

For details, refer to the RS-485 Communications User's Manual, "Format number list."

3.4.9 Setting favorites function codes data: "Favorites: 0.FnC"

With menu number 0 "Favorites" in the Programming mode, you can display only the function codes set as favorites from all the function codes and change the function code data. There is no limit to the number of registered function codes.

Favorites registration and removal method

In menu number1 "Data Setting," press the ▸▸ and FUNC/DATA keys at the same time when the number of the function code you want to register is display to register it as a favorite.

The following example describes how to register F01 "Frequency Setting 1" as a favorite and remove it from the favorites.

While F01 is displayed, press the ▸▸ and FUNC/DATA keys at the same time to register it as a favorite. A dot indicating that the function code has been registered is displayed at the bottom right of the letter indicating the function code Gr. With the same procedure you can remove the function code from the favorites and make the dot disappear.

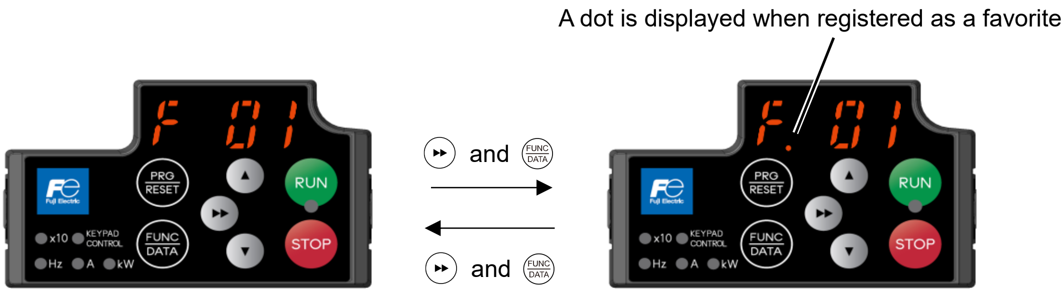


Figure 3.4-5 Registration and display as a favorite

Function codes registered as favorites can be copied using the Data Copying function with the keypad.

You may write "13" in H03 to erase all function codes registered as favorites.

3.5 Alarm mode

If an abnormal condition arises, the protective function is invoked and issues an alarm, then the inverter automatically enters Alarm mode. At the same time, an alarm code appears on the LED monitor.

3.5.1 Releasing the alarm and switching to Running mode

Remove the cause of the alarm and press the PRG/RESET key to release the alarm and return to Running mode. The alarm can be removed using the PRG/RESET key only when the alarm code is displayed.

3.5.2 Displaying the alarm history

It is possible to display the most recent 10 alarm codes in addition to the one currently displayed. Previous alarm codes can be displayed by pressing the ▲/▼ key while the current alarm code is displayed.

3.5.3 Displaying the status of inverter at the time of an alarm

Pressing the FUNC/DATA key while an alarm code is displayed allows you to check various information about the alarm (output frequency, output current, etc.) retroactively from the most recent to the last four alarms. The item number and data for each running status information will be displayed alternately.

Further, you can view various information items on the running status of the inverter using the ▲/▼ keys. The information displayed is the same as for Menu number 6 “Alarm Information” in Programming mode. For details, refer to Table 3.4-14 in “3.4.6 Reading alarm information: “Alarm Information: 6.AL .”

Pressing the PRG/RESET key while the running status information is displayed returns to the alarm code display.

Note When the running status information is displayed after removal of the alarm cause, pressing the PRG/RESET key twice returns to the alarm code display and releases the inverter from the alarm state. This means that the motor starts running if a run command has been received by this time.

3.5.4 Switching to Programming mode

You can also switch to Programming mode by pressing “STOP+PRG/RESET keys” simultaneously with the alarm displayed, and modify the function code data.

3.6 About the display content of Ethernet built-in type (E3N)

For information on the E3N front LED monitor, refer to Chapter 9 “9.3.8 About the display content of Ethernet built-in type (E3N).”

Chapter 4
TEST RUN PROCEDURE

This chapter describes basic settings required for making a test run.

Contents

4.1 Test Run Procedure Flowchart

Make a test run of the motor using the flowchart given below.
This chapter describes the test run procedure with motor 1 dedicated function codes.

Note For motor 2, replace those function codes with motor 2 dedicated ones.
These function codes are marked with "*."

For a comparison of the functions to replace, refer to Chapter 5 "5.3.7 A codes (Motor 2 parameters)."

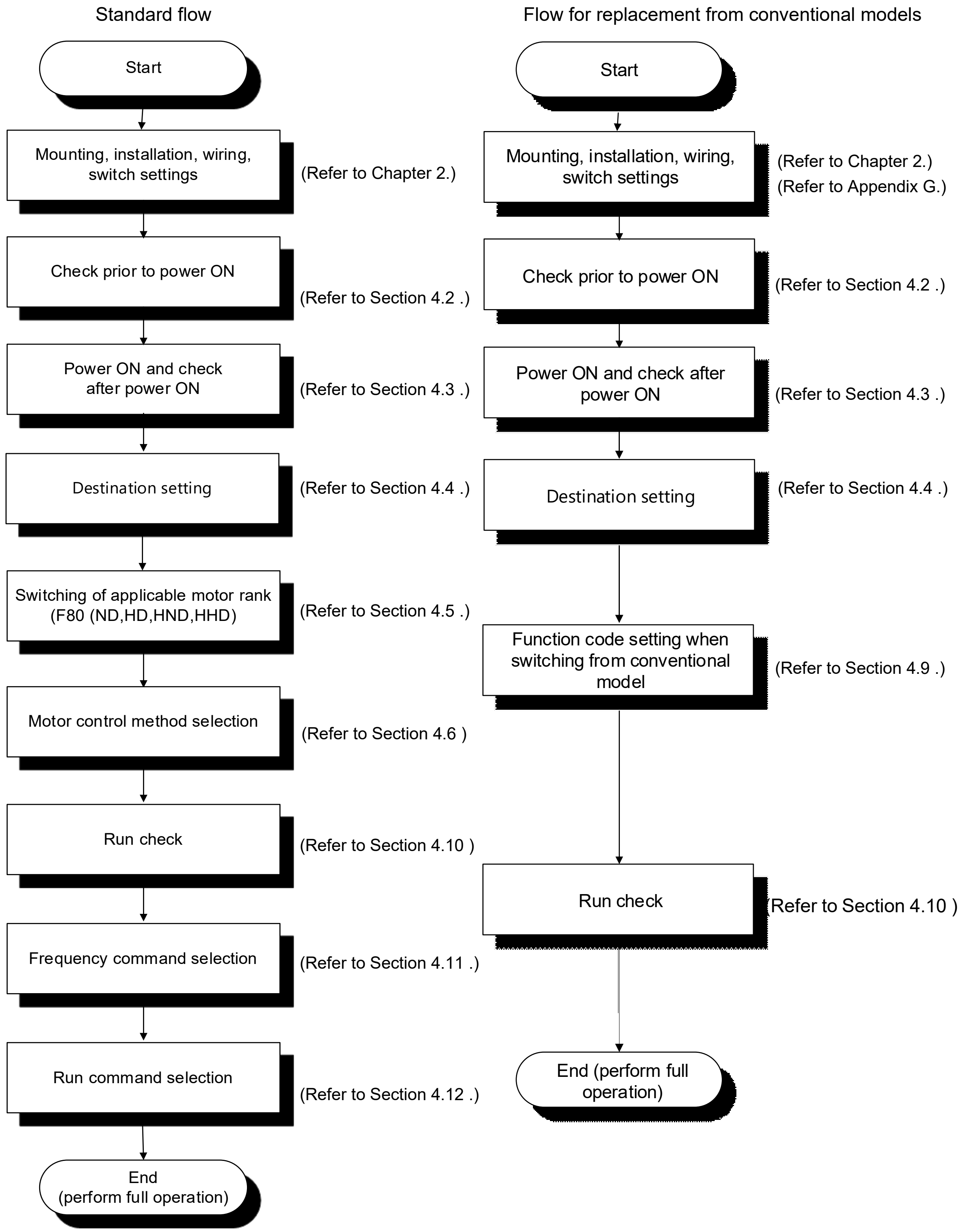


Figure 4.1-1 Test run procedure

4.2 Checking Prior to Powering On

Check the following before powering on the inverter.

(1) Check that the main power supply input terminals ([L1/R], [L2/S], and [L3/T] or [L1/L] and [L2/N]), the inverter output terminals ([U], [V], and [W]) and the inverter grounding terminal ([⏚G]) are correctly connected. (Refer to Figure 4.2-1.)

⚠WARNING⚠

- Never connect power supply wires to the inverter output terminals [U], [V], and [W]. Doing so and turning the power ON damages the inverter.
- Be sure to connect the grounding wires of the inverter and the motor to the ground electrodes.

Failure to observe this could result in electric shock.

(2) Check the control circuit terminals and main circuit terminals for short circuits or ground faults.

(3) Check for loose terminals, connectors and screws.

(4) Check that the motor is separated from mechanical equipment.

(5) Make sure that all switches of devices connected to the inverter are turned OFF.
(Powering on the inverter with any of those switches being ON may cause an unexpected motor operation.)

(6) Check that safety measures are taken against runaway of the equipment, e.g., measures to prevent people from coming too close to the equipment.

(7) Check that the optional DC reactor (DCR) is connected to the DC reactor terminals [P1] and [P(+)].

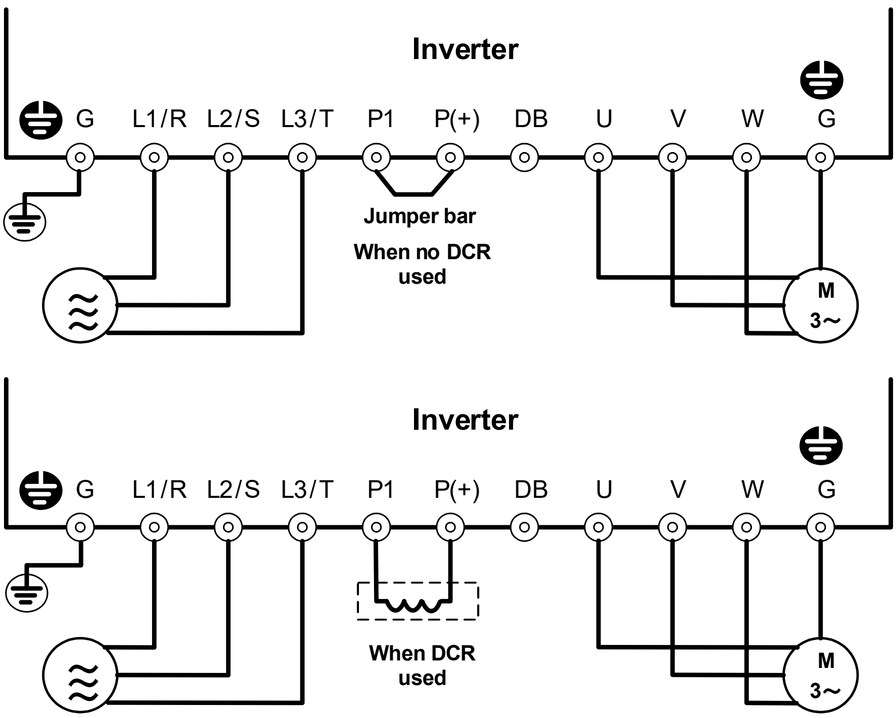


Figure 4.2-1 Connection of main circuit terminals (for three-phase type)

4.3 Powering ON and Checking

⚠WARNING⚠

- Be sure to mount the front cover before turning the power ON. Do not remove the cover when the inverter power is ON.
- Do not operate the unit with wet hands.

Failure to observe this could result in electric shock.

Turn the power ON and check the following points. The following is a case when no function code data is changed from the factory defaults.

- Basic type/EMC filter built-in type

(1) Check that the LED monitor displays 8.dES (indicating that the destination is not set), and that it is blinking. (Refer to Figure 4.3-1.)

(2) Check that the inverter cooling fans rotate. (Only with the models equipped with cooling fans.)

Figure 4.3-1 Display of the LED monitor after power-on

Note: With the E3E (EMC filter built-in type), noise may be generated from the reactor, the capacitor, or other parts inside the inverter due to distortions in the power supply voltage or other causes. This is not a malfunction.

- Ethernet built-in type

(1) Check that FE is displayed on the LED monitor for 1 s after the power has been supplied, and then that "- -" is displayed.

(2) Check that the inverter cooling fans rotate. (Only with the models equipped with cooling fans.)

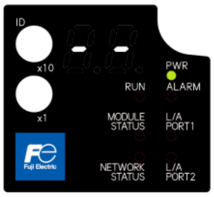


Figure 4.3-2 LED monitor display 1 s after power -on

4.4 Destination setting

For inverter type FRN****E3☐-2G/4G/7G (FRENIC-Ace Global Model), the destination must be set first after the initial power supply. Without setting the destination, the function code cannot be changed. The inverter cannot be operated either. By setting the destination, basic function codes such as rated voltage, rated frequency, etc. are initialized to general values in each region (Table 4.4-1). If the destination value setting is changed after the initial destination setting, it can be changed with (8.dES in the program mode menu or function code H101. If the destination is reset by (8.dES,, all function codes are initialized to the factory defaults. If the destination is set by H101, only the function codes in Table 4.4-1 are initialized to the values in Table 4.4-1. The destination can be selected from the regions of Japan, Asia, China, Europe, Americas and Korea.

If the function code set including the destination setting function code (H101) is copied with the data copy function or the FRENIC loader, manual destination setting is not required.

Set the initial destination as shown below. Refer to Figure 4.4-1 on the page 4-6.

(1) With (8.dES, displayed, press FUNC/DATA key first.

(2) ASIA (Asian region) is displayed first. For other regions, while pressing STOP key and press ▲ key or ▼ key to select the destination.

(3) After selecting the destination, SAVE is displayed by pressing FUNC/DATA key and the destination setting is completed. Then, 0.00 is displayed.

Table 4.4-1 Initial value for each destination

Destination		Asia	China	Europe	Americas	Korea	Japan
LED Display		ASIA	CHn	Eu	AMEr	Kor	JPn
H101	Destination	2	3	4	5	7	1
F03/A01	Maximum output frequency 1, 2	60.0Hz (200V) 50.0Hz (400V)	50.0Hz	50.0Hz	60.0Hz	60.0Hz	60.0Hz
E31/E36/E54	Frequency detection 1 to 3 (Level)						
F04/A02	Base frequency 1, 2						50.0Hz
F05/A03	Rated voltage at base frequency 1, 2	220/415V	200/380V	230/400V	230/460V	200/400V	200/400V
F06/A04	Maximum output voltage 1, 2						
F07/F08/ E10 to E15/ H54 to H56	Acceleration time/ Deceleration time	6.00s: Except below 20.0s: FRN0115E3☐-2G / FRN0059E3☐-4G or more					6.00s
F14	Restart mode after momentary power failure (Mode selection)	1	1	0	0	1	1
F44	Current limiter (Level)	Please refer to Table 4.5-2					
F80	ND/HD/HND/HHD mode selection	0 (HHD): FRN-E3E-7G 1 (HND): FRN-E3☐-2G(except for FRN0012, 0020E3☐-2G) 4 (HND): FRN-E3S/N-7G, FRN0012, 0020E3☐-2G 4 (ND): FRN-E3☐-4G					0 (HHD)
P02/A16	Motor 1, 2 (Rated capacity)	Set in kW			Set in HP	Set in kW	
P99/A39	Motor 1, 2 selection	5			1	5	
H96	STOP key priority / Start check function	0	0	0	2: E3N 3: E3S/E	0	0
K01	Multifunction keypad TP-A2SW (Language selection)	1	6	1	1	1	0

<table>
<tr><th colspan="2">Destination</th><th>Asia</th><th>China</th><th>Europe</th><th>Americas</th><th>Korea</th><th>Japan</th></tr>
<tr><td>F09/A05</td><td>Torque boost 1, 2</td><td colspan="3" rowspan="5">Standard value for Fuji IE3 motor</td><td>0.00%</td><td colspan="2" rowspan="5">Standard value for Fuji IE3 motor</td></tr>
<tr><td>F11/A07</td><td>Electronic thermal 1, 2 (Overload detection level)</td><td rowspan="4">Standard value for HP rating motor</td></tr>
<tr><td>E34/E37/E55</td><td>Overload early warning/Current detection 1 to 3</td></tr>
<tr><td>P03/A17</td><td>Motor 1, 2 (Rated current)</td></tr>
<tr><td>P06/A20</td><td>Motor 1, 2 (No-load current)</td></tr>
<tr><td>P07/A21</td><td>Motor 1, 2 (%R1)</td><td colspan="3" rowspan="8">Standard value for Fuji IE3 motor</td><td rowspan="8">Standard value for HP rating motor</td><td colspan="2" rowspan="8">Standard value for Fuji IE3 motor</td></tr>
<tr><td>P08/A22</td><td>Motor 1, 2 (%X)</td></tr>
<tr><td>P12/A26</td><td>Motor 1, 2 (Rated slip frequency)</td></tr>
<tr><td>P13/A27</td><td>Motor 1, 2 (Iron loss factor 1)</td></tr>
<tr><td>P16/A30 to P20/A34</td><td>Motor 1, 2 (Magnetic saturation factor 1 to 5)</td></tr>
<tr><td>P55/A55</td><td>Motor 1, 2 (Torque current under vector control)</td></tr>
<tr><td>P56/A56</td><td>Motor 1, 2 (Induced voltage factor under vector control)</td></tr>
<tr><td>P57/A57</td><td>Motor 1, 2 (For adjustment by manufacturer)</td></tr>
</table>

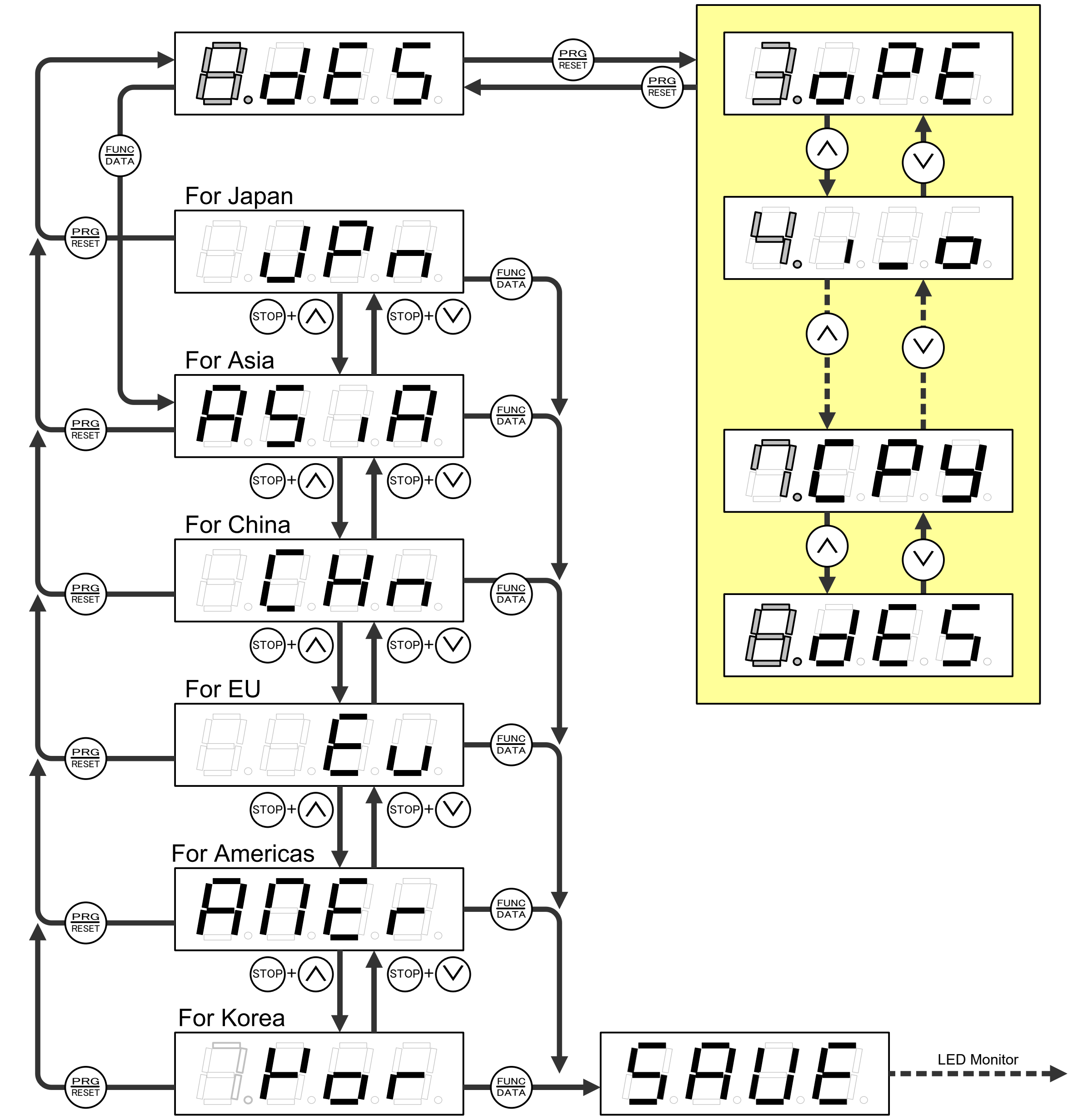


Figure 4.4-1 Destination setting status transition chart

4.5 Switching the Applicable Motor Rating (ND, HD, HND and HHD Modes)

The ND mode is set by default with the three-phase 200 V, three-phase 400 V, and single-phase 200 V series.

Changing the data of function code F80 switches the applicable motor rank to match load conditions. In HD, HND or HHD mode, the inverter drives a motor whose capacity is one or two rank lower than the inverter's one.

Pay attention since the ambient temperature requirement is 40 °C (104 °F) or less with FRN0012, 0020E3□-2G / FRN0007, 0012E3□-4G (HND Mode), FRN0004 to 0012E3□-7G (HND Mode) and FRN0002 to 0072E3□-4G (ND/HD Mode).

For details, refer to Chapter 12 “SPECIFICATIONS.”

Double key operation (STOP key + ▲/▼ keys) is required to change function code F80 data.

Table4.5-1

F80 Data	Drive mode	Application	Continuous current rating level	Overload capability
0	HHD mode	Heavy-duty load	Refer to the rated current value mentioned in Chapter 12 “SPECIFICATIONS.”	150% 1 min, 200% 0.5 s
1 (*1)	HND mode	General load	Refer to the rated current value mentioned in Chapter 12 “SPECIFICATIONS.”	120% 1 min
4 (*2)	HND mode	General load	Refer to the rated current value mentioned in Chapter 12 “SPECIFICATIONS.”	120% 1 min
3 (*3)	HD mode	Heavy-duty load	Refer to the rated current value mentioned in Chapter 12 “SPECIFICATIONS.”	150% 1 min
4 (*3)	ND mode	General load	Refer to the rated current value mentioned in Chapter 12 “SPECIFICATIONS.”	120% 1 min

Note: A box (□) in the above table replaces S (Basic type) or N (Ethernet built-in type) or E (EMC filter built-in type) depending on the enclosure.

*1: It cannot be selected on all models of the single-phase 200 V series, and on FRN0012, 0020E3□-2G.

*2: It can be selected only on FRN0001 to 0012E3□-7G, FRN0012, 0020E3□-2G. ND is displayed on the multi-function keypad.

*3: It cannot be selected in the single-phase 200 V series and the three-phase 200 V series.

Refer to Chapter 12 “SPECIFICATIONS” since ND, HD, and HND are not supported on some models due to the inverter rated voltage and capacity.

Each specification is subject to restrictions on the following function codes and internal processing.

Table 4.5-2

Function Code	Name	HHD mode	HND mode (F80=1)	HD mode (F80=3)	HND mode ND mode (F80=4)	Remarks
F21*	DC braking 1 (Overload detection level)	Setting range: 0 to 100%	Setting range: 0 to 80%		Setting range 0 to 60%	In the ND/HD/HND mode, a value out of the range, if specified, automatically changes to the maximum value allowable in the ND/HD/HND mode.
F26	Motor sound (Carrier frequency)	Setting range: 0.75 to 16 kHz	Setting range: 0.75 to 16 kHz FRN0001 to 0010E3△-2G FRN0030 to 0088E3△-2G FRN0002 to 0059E3□-4G 0.75 to 10 kHz FRN0115E3△-2G, FRN0072E3□-4G	Setting range: 0.75 to 16 kHz FRN0002 to 0059E3□-4G 0.75 to 10 kHz FRN0072E3□-4G	Setting range: ND mode 0.75 to 10 kHz FRN0002 to 0059E3□-4G 0.75 to 6 kHz FRN0072E3□-4G HND mode 0.75 to 10 kHz FRN0012, 0020E3△-2G FRN0001 to 0012E3△-7G	
F44	Current limiter (Overload detection level)	Initial value:180% FRN0001 to 0069E3△-2G FRN0002 to 0044E3□-4G FRN0001 to 0012E3□-7G Initial value:160% FRN0088, 0115E3△-2G FRN0059, 0072E3□-4G	Initial value: 130%	Initial value: 160%	Initial value: 130%	Switching the drive mode with function code F80 automatically initializes the data to the value specified at left.
—	Current indication and output	Based on the rated current level for HHD mode	Based on the rated current level for HND mode	Based on the rated current level for HD mode	Based on the rated current level for ND and HND mode	

Note: A box (□) in the above table replaces S (Basic type) or N (Ethernet built-in type) or E (EMC filter built-in type) depending on the enclosure.
A triangle (△) in the above table replaces S (Basic type) or N (Ethernet built-in type) depending on the enclosure.

Switching between the drive modes does not automatically change the motor rated capacity (P02*) to the one suitable for the rank-changed motor, so configure the P02* data to match the applied motor rating as required.

4.6 Selecting a Desired Motor Drive Control

The FRENIC-Ace supports the following motor drive controls.

Refer to "4.7 Performance Comparison for Drive Controls (Summary)" for the characteristics of each drive control method.

Table 4.6-1

F42* Data	Inverter drive control	Basic control	Motor type	Speed feedback	Speed control	Refer to:
0	V/f control with slip compensation inactive	V/f control	Induction motor	No	Frequency control	4.8.1 [1]
1	Dynamic torque vector control				Frequency control with Slip compensation	4.8.1 [3]
2	V/f control with slip compensation active					
3	V/f control with sensor *1			Yes	Frequency control with ASR (Auto speed regulator)	4.8.1 [2]
4	Dynamic torque vector control with sensor *1					4.8.1 [4]
5	Sensorless vector control	Vector control		No (estimated speed)	Speed control with automatic speed regulator (ASR)	4.8.1 [3]
6	Vector control with sensor *1			Yes		4.8.1 [4]
15	Sensorless vector control		PMSM	No (estimated speed)		4.8.2 [1]
16	Vector control with sensor *1			Yes		4.8.2 [2]

*1 Not supported with the Ethernet built-in type (E3N)

4.6.1 V/f control with slip compensation inactive for induction motor

Under this control, the inverter controls a motor with the voltage and frequency according to the V/f pattern specified by function codes. This control disables all automatically controlled features such as the slip compensation, so no unpredictable output fluctuation results, enabling stable operation with constant output frequency.

4.6.2 V/f control with slip compensation active for Induction motor

Applying any load to an induction motor causes a rotational slip due to the motor characteristics, decreasing the motor rotation. The inverter's slip compensation function first presumes the slip value of the motor based on the motor torque generated and raises the output frequency to compensate for the decrease in motor rotation. This prevents the motor from decreasing the rotation due to the slip. That is, this function is effective for improving the motor speed control accuracy.

The compensation value is specified by combination of function codes P12* (Rated slip frequency), P09* (Slip compensation gain for driving) and P11* (Slip compensation gain for braking).

H68* enables or disables the slip compensation function according to the motor driving conditions.

Table 4.6-2

H68* data	Motor driving conditions		Motor driving frequency range	
	Accl/Decel	Constant speed	Base frequency or below	Above the base frequency
0	Enable	Enable	Enable	Enable
1	Disable	Enable	Enable	Enable
2	Enable	Enable	Enable	Disable
3	Disable	Enable	Enable	Disable

4.6.3 Dynamic torque vector control for Induction motor

To get the maximum torque out of a motor, this control calculates the motor torque for the load applied and uses it to optimize the voltage and current vector output. Selecting this control automatically enables the auto torque boost and slip compensation function.

This control is effective for improving the system response to external disturbances such as load fluctuation, and the motor speed control accuracy. Note that the inverter may not respond to a rapid load fluctuation since this control is an open-loop V/f control that does not perform the current control, unlike the vector control. The advantages of this control include larger maximum torque per output current than that the vector control.

4.6.4 V/f Control with sensor for Induction motor

Applying any load to an induction motor causes a rotational slip due to the motor characteristics, decreasing the motor rotation.
Under V/f control with sensor, the inverter detects the motor rotation using the encoder mounted on the motor shaft and compensates for the decrease in slip frequency by the PI control to match the motor rotation with the commanded speed. This improves the motor speed control accuracy.

4.6.5 Dynamic torque vector control with sensor for Induction motor

The difference from the "V/f control with sensor" stated above is that this method calculates the motor torque for the load applied and uses the calculated torque to optimize the output voltage and current vectors for getting the maximal torque out of a motor. This control is effective for improving the system response to external disturbances such as load fluctuations, and for improving the motor speed control accuracy.

4.6.6 Sensorless vector control for Induction motor

This control estimates the motor speed based on the inverter's output voltage and current to use the estimated speed for speed control. In addition, it decomposes the motor drive current into the exciting and torque current components, and controls each of those components in vector. No PG (pulse generator) interface card is required. It is possible to obtain the desired response by adjusting the control constants (PI constants) using the speed regulator (PI controller).

With vector control, a difference (voltage margin) is required between the voltage that the inverter is capable of outputting and the motor induced voltage to a certain extent in order to control the motor current. Generally speaking, general-purpose motors are designed for use with commercial power supplies, but due to the need for this voltage margin, it is necessary to control the current by suppressing the motor terminal voltage. By doing so, it is not possible to deliver rated torque even when the original motor rated current is flowing. To ensure that the rated torque is delivered, it is necessary to increase the rated current (the same applies with vector control with sensor).

4.6.7 Vector Control with sensor for Induction motor

This control requires an optional PG (pulse generator) and an optional PG interface card to be mounted on a motor shaft and on the inverter, respectively. The inverter detects the motor's rotational position and speed from PG feedback signals and uses them in the control. In addition, it decomposes the motor drive current into the exciting and torque current components, and controls each of components in vector. It is possible to obtain the desired response by adjusting the control constants (PI constants) using the speed regulator (PI controller). This control enables the speed control with higher accuracy and quicker response than the vector control without sensor.

Note Slip compensation, dynamic torque vector control, sensorless vector control, and vector control with sensor use motor constants. Consequently, the following conditions should be satisfied; otherwise, full control performance may not be obtained.

- A single motor should be controlled per inverter.
- Motor parameters P02*, P03*, P06* to P13* should be properly configured or auto-tuning should be performed.
- If the capacity of the motor being controlled is smaller than the inverter rated capacity, the current detection resolution will deteriorate, and control performance will drop. In such cases, a motor and inverter combination up to one rank lower is recommended.
- The wiring distance between the inverter and motor should be 50 m (164 ft) or less for FRN0001 to 0020E3☐-2G / FRN0002 to 0012E3☐-4G / FRN0001 to 0012E3☐-7G, and 100 m (328.084 ft) or less for FRN0030 to 0115E3☐-2G / FRN0022 to 0072E3☐-4G. If it is longer, the inverter may not control the motor due to leakage current flowing through stray capacitance to the ground or between wires. Especially, small capacity inverters whose rated current is also small may be unable to control the motor correctly even when the wiring is less than 100 m (328 ft). In that case, make the wiring length as short as possible or use a wire with small stray capacitance (e.g., loosely-bundled cable) to minimize the stray capacitance.

4.6.8 Sensorless vector control (PMSMs (permanent magnet synchronous motor))

This control estimates the motor speed based on the inverter's output voltage and current to use the estimated speed for speed control. In addition, it decomposes the motor drive current into the exciting and torque current components, and controls each of those components in vector. No PG (pulse generator) interface card is required. It is possible to obtain the desired response by adjusting the control constants (PI constants) using the speed regulator (PI controller).

4.6.9 Vector control with sensor (PMSMs)

This control requires an optional PG (pulse generator) and an optional PG interface card to be mounted on a motor shaft and on the inverter, respectively. The inverter detects the motor's rotational position and speed from PG feedback signals and uses them in the control. In addition, it decomposes the motor drive current into the exciting and torque current components, and controls each of components in vector. It is possible to obtain the desired response by adjusting the control constants (PI constants) using the speed regulator (PI controller).

This control enables the speed control with higher accuracy and quicker response than the sensorless vector control without.

Note Sensorless vector control/vector control with sensor (PMSM) is enabled only when motor 1 is selected. Pay sufficient attention since the motor may be damaged when the PMSM is driven with motor 2 selected. For information on motor switching, refer to "Chapter 5 5.3.7 A codes (Motor 2 parameters)."

Sensorless vector control/vector control with sensor (PMSM) uses the motor constant. Consequently, the following conditions should be satisfied; otherwise, full control performance may not be obtained.

- A single motor should be controlled per inverter.
- Motor parameters P02, P03, P30 and P60 to P63 should be properly configured. Or, auto-tuning (P04) should be performed.
- If the capacity of the motor being controlled is smaller than the inverter rated capacity, the current detection resolution will deteriorate, and control performance will drop. In such cases, a motor and inverter combination up to one rank lower is recommended.
- The wiring distance between the inverter and motor should be 50 m (164 ft) or less for FRN0001 to 0020E3☐-2G / FRN0002 to 0012E3☐-4G / FRN0001 to 0012E3☐-7G, and 100 m (328.084 ft) or less for FRN0030 to 0115E3☐-2G / FRN0022 to 0072E3☐-4G. If it is longer, the inverter may not control the motor due to leakage current flowing through stray capacitance to the ground or between wires. Especially, small capacity inverters whose rated current is also small may be unable to control the motor correctly even when the wiring is less than 100 m (328 ft). In that case, make the wiring length as short as possible or use a wire with small stray capacitance (e.g., loosely-bundled cable) to minimize the stray capacitance.
- To use the inverter with the output frequency exceeding 120 Hz (in case of ND mode, up to 120 Hz), it is recommended that the carrier frequency (F26) be set to 5 kHz or higher.

4.7 Performance Comparison for Drive Controls (Summary)

Each drive control has advantages and disadvantages. Table 4.8-1 compares the different drive controls, showing their relative performance in each characteristic. Select the one that shows high performance in the characteristics that are important in your machine. In rare cases, the performance shown below may not be obtained due to various conditions including motor characteristics or mechanical rigidity. The final performance should be determined by adjusting the speed control system or other elements with the inverter being connected to the machine (load).
If you have any questions, contact your Fuji Electric representative.

Table 4.8-1

F42* data	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**15**	**16**
Inverter drive control	**V/f control: without slip compensation**	**Vector control without sensor (Dynamic torque vector control)**	**V/f control: with slip compensation**	**V/f Control with sensor**	**V/f Control with sensor**	**Sensorless vector control**	**Vector control with sensor**	**Sensorless vector control**	**Vector control with sensor**
Applicable motor	Induction motor							PMSM	
PG (pulse generator, encoder)	Not required	Not required	Not required	Required	Required	Not required	Required	Not required	Required
Motor parameters (Tuning, data sheet)	Not required	Required	Required (Slip frequency)	Not required	Required	Required	Required	Required	Required
Speed control (speed regulator)	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Current control (current regulator)	No	No	No	No	No	Yes	Yes	Yes	Yes
Output frequency accuracy	◎	△	△	△	△	△	△	△	△
Speed control accuracy	▲	△	▲	◎	◎	○	◎	◎	◎
Speed control response	▲	△	△	◦	○	○	◎	○	◎
Zero speed control	—	—	—	—	—	△	◎	△ (motor dependent)	◎
Torque accuracy	▲	○	▲	▲	○	◎	◎	○	◎
Torque responsiveness	▲	△	▲	▲	△	○	◎	○	◎
Starting torque	▲	○	▲	▲	○	○	◎	△	◎
Maximum torque	◎	◎	◎	◎	◎	Y (Control based on output voltage ≈ power supply voltage)	Y (Control based on output voltage ≈ power supply voltage)	Y (Control based on output voltage ≈ power supply voltage)	Y (Control based on output voltage ≈ power supply voltage)
Torque control	Not possible	Not possible	Not possible	Not possible	Not possible	Possible	Possible	Not possible	Possible
Operation with multiple motors	Possible	Not possible	Not possible	Not possible	Not possible	Not possible	Not possible	Not possible	Not possible
Main applications	Variable speed applications for which responsiveness, speed/torque accuracy are unnecessary	Variable speed applications for which starting torque, torque accuracy are necessary, but for which speed accuracy is not	Variable speed applications for which speed accuracy is necessary to some extent, but for which a level of responsiveness and torque accuracy requiring the use of an encoder is not	Variable speed applications for which speed accuracy is necessary, but for which responsiveness and torque accuracy are not	Variable speed applications for which starting torque and speed accuracy are necessary	Variable speed applications for which starting torque, speed/torque responsiveness, and accuracy are necessary to some extent, but not at a level that requires the use of an encoder	Variable speed applications for which starting torque, speed/torque responsiveness, and high-accuracy control are necessary	Variable speed applications for which responsiveness and speed accuracy are necessary to some extent, but for which a level of starting torque that requires the use of an encoder is not	Variable speed applications for which starting torque, speed/torque responsiveness, and high-accuracy control are necessary

Relative performance symbols: ◎: Excellent, ○: Good, △: Effective, ▲: Less effective, —: Not effective

4.8 Configuring Function Codes for Drive Controls

The relation of the motor control method, motor selection and motor parameter setting is shown in Figure 4.8-1. It is necessary to change the motor parameter setting depending on the driven motor.

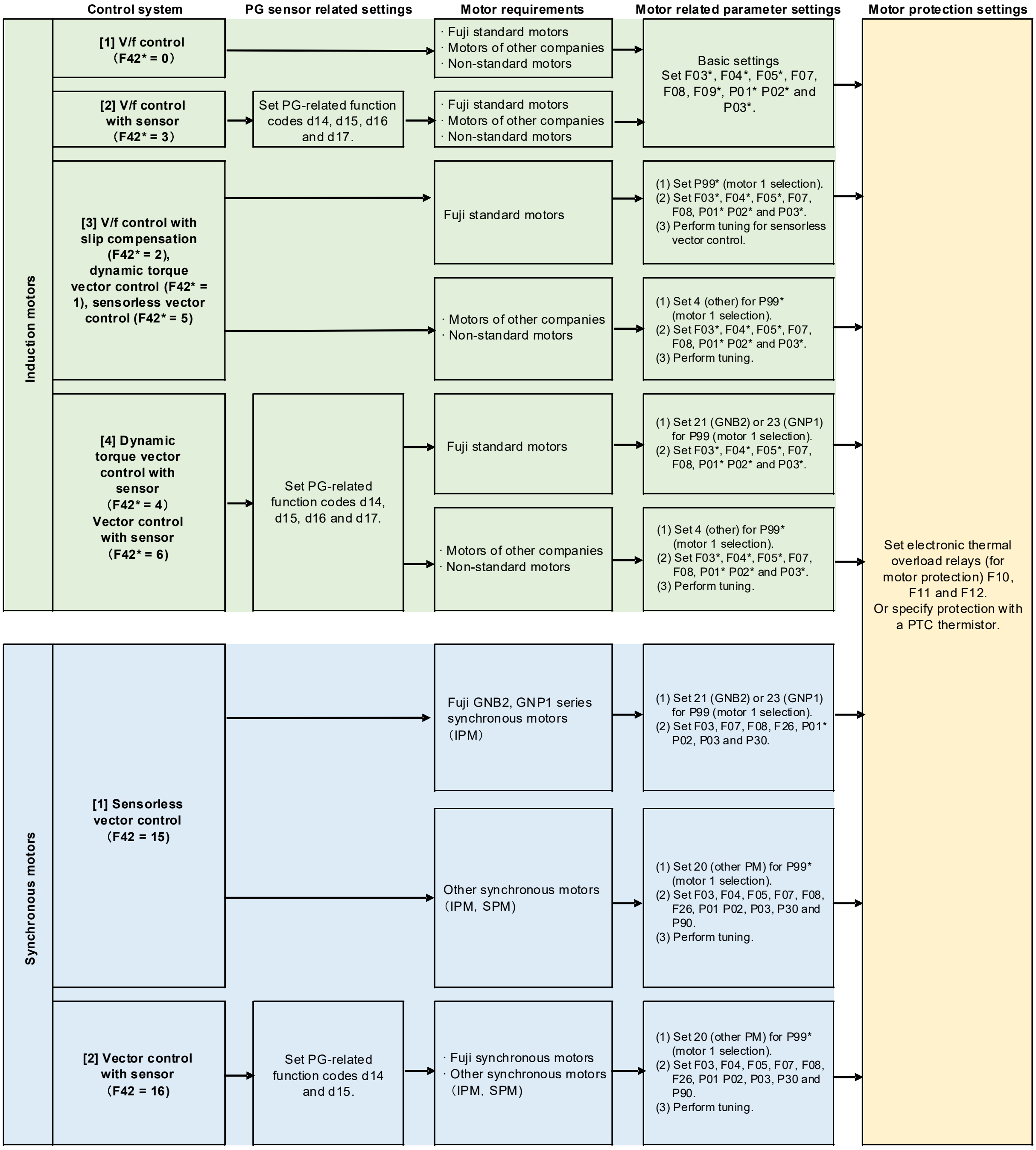


Figure 4.8-1

Note Factory defaults are set to drive the induction motor with V/f control. (F42 = 0)
The motor cannot be driven properly if the PMSM is connected.

If the PMSM is driven, it is necessary to set F42=15 or 16 to change the drive control mode for driving the PMSM.

For details, refer to the basic settings in “4.8.2 PMSM operation.”

Note If F42 is changed to any other value from 15/16 or vice versa, settings related to motor parameters such as F04, F05, and P01 will be changed. In this case, re-configuration is required.

For details, refer to Chapter 5 “5.3.4 P codes (Motor 1 parameters).”

Tip It is better to execute the first test run under speed control temporarily even if torque control (H18 = 2 or 3) is used.
It is recommended to change to torque control for the test run after checking that the operation is normal under speed control (H18 = 0).

4.8.1 Driving an Induction Motor (Induction motor)

[1] If running the motor with simple V/f control

Basic Settings

Under the V/f control (F42* = 0), any of the following cases requires configuring the basic function codes given below and auto-tuning. For the motor ratings, check the ratings printed on the motor's nameplate. For design values of the machine, ask system integrators or machine manufacturers about them.

For details on how to modify the function code data, refer to Chapter 3 “3.4.1 Setting function codes: “Data Setting: 1.F _ _ through 1.P _ _”.”

Table 4.8-1

Function code	Name	Function code data	Factory default
F 04*	Base frequency 1	Motor ratings (printed on the nameplate of the motor)	Please refer to Table 4.4-1 Initial value for each destination
F 05*	Rated voltage at base frequency 1		
P 99*	Motor 1 selection	0: Fuji standard motors, 8-series 3: Fuji standard motors, 6-series 4. Non-standard motors, motors of other companies 5: Fuji premium efficiency motor	
P 02*	Motor 1 (Rated capacity)	Applicable motor capacity	Standard applicable motor capacity
F 03*	Maximum frequency 1	Machine design values (Note) For the test run of the motor, increase values so that they are longer than your machine design values. If the specified time is short, the inverter may not run the motor properly.	Please refer to Table 4.4-1 Initial value for each destination
F 07	Acceleration time 1 (Note)		6.00 (s)
F 08	Deceleration time 1 (Note)		

Note When accessing the function code P02*, take into account that changing the P02* data automatically updates the data of the function codes P03*, P06* to P23*, P55*, P56*, and H46.

If using control functions such as auto torque boost, torque calculation value monitoring, auto energy saving, torque limiting, anti-regenerative control, auto search, slip compensation, torque vectors, droop control, and overload stop function, it is necessary to set the appropriate motor constants.

In any of the following cases, the full control performance may not be obtained from the inverter because the motor parameters differ from the factory defaults, so perform auto-tuning.

- The driven motor is Fuji standard motors, 6-series（P99*=3）
- The driven motor is a non-Fuji or a Fuji non-standard one（P99*=4）
- The wiring distance between the inverter and the motor is too long (generally 20 m (66 ft) or more).
- A reactor is installed between the inverter and the motor.

Refer to "[5] Induction motor tuning method" if performing tuning.

[2] If running the motor with V/f control with sensor

Configuring the function codes concerning a PG (pulse generator)

Configuring the function codes concerning a PG (pulse generator) and PG signals If "V/f control with sensor (F42*=3)", "Dynamic torque vector control with sensor(F42*=4)" or "Vector control with sensor (F42*=6)" is used, setting of the following function codes is necessary to receive the rotation direction and speed detection signal from the speed sensor correctly.

For details on how to modify the function code data, refer to Chapter 3 "3.4.1 Setting function codes: "Data Setting: 1.F _ _ through 1.P _ _"."

Table 4.8-2

Function code	Name	Function code data	Default value
d 14	PG option Ch2 *1 Pulse input format	2: A, B phase 90° phase difference (B phase lead) 3: A, B phase 90° phase difference (A phase lead)	2: A, B phase (B phase lead)
d 15	PG option Ch2 *1 Pulse count	Pulse count of the control target motor encoder 0400 (HEX) / 1024 P/R	0400 (HEX)
d 16	PG option Ch2 *1 Scaling factor 1	Reduction ratio between the motor and the encoder If it is directly connected to the motor shaft, the factory default value "1" does not need to be changed. Motor speed = Encoder speed × (d17) / (d16)	1
d 17	PG option Ch2 *1 Scaling factor 2		1

*1 If PG input switching "PG-SEL" (data = 83) has not been set for function codes E01 to E09, the motor runs based on encoder input at the speed feedback side.
For details on operation when "PG-SEL" is set, refer to "■ PG input switching "PG-SEL" assignment" in Chapter 5 "5.3.2 E codes (Extension terminal functions)."

Note: If the rotation direction/speed detection signal from the encoder does not match with the motor rotation direction, excessive current is applied. In the case of the vector control with speed sensor, the motor does not reach the set frequency but rotates slowly at the speed equivalent to the slip frequency. In this case, check that the phase order of motor wires is correct and that the encoder wires are correctly connected and are not broken.

Tip: In 4_17 to 4_18 of I/O check, the number of feedback pulses per second of AB phase and Z phase can be checked. In 3_29 of the drive monitor, the frequency [Hz] calculated from the speed detection signal from the encoder can be checked. These are displayed regardless of the control method if the PG option card is mounted and the encoder is wired.

Fuji regards counter-clockwise CCW as the forward rotation direction viewed from the motor output shaft as shown in Figure 4.8-2. During rotation in the forward direction, the encoder pulse forms a forward rotation signal (B phase leads by 90 degrees), and during rotation in the reverse direction, a reverse rotation signal (A phase leads by 90 degrees).

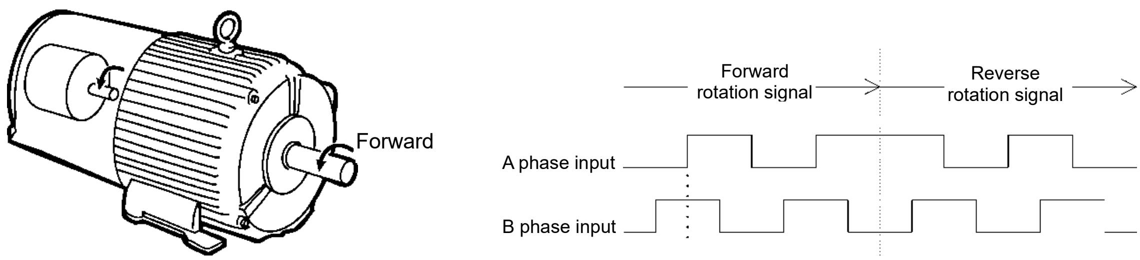


Figure 4.8-2

Note: In the case of using motors which comply with IEC standard, their rotation directions are opposite to that in Figure 4.8-2.

Basic Settings

If using “V/f control with sensor (F42* = 3)”, it is necessary to set the basic function codes below.

Configure the function codes listed below according to the motor ratings and design values of the machine. For the motor ratings, check the ratings printed on the motor's nameplate. For design values of the machine, ask system integrators or machine manufacturers about them.

For details on how to modify the function code data, refer to Chapter 3 “3.4.1 Setting function codes: “Data Setting: 1.F _ _ through 1.P _ _”.”

(1) Setting motor basic constants

Table 4.8-3

<table>
<tr><th>Function code</th><th>Name</th><th>Function code data</th><th>Factory default</th></tr>
<tr><td>F 04*</td><td>Base frequency 1</td><td rowspan="2">Motor ratings (printed on the nameplate of the motor)</td><td rowspan="3">Please refer to Table 4.4-1 Initial value for each destination</td></tr>
<tr><td>F 05*</td><td>Rated voltage at base frequency 1</td></tr>
<tr><td>P 99*</td><td>Motor 1 selection</td><td>0: Fuji standard motors, 8-series
3: Fuji standard motors, 6-series
4. Non-standard motors, motors of other companies
5: Fuji premium efficiency motor</td></tr>
<tr><td>P 02*</td><td>Motor 1 (Rated capacity)</td><td>Applicable motor capacity</td><td>Standard applicable motor capacity</td></tr>
<tr><td>F 03*</td><td>Maximum frequency 1</td><td rowspan="3">Machine design values
(Note) For the test run of the motor, increase values so that they are longer than your machine design values.
If the specified time is short, the inverter may not run the motor properly.</td><td>Please refer to Table 4.4-1 Initial value for each destination</td></tr>
<tr><td>F 07</td><td>Acceleration time 1 (Note)</td><td rowspan="2">6.00 (s)</td></tr>
<tr><td>F 08</td><td>Deceleration time 1 (Note)</td></tr>
</table>

(2) Initializing motor constants

After the above configuration, initialize motor 1 with the function code (H03 = 2).
Necessary motor constant related function codes are automatically set. For details, refer to Chapter 5 "5.3.5 H codes (High-performance Functions)."

Note When accessing the function code P02*, take into account that changing the P02* data automatically updates the data of the function codes P03*, P06* to P23*, P55*, P56*, and H46.

If using control functions such as auto torque boost, torque calculation value monitoring, auto energy saving, torque limiting, anti-regenerative control, auto search, slip compensation, torque vectors, droop control, and overload stop function, it is necessary to set the appropriate motor constants.

In any of the following cases, the full control performance may not be obtained from the inverter because the motor parameters differ from the factory defaults, so perform auto-tuning.

- The driven motor is Fuji standard motors, 6-series (P99*=3)
- The driven motor is a non-Fuji or a Fuji non-standard one (P99*=4)
- The wiring distance between the inverter and the motor is too long (generally 20 m (65.6 ft) or more).
- A reactor is installed between the inverter and the motor.

Refer to "[5] Induction motor tuning method" if performing tuning.

[3] If running the motor with V/f control with slip compensation, dynamic torque vector control, or sensorless vector control

Basic Settings

If using “V/f control with slip compensation (F42* = 2)”, “Dynamic torque vector control (F42* = 1”, or “Sensorless vector control (F42* = 5)”, it is necessary to set the basic function codes below.

Configure the function codes listed below according to the motor ratings and design values of the machine. For the motor ratings, check the ratings printed on the motor's nameplate. For design values of the machine, ask system integrators or machine manufacturers about them.

For details on how to modify the function code data, refer to Chapter 3 “3.4.1 Setting function codes: “Data Setting: 1.F _ _ through 1.P _ _”.”

Fuji standard motors

(1) Setting motor basic constants

Table 4.8-4

Function code	Name	Function code data	Factory default
F 04*	Base frequency 1	Motor ratings (printed on the nameplate of the motor)	Please refer to Table 4.4-1 Initial value for each destination
F 05*	Rated voltage at base frequency 1		
P 99*	Motor 1 selection	0: Fuji standard motors, 8-series 3: Fuji standard motors, 6-series 5: Fuji premium efficiency motor	
P 02*	Motor 1 (Rated capacity)	Applicable motor capacity	Standard applicable motor capacity
F 03*	Maximum frequency 1	Machine design values (Note) For the test run of the motor, increase values so that they are longer than your machine design values. If the specified time is short, the inverter may not run the motor properly.	Please refer to Table 4.4-1 Initial value for each destination
F 07	Acceleration time 1 (Note)		6.00 (s)
F 08	Deceleration time 1 (Note)		

(2) Initializing motor constants

After the above configuration, initialize motor 1 with the function code (H03 = 2).
Necessary motor constant related function codes are automatically set. For details, refer to Chapter 5 "5.3.5 H codes (High performance functions).".

Note
- When accessing the function code P02*, take into account that changing the P02* data automatically updates the data of the function codes P03*, P06* to P23*, P55*, P56*, and H46.
- If using a Fuji standard motor, 6-series (P99* = 3), the motor constants for the Fuji standard motor, 8-series are input. Either input the motor constants for the 6-series manually, or perform tuning.
- Even for Fuji standard motors, perform tuning in such cases as when the length of wiring between the inverter and motor is long (generally 20 m (65.6 ft) or more), or if connecting a reactor between the inverter and motor.

(3) Performing tuning

Even for Fuji standard motors, be sure to perform tuning if using sensorless vector control.

Perform tuning in accordance with the “[5] Induction motor tuning method.”

<u>Fuji non-standard motors, motors of other companies</u>

(1) Setting motor basic constants

Table 4.8-5

<table>
<tr><th>Function code</th><th>Name</th><th>Function code data</th><th>Factory default</th></tr>
<tr><td>P99 *</td><td>Motor 1 selection</td><td>4: Other motors</td><td rowspan="3">Please refer to Table 4.4-1 Initial value for each destination</td></tr>
<tr><td>F04 *</td><td>Base frequency 1</td><td rowspan="4">Motor rated value (printed on motor rating nameplate)

If the motor synchronous rotation speed is identified, calculate and set F04* by the following formula.

$\frac{\text{Synchronous speed}}{120} \times \text{No. of poles}$</td></tr>
<tr><td>F05 *</td><td>Rated voltage at base frequency 1</td></tr>
<tr><td>P02 *</td><td>Motor 1 (Rated capacity)</td><td>Standard applicable motor capacity</td></tr>
<tr><td>P03 *</td><td>Motor 1 (Rated current)</td><td rowspan="3">Please refer to Table 4.4-1 Initial value for each destination</td></tr>
<tr><td>P06 *</td><td>Motor 1 (No-load current)</td><td>Setting is not necessary if rotation tuning is possible.
In case of difficult to execute rotation tuning: Set the value in the motor test report or the value calculated by the following formula.
$\sqrt{(P03)^2-(P55)^2}$</td></tr>
<tr><td>F03 *</td><td>Maximum frequency 1</td><td rowspan="3">Machine design values
(Note) For the test run of the motor, increase values so that they are longer than your machine design values.
If the specified time is short, the inverter may not run the motor properly.</td></tr>
<tr><td>F07</td><td>Acceleration time 1 (Note)</td><td rowspan="2">6.00 (s)</td></tr>
<tr><td>F08</td><td>Deceleration time 1 (Note)</td></tr>
</table>

Note When accessing the function code P02*, take into account that changing the P02* data automatically updates the data of some function codes. For details, refer to <u>Chapter 5 "5.3.4 P codes (Motor 1 parameters) and 5.3.5 H codes (High performance functions)."</u>

Note By initializing motor constants after setting the above function codes, there will be function codes that are rewritten automatically. For details, refer to <u>Chapter 5 "5.3.4 P codes (Motor 1 parameters) and 5.3.5 H codes (High performance functions)."</u>

(2) Performing tuning

Perform tuning in accordance with the “[5] Induction motor tuning method.”

[4] If running the motor with dynamic torque vector control with sensor or vector control with sensor

Configuring the function codes concerning a PG (pulse generator)

If the motor is driven under “Dynamic torque vector control with sensor (F42* = 4)“ or “Vector control with sensor (F42* = 6),” it is necessary to set the motor parameters.

Set function codes in accordance with “**[2]** If running the motor with V/f control with sensor -Configuring the function codes concerning a PG (pulse generator) and PG signals.”

Basic Settings

If using “Dynamic torque vector control with sensor (F42* = 4)” or “Vector control with sensor (F42* = 6)”, it is necessary to set the basic function codes below.

Configure the function codes listed below according to the motor ratings and design values of the machine. For the motor ratings, check the ratings printed on the motor's nameplate. For design values of the machine, ask system integrators or machine manufacturers about them.

For details on how to modify the function code data, refer to Chapter 3 “3.4.1 Setting function codes: “Data Setting: 1.F _ _ through 1.P _ _”.”

Fuji standard motors

(1) Setting motor basic constants

Table 4.8-6

Function code	Name	Function code data	Factory default
F04*	Base frequency 1	Motor ratings (printed on the nameplate of the motor)	Please refer to Table 4.4-1 Initial value for each destination
F05*	Rated voltage at base frequency 1		
P99*	Motor 1 selection	0: Fuji standard motors, 8-series 3: Fuji standard motors, 6-series 5: Fuji premium efficiency motor	
P01*	Motor 1 (No. of poles)	No. of applicable motor poles	4 (poles)
P02*	Motor 1 (Rated capacity)	Applicable motor capacity	Standard applicable motor capacity
F03*	Maximum frequency 1	Machine design values (Note) For the test run of the motor, increase values so that they are longer than your machine design values. If the specified time is short, the inverter may not run the motor properly.	Please refer to Table 4.4-1 Initial value for each destination
F07	Acceleration time 1 (Note)		6.00 (s)
F08	Deceleration time 1 (Note)		

(2) Initializing motor constants

After the above configuration, initialize motor 1 with the function code (H03 = 2).
Necessary motor constant related function codes are automatically set. For details, refer to Chapter 5 "5.3.5 H codes (High performance functions)."

Note
- When accessing the function code P02*, take into account that changing the P02* data automatically updates the data of the function codes P03*, P06* to P23*, P55*, P56*, and H46.
- If using a Fuji standard motor, 6-series (P99* = 3), the motor constants for the Fuji standard motor, 8-series are input. Either input the motor constants for the 6-series manually, or perform tuning.
- Even for Fuji standard motors, perform tuning in such cases as when the length of wiring between the inverter and motor is long (generally 20 m (65.6 ft) or more), or if connecting a reactor between the inverter and motor.

Fuji non-standard motors, motors of other companies

(1) Setting motor basic constants

Table 4.8-7

<table>
<tr><th>Function code</th><th>Name</th><th>Function code data</th><th>Factory default</th></tr>
<tr><td>P99*</td><td>Motor 1 selection</td><td>4: Other motors</td><td rowspan="3">Please refer to Table 4.4-1 Initial value for each destination</td></tr>
<tr><td>F04*</td><td>Base frequency 1</td><td rowspan="5">Motor rated value (printed on motor rating nameplate)

If the motor synchronous rotation speed is identified, calculate and set F04* by the following formula.

$\frac{\text{Synchronous speed}}{120} \times \text{No. of poles}$</td></tr>
<tr><td>F05*</td><td>Rated voltage at base frequency 1</td></tr>
<tr><td>P01*</td><td>Motor 1 (No. of poles)</td><td>4 (poles)</td></tr>
<tr><td>P02*</td><td>Motor 1 (Rated capacity)</td><td>Standard applicable motor capacity</td></tr>
<tr><td>P03*</td><td>Motor 1 (Rated current)</td><td rowspan="3">Please refer to Table 4.4-1 Initial value for each destination</td></tr>
<tr><td>P06*</td><td>Motor 1 (No-load current)</td><td>Setting is not necessary if rotation tuning is possible.

In case of difficult to execute rotation tuning: Set the value in the motor test report or the value calculated by the following formula.
$\sqrt{(P03)^2-(P55)^2}$</td></tr>
<tr><td>F03*</td><td>Maximum frequency 1</td><td rowspan="3">Machine design values
(Note) For the test run of the motor, increase values so that they are longer than your machine design values. If the specified time is short, the inverter may not run the motor properly.</td></tr>
<tr><td>F07</td><td>Acceleration time 1 (Note)</td><td rowspan="2">6.00 (s)</td></tr>
<tr><td>F08</td><td>Deceleration time 1 (Note)</td></tr>
</table>

Note: When accessing the function code P02*, take into account that changing the P02* data automatically updates the data of some function codes. For details, refer to Chapter 5 "5.3.4 P codes (Motor 1 parameters) and 5.3.5 H codes (High performance functions)."

Note: By initializing motor constants after setting the above function codes, there will be function codes that are rewritten automatically. For details, refer to Chapter 5 "5.3.4 P codes (Motor 1 parameters) and 5.3.5 H codes (High performance functions)."

(2) Performing tuning

Perform tuning in accordance with the "[5] Induction motor tuning method."

[5] Induction motor tuning method

If performing tuning, do so using the following procedure after specifying settings based on the control method indicated previously (4.8.1 [1] to [4]).

■ Selection of tuning type

Check the situation of the machine and select “Tuning with the motor stopped (P04* = 1)” or “Tuning with the motor running (P04* = 2).” For the latter tuning, adjust the acceleration and deceleration times (F07 and F08) and specify the rotation direction that matches the actual rotation direction of the machine.

Note When selecting tuning with the motor running (P04* = 2), the motor will rotate at a speed 50% of the base frequency, allowing tuning to be performed safely.

Table 4.8-8

P04* Data	Tuning type	Motor parameters subjected to tuning	Operation	Select under the following conditions
1	Tuning with the motor stopped	Primary resistance (%R1) (P07*) Leakage reactance (%X) (P08*) Rated slip frequency (P12*) %X correction factor 1 (P53*)	Tuning with the motor stopped	Cannot rotate the motor.
2	Tuning while the motor is running	No-load current (P06*) Primary resistance (%R1) (P07*) Leakage reactance (%X) (P08*) Rated slip frequency (P12*) Magnetic saturation factor 1 to 5 (P16* to P20*) %X correction factor 1 (P53*)	Tune the %R1 and %X, with the motor stopped, tune the no-load current and magnetic saturation factor, with the motor running at 50% of the base frequency; tune the rated slip frequency again, with the motor stopped.	Can rotate the motor, provided that it is safe. Note that little load should be applied during tuning. Tuning with load applied decreases the tuning accuracy.
5	Tuning with the motor stopped (%R1, %X only)	Primary resistance (%R1) (P07*) Leakage reactance (%X) (P08*) %X correction factor 1 (P53*)	Tuning with the motor stopped	Cannot rotate the motor. *This tuning applies when only the wiring length has been changed during the actual installation after executing P04*=2 during a test run.

The tuning results of motor parameters will be automatically saved into their respective function codes.

If tuning by P04* is performed, the tuning results will be stored into P* codes (Motor 1* parameters).
To tune motor 2, execute tuning with A18.

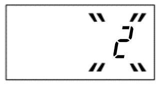
■ Preparation of machine

In preparation for tuning, remove the motor coupling with the load and deactivate the safety devices before rotation tuning.

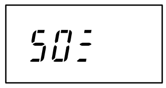
■ Tuning procedure

Note The following procedure is for **types other than the Ethernet built-in type (E3N)**.
Perform tuning **via FRENIC-Loader or Ethernet communication if using an E3N inverter**.

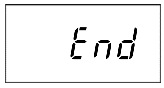
1) Set function code P04 to “1”, “2” or “5” and press the FUNC/DATA key.
   (“ 1 or 2 or 5 will blink slowly ”)
2) Enter a run command.
   (The factory default is RUN key on the keypad for forward rotation.)
   To switch to reverse rotation or to select the terminal signal “FWD” or “REV” as a run command, change the data of function code F02.
3) The moment a run command is entered, tuning starts, and the display shows the progress in %.
4) If P04* = 2, after the tuning in “3)” above, the motor is accelerated to approximately 50% of the base frequency and then tuning starts.
   Upon completion of measurements, the motor decelerates to a stop.
5) If the terminal signal “FWD” or “REV” is selected as a run command (F02 = 1), “End” appears upon completion of measurement. Turning the run command OFF completes the tuning.
   If the run command has been given through the keypad or the communications link, it automatically turns OFF upon completion of the measurements, which completes the tuning.
6) Upon completion of the tuning, the subsequent function code appears on the keypad.

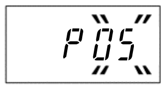


Blinking will slow down.



(Lights up)





(The subsequent function code

Note The initial setting for the speed regulator (ASR) is rather low to prevent hunting. However, hunting may occur during tuning due to mechanical conditions. If so, a tuning error (Er7) or speed mismatch (ErE) may occur. When Er7 occurs, lower the speed control gain, and when ErE occurs, cancel the speed mismatch detection (d23 = 0), and then perform tuning again.

■ Tuning errors (induction motors)

If the tuning result is incorrect, in the worst-case scenario, control performance will be adversely affected, possibly resulting in hunting or accuracy issues. Consequently, if the inverter determines that there is an abnormality in the tuning sequence or tuning results, “Er7” appears, and the tuning data is destroyed.

Listed below are possible causes that trigger tuning errors and measures.

Table 4.8-9

Possible tuning error causes	Er7 Error sub code (%X)	Details and measures
Error in tuning results	1 2 3 4	An interphase voltage unbalance or output phase loss has been detected. Tuning has resulted in an abnormally high or low value of a parameter due to the output circuit opened. ・If an abnormality occurs with the motor constants due to motor burnout, etc. ➔ Check for abnormalities with the motor wiring or the motor itself.
Sequence error	7 8 9	Before completion of tuning, a run command has been turned OFF. Or during tuning, terminal command “STOP” (Force to stop) or “BX” (Coast to a stop) has been entered. ➔ Do not stop the inverter running until completion of tuning.
Overcurrent error	6 10	During tuning, an excessively large current has flown. ➔Check the state of the machine brake. Check also that the motor can rotate mechanically. ➔Check whether the torque boost value is high and the current value is abnormally large at slow speed. ➔Check whether the acceleration time setting is short and the current limiter is operating.

Possible tuning error causes	Er7 Error sub code (%X)	Details and measures
Undervoltage	11	If DC intermediate voltage is low and tuning is performed. ➔Check whether the main power is input normally.
Tuning frequency error (only when P04=2)	13	The maximum frequency or the frequency limiter (high) has limited the output frequency. ➔Make the changes so that the limit value is 50% or more of the base frequency.
Acceleration time timeout (only when P04=2)	18	The output frequency has not reached 50% of the base frequency within the specified acceleration time "F07×300%". ➔ Increase the F07 setting.

For the method for checking the error subcodes, refer to Chapter 3 "3.4.6 Reading alarm information: "Alarm Information: 6.AL".
With the Ethernet built-in type, it is possible to read the function code (X03) and check the content of the error subcodes.
If any of these errors occurs, remove the error cause and perform tuning again, or consult your Fuji Electric representative.

Note If a filter other than the Fuji output filter (option) (OFL-☐☐☐-4A) is connected to the inverter's output (secondary) circuit, the tuning result cannot be assured. When replacing the inverter connected with such a filter, make a note of the old inverter's settings for the primary resistance %R1, leakage reactance %X, no-load current, and rated slip frequency, and specify those values to the new inverter's function codes.

Vibration that may occur when the motor's coupling is elastic can be regarded as normal vibration due to the output voltage pattern applied in tuning. The tuning does not always result in an error; however, run the motor and check its running state.

4.8.2 PMSM operation

[1] If running the motor with sensorless vector control (PMSMs)

Basic Settings

If using “Sensorless vector control (F42 = 15)”, it is necessary to set the basic function codes below.

Configure the function codes listed below according to the motor ratings and design values of the machine. For the motor ratings, check the ratings printed on the motor's nameplate. For design values of the machine, ask system integrators or machine manufacturers about them.

For details on how to modify the function code data, refer to Chapter 3 “3.4.1 Setting function codes: “Data Setting: 1.F _ _ through 1.P _ _”.”

Fuji standard PMSM (GNB2, GNP1 series)

(1) Setting motor basic constants

Table 4.8-10

Function code	Name	Function code data	Factory default
F26	Motor sound (carrier frequency)	2 kHz or more	2 kHz
F42	Drive control selection 1	15: Sensorless vector control (PMSMs)	0: V/f control without slip compensation
P99	Motor 1 selection	21: Fuji PMSM (GNB2 series) 23: Fuji PMSM (GNP1 series) If 15 is not set for F42, 21 or 23 cannot be set for P99.	Please refer to Table 4.4-1 Initial value for each destination
P02	Motor 1 (Rated capacity)	Applicable motor capacity	Standard applicable motor capacity
P30	PMSM 1 (magnetic pole position detection method)	Motor type and starting method 1: IPM	1: IPM
F03	Maximum frequency 1	Machine design values (Note) For the test run of the motor, increase values so that they are longer than your machine design values. If the specified time is short, the inverter may not run the motor properly.	Please refer to Table 4.4-1 Initial value for each destination
F15	Frequency limiter (upper limit)		70.0 (Hz)
F07	Acceleration time 1 (Note)		6.00 (s)
F08	Deceleration time 1 (Note)		

(2) Initializing motor constants

After setting the basic motor constants, motor constants are automatic set for each function code by initializing the motor constants with H03 = 2.

* If H03 is changed, double key operation with the "STOP key + ▲/▼ keys” is necessary.

* After initialization, the data of function code H03 automatically returns to “0” (Factory default value).

For details on how to make changes to function code data, refer to Chapter 3 “3.4.1 Setting up function codes “Data Setting: 1.F _ to 1.P _ _”.”

Fuji non-standard motors, motors of other companies

(1) Selection of motor type and pole position detection method

PMSMs are categorized into the following types based on the structure of the rotor.

a) SPM (Surface Permanent Magnet)
b) IPM (Interior permanent magnet)

The starting magnetic pole position detection method depends on the motor type. In most cases, the IPMs are generally used, but the SPMs are sometimes used. Check the specifications with the motor manufacturer before using PMSMs.

Set the initial magnetic position detection mode to the function code P30. For details, refer to Chapter 5 "5.3.4 P codes (Motor 1 parameters)."

If the motor type is unknown, set P30 = 1 if performing tuning, and P30 =0 if not.

(2) Setting motor basic constants

To drive another manufacturer's PMSM, set the motor parameters shown in Table 4.8 11 and execute offline tuning. Check the motor parameters on the motor rating nameplate or consult with the motor manufacturer before setting them.

Note Depending on the order, there may be cases where motor constants for PMSMs are set individually when the product is shipped. Please note that by initializing data using with H03, motor constant data will be lost. Record the motor constants prior to initialization.

Set motor constants after selecting sensorless vector control with F42 = 15.

Set the motor constants shown in the following table. The setting values are determined by the values on the motor nameplate and machine specifications. Check the nameplate values and machine specifications beforehand.

Table 4.8-11

<table>
<tr><th>Function code</th><th>Name</th><th>Function code data</th><th>Factory default</th></tr>
<tr><td>F 26</td><td>Motor sound (carrier frequency)</td><td>Check the motor specifications and set.</td><td>2 kHz</td></tr>
<tr><td>F 42</td><td>Drive control selection 1</td><td>15: Sensorless vector control (PMSMs)</td><td>0: V/f control without slip compensation</td></tr>
<tr><td>P 99</td><td>Motor 1 selection</td><td>20: Other motors (PMSMs)
If 15 is not set for F42, 20 cannot be set for P99.</td><td rowspan="3">Please refer to Table Initial value for each destination</td></tr>
<tr><td>F 04</td><td>Base frequency 1</td><td rowspan="5">Motor ratings (printed on the nameplate of the motor)
If the motor synchronous speed is known, calculate and set F04 by the following formula.
$\frac{\text{Synchronous speed}}{120} \times \text{No. of poles}$</td></tr>
<tr><td>F 05</td><td>Rated voltage at base frequency 1</td></tr>
<tr><td>P 01</td><td>Motor 1 (No. of poles)</td><td>4 (poles)</td></tr>
<tr><td>P 02</td><td>Motor 1 (Rated capacity)</td><td>Standard applicable motor capacity</td></tr>
<tr><td>P 03</td><td>Motor 1 (Rated current)</td><td>Please refer to Table Initial value for each destination</td></tr>
<tr><td>P 30</td><td>PMSM 1 (magnetic pole position detection method)</td><td>Motor type and starting method
If 0: Rotor structure (magnet layout) is unknown:
1: IPM
2: SPM
3: IPM (current draw method)
4: High-frequency superimposing method</td><td>1: IPM</td></tr>
</table>

<table>
<tr><th>Function code</th><th>Name</th><th>Function code data</th><th>Factory default</th></tr>
<tr><td>P 63</td><td>PMSM 1 (induced voltage)</td><td>Value described in motor test report
If the value is unknown, execute tuning with the motor running.</td><td>Fuji standard PMSM (GNB2 series) constant</td></tr>
<tr><td>P 64</td><td>PMSM 1 (iron loss factor)</td><td>Set the iron loss described in motor test report divided by Motor rated capacity: p 02.
Set 0% if the iron loss is unknown.</td><td>Fuji standard PMSM (GNB2 series) constant</td></tr>
<tr><td>P 90</td><td>PMSM 1 (overcurrent protection level)</td><td>Set the demagnetization limit current. Set to prevent demagnetizing the motor. If it is unknown, set approx. 200% of motor rated current.</td><td>Fuji standard PMSM (GNB2 series) constant</td></tr>
<tr><td>F 03</td><td>Maximum frequency 1</td><td rowspan="4">Machine design values
(Note) For the test run of the motor, increase values so that they are longer than your machine design values.
If the specified time is short, the inverter may not run the motor properly.</td><td>Please refer to Table 4.4-1 Initial value for each destination</td></tr>
<tr><td>F 15</td><td>Frequency limiter (upper limit)</td><td>70.0 (Hz)</td></tr>
<tr><td>F 07</td><td>Acceleration time 1 (Note)</td><td rowspan="2">6.00 (s)</td></tr>
<tr><td>F 08</td><td>Deceleration time 1 (Note)</td></tr>
</table>

(3) Performing tuning (PMSMs)

Perform tuning in accordance with the "**[3]** PMSM tuning method.”

Note If a filter other than the Fuji optional output filter (OFL-☐☐☐-☐A) is connected to the inverter's output (secondary) circuit, the tuning result cannot be assured.

Vibration that may occur when the motor's coupling is elastic can be regarded as normal vibration due to the output voltage pattern applied in tuning. The tuning does not always result in an error; however, run the motor and check its running state.

[2] If driving the motor under vector control with sensor (PMSMs)

Configuring the function codes concerning a PG (pulse generator)

If using “Vector control with sensor (F42 = 16)”, it is necessary to set the following function codes in order to receive receipt speed feedback value from the encoder.

For details on how to modify the function code data, refer to Chapter 3 “3.4.1 Setting function codes: “Data Setting: 1.F_ _ through 1.P_ _”.”

Table 4.8-12

Function code	Name	Function code data	Factory default
d 14	PG option Ch2 *2 Pulse input format	2: A, B phase 90° phase difference (B phase lead) + Z-phase 3: A, B phase 90° phase difference (A phase lead) + Z-phase	2: A, B phase (B phase lead)
d 15	PG option Ch2 *2 Pulse count	Pulse count of the control target motor encoder 0400 (HEX) / 1024 P/R	0400 (HEX)

*2 If performing PMSM control, the motor runs based on encoder input at the speed feedback side.

Note If the rotation direction/speed detection signal from the encoder does not match with the motor rotation direction, excessive current is applied. In the case of the vector control with sensor, the motor does not reach the set frequency but rotates slowly at very low speed. In this case, check that the phase order of motor wires is correct, and that the encoder wires are correctly connected and are not broken.

Tip In 4_17 to 4_18 of I/O check, the number of feedback pulses per second of AB phase and Z phase can be checked. In 3_29 of the drive monitor, the frequency [Hz] calculated from the speed detection signal from the encoder can be checked. These are displayed regardless of the control method if the PG option card is mounted and the encoder is wired.

Fuji regards counter-clockwise (CCW) as the forward rotation direction viewed from the motor output shaft as shown in Figure 4.8-3. During rotation in the forward direction, the encoder pulse forms a forward rotation signal (B phase leads by 90 degrees) as shown in Figure 4.8-3, and during rotation in the reverse direction, a reverse rotation signal (A phase leads by 90 degrees).

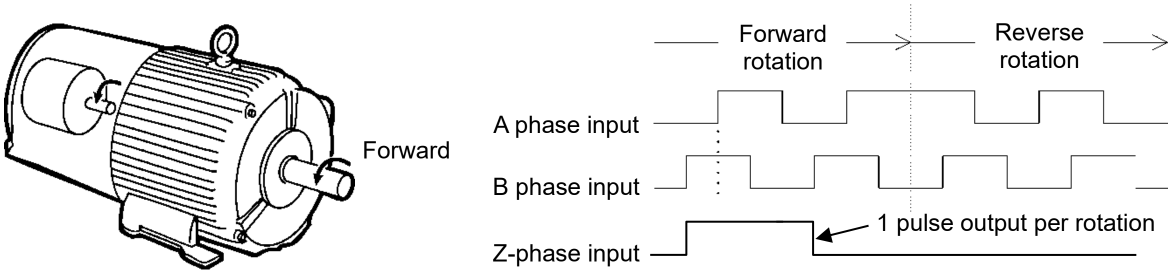


Figure 4.8-3

Note In the case of using motors which comply with IEC standard, their rotation directions are opposite to that in Figure 4.8-3.

Basic Settings

If using "Vector control with sensor (F42 = 16)", it is necessary to set the basic function codes below.

Configure the function codes listed below according to the motor ratings and design values of the machine. For the motor ratings, check the ratings printed on the motor's nameplate. For design values of the machine, ask system integrators or machine manufacturers about them.

For details on how to modify the function code data, refer to Chapter 3 "3.4.1 Setting function codes: "Data Setting: 1.F _ _ through 1.P _ _"."

Fuji non-standard motors, motors of other companies

(1) Selection of motor type and pole position detection method

PMSMs are categorized into the following types based on the structure of the rotor.

a) SPM (Surface Permanent Magnet)
b) IPM (Interior permanent magnet)

The starting magnetic pole position detection method depends on the motor type. In most cases, the IPMs are generally used, but the SPMs are sometimes used. Check the specifications with the motor manufacturer before using PMSMs.

Set the Initial magnetic position detection mode to the function code P30. For details, refer to Chapter 5 "5.3.4 P codes (Motor 1 parameters)".

If the motor type is unknown, set P30 = 1 if performing tuning, and P30 = 0 if not.

(2) Setting motor basic constants

To drive another manufacturer's PMSM, set the motor parameters shown in Table 4.8-13 and execute offline tuning. Check the motor parameters on the motor rating nameplate or consult with the motor manufacturer before setting them.

Note Depending on the order, there may be cases where motor constants for PMSMs are set individually when the product is shipped. Please note that by initializing data using with H03, motor constant data will be lost. Record the motor constants prior to initialization.

Set motor constants after selecting vector control with sensor F42 = 16.

Set the motor constants shown in the following table. The setting values are determined by the values on the motor nameplate and machine specifications. Check the nameplate values and machine specifications beforehand.

Table 4.8-13

<table>
<tr><th>Function code</th><th>Name</th><th>Function code data</th><th>Factory default</th></tr>
<tr><td>F26</td><td>Motor sound (carrier frequency)</td><td>Check the motor specifications and set.</td><td>2 kHz</td></tr>
<tr><td>F42</td><td>Drive control selection 1</td><td>16: Vector control with sensor (PMSMs)</td><td>0: V/f control with slip compensation inactive</td></tr>
<tr><td>P99</td><td>Motor 1 selection</td><td>20: Other motors (PMSMs)
If 16 is not set for F42, 20 cannot be set for P99.</td><td rowspan="3">Please refer to Table 4.4-1 Initial value for each destination</td></tr>
<tr><td>F04</td><td>Base frequency 1</td><td rowspan="5">Motor ratings (printed on the nameplate of the motor)
If the motor synchronous speed is known, calculate F05 by the following formula and set it.
$\frac{\text{Synchronous speed}}{120} \times \text{No. of poles}$</td></tr>
<tr><td>F05</td><td>Rated voltage at base frequency 1</td></tr>
<tr><td>P01</td><td>Motor 1 (No. of poles)</td><td>4 (poles)</td></tr>
<tr><td>P02</td><td>Motor 1 (Rated capacity)</td><td>Standard applicable motor capacity</td></tr>
<tr><td>P03</td><td>Motor 1 (Rated current)</td><td>Please refer to Table 4.4-1 Initial value for each destination</td></tr>
<tr><td>P30</td><td>PMSM 1 (magnetic pole position detection method)</td><td>Motor type and magnetic pole position detection method
0: Current draw method (if motor type is unknown)
1: IPM
2: SPM
3: IPM (current draw method)
4: High-frequency superimposing method</td><td>1: IPM</td></tr>
<tr><td>P63</td><td>PMSM 1 (Induced voltage)</td><td>Value described in motor test report
If the value is unknown, execute tuning with the motor running.</td><td>Fuji standard PMSM (GNB2 series) constant</td></tr>
<tr><td>P64</td><td>PMSM 1 (iron loss factor)</td><td>Set the iron loss described in motor test report divided by Motor rated capacity: P02.
Set 0%, if the iron loss is unknown.</td><td>Fuji standard PMSM (GNB2 series) constant</td></tr>
<tr><td>P90</td><td>PMSM 1 (Overcurrent protection level)</td><td>Set the demagnetization limit current. Set to prevent demagnetizing the motor. If it is unknown, set approx. 200% of motor rated current.</td><td>Fuji standard PMSM (GNB2 series) constant</td></tr>
</table>

Table 4.8-13 cont.

Function code	Name	Function code data	Factory default
d01	Speed control 1 (Speed command filter)	Characteristics of the speed controller *1: The values to the right are set automatically when 15, 16 are set for the function code F42. However, since it is possible to increase the sensitivity with vector control with sensor, set the initial values to the following values before starting. d01 =0.020(s)	0.200 (s) *1
d02	(Speed detection filter)	d02 =0.005(s)	0.025 (s) *1
d03	P (Gain)	d03 =10.0 (times)	2.0 (times) *1
d04	I (Integral time)	d04 =0.100(s)	0.600 (s) *1
F03	Maximum frequency 1	Machine design values (Note) For the test run of the motor, increase values so that they are longer than your machine design values. If the specified time is short, the inverter may not run the motor properly.	Please refer to Table 4.4-1 Initial value for each destination
F15	Frequency limiter (upper limit)		70.0 (Hz)
F07	Acceleration time 1 (Note)		6.00 (s)
F08	Deceleration time 1 (Note)		

(3) Performing tuning (PMSMs)

Perform tuning in accordance with the "**[3]** PMSM tuning method.”

[3] PMSM tuning method

If performing tuning, do so using the following procedure after specifying settings based on the control method indicated previously (4.8.1 [1] to [2]).

■Selection of the tuning type

Check the mechanical state and then choose between tuning with the motor running (P04=2) and tuning with the motor stopped (P04=1).
To adjust only the magnetic pole position offset, choose PMSM magnetic pole position offset tuning (P04=4).
For the latter tuning, adjust the acceleration and deceleration times (F07 and F08) and specify the rotation direction that matches the actual rotation direction of the machine.

Note Tuning with the motor stopped P04=1 cannot be performed with P30=0, 3. If it is executed, the Er7 alarm (subcode 21) will occur.

Since the motor rotates in both the forward and reverse directions during magnetic pole position offset tuning, set the rotational direction limitation function (H08) to 1 (reverse rotation inhibited) if you do not want to make it rotate in the reverse direction due to mechanical limitations.

Since the motor rotates in both the forward and reverse directions during magnetic pole position offset tuning, set the rotational direction limitation function (H08) to 1 (reverse rotation inhibited) if you do not want to make it rotate in the reverse direction due to mechanical limitations.

Table 4.8-14

P04 data		Tuned data	Tuning	Notes
1	Tuning with the motor stopped	Magnetic pole position detection method (P30)* Armature resistance (P60) d-axis inductance (P61) q-axis inductance (P62) For adjustment by manufacturer (P84, P88)	Tune while the motor is stopped.	Cannot rotate the motor. For example, when the load cannot be removed. P30=1 or 2 (refer to the note above)
2	Tune while the motor is rotating	Magnetic pole position detection method (P30)* Armature resistance (P60) d-axis inductance (P61) q-axis inductance (P62) Induced voltage (P63) For adjustment by manufacturer (P84, P88)	Perform tuning of the armature resistance, d-axis inductance, q-axis inductance, and data for adjustment by the manufacturer with the motor stopped. Then, rotate at 50% of the rated frequency to tune the induced voltage.	When the motor can be rotated safely.
4	PMSM magnetic pole position offset tuning	Magnetic pole position offset (P95)	The magnetic pole position offset is tuned while the motor is rotating (speed based on d80).	Execute this to tune only the magnetic pole position. Select vector control with sensor (PMSM) (F42 = 16).

*Available only when tuning is executed with P30=1.

The tuning results are written automatically to the corresponding function code.

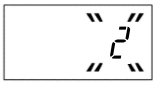
■ **Preparation of machine**

To prepare for the tuning with the motor running, remove the mechanical couplings and disable the safety devices.

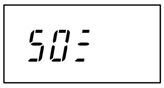
■ **Tuning procedure**

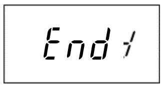
Note The following procedure is for **types other than the Ethernet built-in type (E3N)**.
Perform tuning **via FRENIC-Loader or Ethernet communication if using an E3N inverter**.

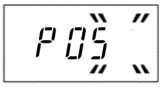
1) Set function code P04 to “1”, “2” or “4” and press the FUNC DATA key.
(The blinking pace of “ 1”, “2 ”, or “4 ” slows down.)
2) Enter a run command.
(The factory default is “RUN key on the keypad for forward rotation.”)
To switch to reverse rotation or to select the terminal signal “FWD” or “REV” as a run command, change the data of function code F02.
3) The moment a run command is entered, and tuning starts, and the progress is shown as %.
4) Make the motor rotate at up to 50% of the base frequency with function code P04=2 (tuning with the motor running) and at 1 Hz (default value) with function code p04=4 (PMSM magnetic pole position offset tuning) to perform the tuning. Upon completion of measurements, the motor decelerates to a stop.
5) If the terminal signal “FWD” or “REV” is selected as a run command (F02 = 1), “End” appears upon completion of measurement. Turning the run command OFF completes the tuning. If the run command has been given through the keypad or the communications link, it automatically turns OFF upon completion of the measurements, which completes the tuning.
6) Upon completion of the tuning, the subsequent function code appears on the keypad.



Blinking will slow down.


(Lights up)





(The subsequent function code appears.)

Note The initial setting for the speed regulator (ASR) is rather low to prevent hunting. However, hunting may occur during tuning due to mechanical conditions. If so, a tuning error (Er7) or speed mismatch (ErE) may occur. When Er7 occurs, lower the speed control gain, and when ErE occurs, cancel the speed mismatch detection (d23 = 0), and then perform tuning again.

■ **Tuning errors (PMSMs)**

Since inappropriate tuning may cause failure of hunting or other operations and decrease the operation accuracy, the error Er7 occurs in the inverter and the tuning values are erased when there is an error in the tuning results. Check the following if the tuning error (Er7) occurs.

- Is the inverter output wiring open?
- Is the machine brake operating?
- Is the coast to stop command BX on?
- Is the function code setting correct?

The causes of tuning error occurrences are shown below.

Table 4.8-15

Possible tuning error causes	Er7 Error sub code	Details and measures
Sequence error	7 8 9	Before completion of tuning, a run command has been turned OFF. Or during tuning, terminal command “STOP” (Force to stop) or “BX” (Coast to a stop) has been entered. ➔ Do not stop the inverter running until completion of tuning.
Overcurrent error	6 10	During tuning, an excessively large current has flown. ➔Check the state of the machine brake. Check also that the motor can rotate mechanically. ➔Check whether the acceleration time setting is short and the current limiter is operating.
Undervoltage	11	If DC intermediate voltage is low and tuning is performed. ➔Check whether the main power is input normally.
Tuning frequency error (only when P04=2)	13	The maximum frequency or the frequency limiter (high) has limited the output frequency. ➔Increase the F03 and F15 settings to values greater than 50% of the base frequency 1 (F04).
Acceleration time over (only when P04=2)	18	The output frequency has not reached 50% of the base frequency within the specified acceleration time “F07×300%”. ➔Increase the F07 setting.
Drive control error	21	It is necessary to rotate the motor to perform magnetic pole position tuning when P30=0 or 3 but P04=1: tuning with the motor stopped has been performed with this setting. P04=5: tuning with the motor stopped has been performed with F42=15. ➔Configure matching settings.
Parameter setting error	5003	The rated impedance or rated inductance is outside the valid range. ➔ Check the F04, F05, and P03 settings.
Magnetic pole position calculation not possible	5005	When P30=1 or 3: The salient pole ratio of the motor inductance is small. When P30=2: The motor has no magnetic saturation characteristic. ➔ When P30=1, decrease the P87 value. However, tuning may not be possible on motors with which magnetic saturation is difficult. ➔ When P30=2 or 3, set P30=0 and adjust until rotation tuning succeeds while increasing gradually F24 from 0.5 to 5.0 s.
Insufficient magnetic saturation	5056	The motor magnetic saturation characteristic is small and the magnetic pole position cannot be determined. ➔ Increase gradually P87 with 120% as the limit. If you cannot see the results, set P30=0 or 3 and F24 to between 0.5 to 5.0 s.
Excessive magnetic saturation	5057	The motor magnetic saturation characteristic is high and a large current is flowing when the magnetic pole position is determined, which poses a risk. ➔ Set P87 to a smaller value.
Error in tuning results	5059 to 5065	An interphase voltage unbalance or phase loss has been detected, or tuning has resulted in an abnormally high or low value due to the output circuit being open or a short-circuit. ➔ Check that there is no problem with the wiring between the inverter and the motor. ➔ If a magnetic contactor (MC) is installed between the inverter and the motor, check that it is not open.

📖 For the method of checking the error subcodes with the keypad, refer to Chapter 3 “3.4.6 Reading alarm information: “Alarm Information: 6.AL”.”

📖 You can check the error subcode by reading the function code X03.

📖 If an error other than Er7 occurs, refer to Chapter 6 “TROUBLESHOOTING” and remove the cause.

If any of these errors occurs, remove the error cause and perform tuning again, or consult your Fuji Electric representative.

4.8.3 Motor temperature protection settings

[1] Electronic thermal overload protection for motor 1

To protect the motor from overheating caused by motor overload, the output current is monitored inside the inverter and the device features an electronic thermal overload protection function that performs a protective operation (0L1) when the current exceeds the set value for a long time.

Set the function according to the characteristics of the motor used.

Function code F10*: Characteristic selection (1: Self-cooling fan (factory default value), 2: Separately powered cooling fan (inverter motor, etc.))
F11*: Operation level (motor rated current x 1.0 to 1.1 range;

the factory setting value is the Fuji standard motor rated current)
F12*: Thermal time constant (operation time at 150% of the operation level)

For details refer to Chapter 5 “5.3.1 F codes (Fundamental functions)”. Set the settings for motor 2 with the function code A.

Note If multiple motors are connected to a single inverter, install separate thermal relays for protection since the motors cannot be protected individually.

[2] Motor protection using a thermistor

When the motor is equipped with a PTC-type thermistor for temperature detection, you may input the signal to the control terminals [C1] and [11] to directly detect the motor temperature and provide temperature protection.

Connection method

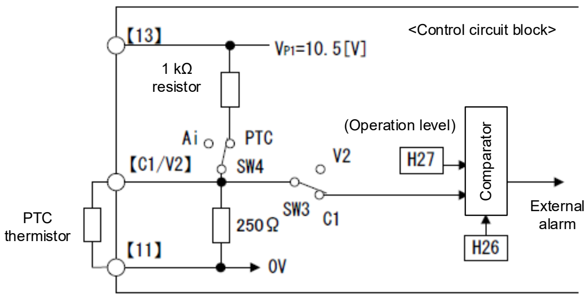


Figure 4.8-4

Note When using the terminal [C1] for PTC thermistor input, it is necessary to change with switches (SW3, SW4) on the control PCB.

Function code H26*: Motor 1 (thermistor operation selection)
0: Disable
1: PTC thermistor (protection stop with 0H4)
2: PTC thermistor (warning output)

H27*: Motor 1 (thermistor detection level)

Set the operation voltage V_{C1} obtained with the following formula to H27*.

$V_{C1} = \frac{Rp}{1000 + 5 \times Rp} \times 10.5(V)$ V_{C1}: Operation voltage, Rp: Thermistor operation resistance

For details refer to Chapter 5 “5.3.5 H codes (High-performance Functions).”

4.9 Function code settings when replacing previous models

Configure the function codes with the procedure below if you replace a Fuji general-purpose inverter (FRENIC-Multi(E1), FRENIC-Ace(E2)) with the FRENIC-Ace(E3).

4.9.1 Replacing the FRENIC-Multi(E1) or FRENIC-Ace(E2)

With the FRENIC-Ace(E3), you can read the function codes of the previous model FRENIC-Multi(E1) or FRENIC-Ace(E2) and copy them to the FRENIC-Ace(E3) using the copying function of the optional keypad (TP-E2) to set the settings easily.

When copying the codes using the keypad, the function codes that have some different specifications are automatically replaced and copied.

[1] Function code copying procedure using the keypad

(1) Advance preparation of the copy destination (Ace(E3))

- The Ace(E3) function codes that do not exist in the previous models are not replaced. If the setting content of the copy destination (Ace(E3)) is unknown, initialize the setting to the factory default in advance.
- Some function codes cannot be copied when the [FWD] and [REV] terminals are ON. Turn OFF the [FWD] and [REV] terminals of the copy destination (Ace(E3)).
- Set the Ace(E3) function code y96 (communication compatibility mode) to 6 (E1) or 7 (E2) in advance. With this setting, communication compatibility function is also enabled when operating the function codes using RS-485 or bus communication, in addition to the copying function with the keypad.

Note: It is necessary to prepare the optional keypad (TP-E2) and relay adapter (CBAD-CP) to copy the function codes using the keypad copying function.

(2) Read the settings data of the existing Multi(E1) or Ace(E2) to the TP-E2 keypad (optional).

Press the PRG/RESET key.

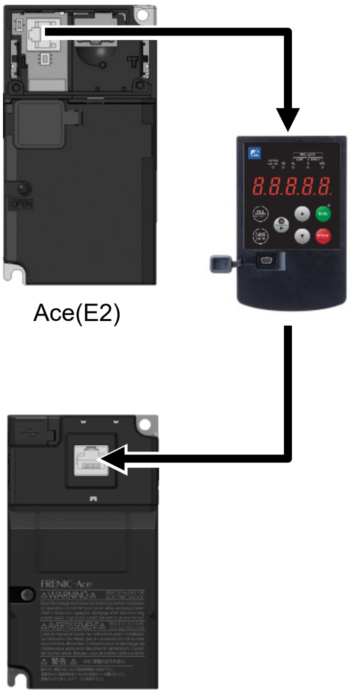
↓

Press ▲ and 7.CPY is displayed.

Press the FUNC/DATA key and rEAd is displayed.

↓

Press the FUNC/DATA key to start the reading process. The process is complete when End is displayed.



Ace(E2)

Ace(E3)

*After installing the optional CBAD-CP (keypad relay adapter).

(3) Connect the TP-E2 keypad to the new FRENIC-Ace(E3) and write the data.

Press the PRG/RESET key.

↓

Press ▼ and 7.CPY is displayed.

↓

Press the FUNC/DATA key and CoPY is displayed.

↓

Press the FUNC/DATA key to start the copy process. The process is complete when End is displayed.

Note The CBAD-CP optional keypad relay adapter must be attached to the inverter to connect the TP-E2 to the FRENIC-Ace(E3).

For details on operation, refer to Chapter 3 “3.4.7 Copying data: “Data Copying: 7.CPY”.”

Note
- When using the verify function of the keypad to compare the function codes, verify errors occur in relation to the function codes added with the Ace(E3) that do not exist in the previous models.
- You may press the PRG/RESET key during the verify process to forcibly end the process.

[2] Procedure to enter the function codes directly from the keypad

The FRENIC-Ace(E3) function codes are basically compatible with the function codes of the FRENIC-Multi(E1) and FRENIC-Ace(E2) and can be used by setting the setting values from the previous models to the same function codes on the Ace(E3). It is not necessary to change the settings of the added function codes since their initial values are compatible with Ace(E3).

Some function codes are not compatible. To use them, it is necessary to change their settings.

[3] Procedure to enter the function codes directly from the PC Loader

Inverters of the Ace(E3) series are **equipped with a USB port** for easy connection to a PC. Therefore, you may read and copy the data using the PC Loader software.

The PC Loader can be downloaded for free from the Fuji Electric website. Refer to the Loader software Instruction Manual for directions on how to use the software.

4.10 Operation check

⚠WARNING
Set the function codes after sufficiently understanding the content of this User's Manual. If operation is performed after recklessly changing function code data, the motor may rotate at a torque and speed at which the machine is unable to tolerate. **Failure to observe this could result in an accident or injury.**

⚠CAUTION
If a problem appears with the inverter or the motor, immediately stop using the product and refer to Chapter 6 "TROUBLESHOOTING" to identify and solve the problem.

Perform the operation check following the procedure below after carrying out the required items in each procedure.

Note
- For the Ethernet built-in type (E3N), factory defaults are set for performing operation via Ethernet communication. When performing a test run of the E3N, perform via either FRENIC-Loader or Ethernet communication. For details, refer to Chapter 9 "9.3 Ethernet Communication Overview."
- When performing frequency setting or operation from the terminal block, set function codes y98 and y99 to "0."

4.10.1 Test run procedure

With the settings set in "4.9 Function code settings when replacing previous models," the operation may start with the prescribed high frequency just after the power is turned on. Therefore, it is recommended to first perform a test run with a low frequency.

The following describes the method to perform a test run with the frequency setting and the run commands set by default from the keypad.

(1) Turn the power on and check that the reference frequency value displayed on the LED monitor is "0.00" and is blinking.

(2) Using the ▲/▼ keys, set the reference frequency to a value as low as 5 Hz.
(Check that the reference frequency is blinking on the LED monitor.)

(3) Press the RUN to start the operation in the forward direction.
(Check that the reference frequency is lit on the LED monitor.)

(4) Press the STOP key to stop the operation.

4.10.2 Check items during a test run

(1) Is the rotation in the forward direction?

(2) Is the rotation smooth? (no motor noise, abnormal vibrations, etc.)

(3) Are the acceleration and deceleration smooth?

If no abnormality is found, press the RUN key again and increase the reference frequency with the ▲/▼ keys. Then, verify the check items above during the test run.

Tip
The speed may increase unexpectedly depending on the function code settings. The probability is particularly high with sensorless vector control and vector control with sensor. There is a speed limit function that prevents dangerous speeds even when the function codes are not set properly.

If you do not fully understand the function codes, for example when you start the product for the first time, it is recommended to use the frequency limiter (upper limit) (F15) and torque control (speed limit) (d32/d33). Safe operation can be ensured when starting the product by gradually increasing the setting value of the speed limit function and starting the product while checking the operation.

The speed limit function works as a speed limiter at overspeed level or during torque control.

For details on the speed limit function, refer to Chapter 5 "FUNCTION CODES."

Tip
When P30 is set to a value other than "0" with sensorless vector control (PMSM), the motor may emit some noise during start-up. This is not a malfunction.

4.10.3 Adjusting the function codes for motor control

Problems such as insufficient torque and overcurrent can be solved by adjusting the function codes.
The main function codes are described below.

For details, refer to Chapter 5 “FUNCTION CODES” or Chapter 6 “TROUBLESHOOTING.”

Table 4.10-1

Function Code	Name	How to adjust	Inverter drive control	
			Induction motor	PMSM
F 07	Acceleration time 1	Increase the acceleration time in situations such as when the acceleration time is short and the current limiter is operating because the current is high.	V/f Vector	Vector
F 08	Deceleration time 1	Increase the deceleration time in situations such as when the deceleration time is short and the overvoltage protection has tripped.	V/f Vector	Vector
F 09*	Torque boost 1	Increase the torque boost when the torque is insufficient during start-up, and decrease the torque boost when there is over-excitation at no load.	V/f	—
F 44	Current limiter (operation level)	Increase the detection level when the stall prevention function operates due to the current reaching the limit during acceleration or deceleration.	V/f	—
P 07*	Motor 1 (%R1)	Increase the value when the starting torque is insufficient with auto torque boost or torque vector control, and decrease the value in case of over-excitation (current is increasing).	V/f Vector	—
P 09*	Motor 1 (Slip compensation gain (for driving))	Decrease the gain when there is excessive slip compensation during driving, and increase the gain when there is insufficient compensation.	V/f (Sensorless) Vector (Sensorless)	-
P 11*	Motor 1 (Slip compensation gain (for braking))	Decrease the gain when there is excessive slip compensation during braking, and increase the gain when there is insufficient compensation.		
H 07	Curve acceleration/deceleration	Enable curve acceleration/deceleration if there is a risk of overshoot when the speed is reached.	V/f Vector	Vector
H 69	Anti-regenerative	Enable the anti-regenerative function when the overvoltage alarm occurs without a braking resistor.	V/f Vector	Vector
H 80*	Output current fluctuation damping gain for motor 1 (For motor 1)	Increase the damping gain when current fluctuation occurs in the motor.	V/f	—

If the operation does not improve after adjusting the function codes above with V/f control with sensor, vector control with sensor, sensorless vector control, PMSM vector control with sensor, and PMSM sensorless vector control, adjust also the following function codes. With these control methods, since speed control is performed with PI control, speed control will not operate correctly if the PI constant does not match the load inertia.

Table 4.10-2

Function Code	Name	How to adjust
d 01*	Speed control 1 (Speed command filter)	Increase the filter constant if excessive overshoot/undershoot occurs when the speed command is changed, and decrease the filter constant if the response to speed command changes is poor.
d 02*	Speed control 1 (Speed detection filter)	Increase the filter constant if you cannot increase the speed control gain because the ripples are superimposed in the speed detection signal.
d 03*	Speed control 1 (P (Gain))	Decrease the gain when hunting occurs and you think that the cause lies in the speed control, and increase the gain if the speed inconsistency or speed deviation alarm (ErE) occurs because the motor response is late.
d 04*	Speed control 1 (I (Integral time))	Decrease the integral time if speed inconsistency or excessive speed deviation (ErE) occurs because the motor response is late, and increase the integral time if the load inertia is high.

4.11 Frequency command selection

Factory defaults are usually set so that frequency commands are input via keypad operation (or, in the case of E3N, via Ethernet communication), but you can change the settings to allow you to select input via external potentiometer, etc. The following describes examples of selectable input formats and their input methods.

4.11.1 Setting the frequency from the keypad

Follow the procedure below.

(1) Function code setting

Table 4.11-1

Function code	Name	Setting	Factory default
F01	Frequency setting 1	0: Keypad display (▲/▼ keys)	0 (E3S/E3E) 1 (E3N)

Note When the keypad is set to Programming or Alarm mode, the ▲/▼ keys are disabled to modify the reference frequency. You need to switch to Running mode to enable frequency setting with the ▲/▼ keys.

If any of higher priority frequency command sources (multistep frequency commands and frequency commands via communications link) is specified, the inverter may run at an unexpected frequency.

(2) When ▲/▼ keys are pressed, reference frequency is displayed and the lowest digit of the reference frequency flashes.

(3) To change the reference frequency, press the ▲/▼ key again.

When frequency setting is performed with ▲/▼ keys, the lowest digit displayed flashes and the data to be changed moves along from the lowest digit to the highest digit.

Tip To set the reference frequency, first press the ▲/▼ key once so that the lowest digit blinks. After that, each time the ▸▸ key is pressed, the cursor moves to the next higher digit where data can be changed. This cursor movement allows you to easily move the cursor to the desired digit and change the data in higher digits.

(4) The new setting can be saved into the inverter's internal memory by pressing FUNC/DATA key.

For details on how to modify the function code data, refer to Chapter 3 "3.4.1 Setting function codes: "Data Setting: 1.F _ _ through 1.P _ _"."

4.11.2 Setting the frequency from an external potentiometer

Follow the procedure below. Make the same settings when inputting an analog voltage from an external device.

(1) Function code setting

Table 4.11-2

Function code	Name	Setting	Factory default
F01	Frequency setting 1	1: Analog 12 input (0 to ±10 V)	0 (E3S/E3E) 1 (E3N)

Note This function code cannot be changed while the inverter is running. To change the setting for this function code, first stop the inverter.

(2) Connect the external potentiometer between terminals [13], [12], and [11].

To input an analog voltage, input DC voltage (0 to 10 V) to the terminals [12] and [11].

(3) Rotate the external potentiometer to deliver the voltage to the terminal [12] and input the frequency command.

For precautions related to wiring, refer to Chapter 2 “INSTALLATION AND WIRING.”

For details on how to modify the function code data, refer to Chapter 3 “3.4.1 Setting function codes: “Data Setting: 1.F _ _ through 1.P _ _”.”

4.11.3 Setting the frequency via multistep frequency selection (speed 1, speed 2, etc.)

Follow the procedure below.

(1) Function code setting

Table 4.11-3

Function code	Name	Setting	Factory default
E01 to E05	Terminals [X1] to [X5] Function	0, 1, 2, 3: Select multistep frequency (0 to 15 steps) [0:SS1, 1:SS2, 2:SS4, 3:SS8]	0, 1 and 2 are assigned to E01 to E03.
C05 to C19	Multistep Frequency 1 to 15	0.00 to 599.00 Hz	0.00

You may switch to frequencies set in advance in the function codes C05 to C19 “multistep frequency” by switching digital input signals from an external device. The selected frequency is determined by setting the data items 0 to 3 to the digital input terminals that have been assigned and using a combination of these input signals.

Table 4.11-4

Combination of input signals of set data				Selected frequency	
3 “SS8”	2 “SS4”	1 “SS2”	0 “SS1”		
OFF	OFF	OFF	ON	C05 Multistep frequency 1	Related function code C05 to C19 Permissible setting range 0.00 to 599.00
OFF	OFF	ON	OFF	C06 Multistep frequency 2	
OFF	OFF	ON	ON	C07 Multistep frequency 3	
OFF	ON	OFF	OFF	C08 Multistep frequency 4	
OFF	ON	OFF	ON	C09 Multistep frequency 5	
OFF	ON	ON	OFF	C10 Multistep frequency 6	
OFF	ON	ON	ON	C11 Multistep frequency 7	
ON	OFF	OFF	OFF	C12 Multistep frequency 8	
ON	OFF	OFF	ON	C13 Multistep frequency 9	
ON	OFF	ON	OFF	C14 Multistep frequency 10	
ON	OFF	ON	ON	C15 Multistep frequency 11	
ON	ON	OFF	OFF	C16 Multistep frequency 12	
ON	ON	OFF	ON	C17 Multistep frequency 13	
ON	ON	ON	OFF	C18 Multistep frequency 14	
ON	ON	ON	ON	C19 Multistep frequency 15	

(2) Connect the multistep frequency setting switches between the terminals [X] and [CM].

(3) The multistep frequency is selected using combinations of multistep frequency setting switches set to on (shorted).

For precautions related to wiring, refer to Chapter 2 “INSTALLATION AND WIRING.”

For details on how to modify the function code data, refer to Chapter 3 “3.4.1 Setting function codes: “Data Setting: 1.F _ _ through 1.P _ _”.”

Note With the multistep frequency setting switches set to ON (shorted) (between terminal [X] and [CM]), the frequency setting set with F01: Frequency setting 1 is disabled when the multistep frequency setting is enabled.

4.12 Run command selection

Factory defaults are set so that run commands are input via keypad (RUN key, STOP key) operation (or, in the case of E3N, via Ethernet communication), but you can change the settings to allow you to select input via external signal. The following describes examples of each selectable input format and their input methods.

4.12.1 Setting the run commands from the keypad

Follow the procedure below.

(1) Function code setting

Table 4.12-1

Function code	Name	Setting	Factory default
F02	Operation method	0: Keypad operation (Rotation direction input: Terminal block) 2: Keypad operation (forward rotation) 3: Keypad operation (reverse rotation)	2 (E3S/E3E)

(2) F02=0: Press the RUN key to run the product. Press the STOP key to stop.

The rotation direction is specified with the terminals [FWD] and [REV]. Connect the switch for the run command in the forward direction between the terminals [FW] and [CM], and the switch for the run command in the reverse direction between the terminals [REV] and [CM].

(3) F02=2: Press the RUN key of the keypad to run the product in the forward direction. Press the STOP key to stop.

(4) F02=3: Press the RUN key of the keypad to run the product in the reverse direction. Press the STOP key to stop.

For details on how to modify the function code data, refer to Chapter 3 “3.4.1 Setting function codes: “Data Setting: 1.F _ _ through 1.P _ _”.”

4.12.2 Setting the run commands with an external signal (terminals [FW] and [REV])

Follow the procedure below.

(1) Function code setting

Table 4.12-2

Function code	Name	Setting	Factory default
F02	Operation method	1: External signal (digital input)	2 (E3S/E3E)

Note F02 setting cannot be changed when the terminals [FWD] and [REV] are ON (shorted). Set the terminals [FWD] and [REV] to OFF before changing the settings.

(2) Connect the switch for the run command in the forward direction between the terminals [FW] and [CM], and the switch for the run command in the reverse direction between the terminals [REV] and [CM].

(3) The product starts to run when the switch for the run command is ON (shorted).

For precautions related to wiring, refer to Chapter 2 “INSTALLATION AND WIRING.”

For details on how to modify the function code data, refer to Chapter 3 “3.4.1 Setting function codes: “Data Setting: 1.F _ _ through 1.P _ _”.”

Chapter 5
FUNCTION CODES

This chapter explains the table of function codes and the detail of each function code.

Contents

5.1 Function Codes Overview

Function codes are used for selecting various functions of FRENIC-Ace.

Function codes comprise 3 digits or 4 digits of alphanumeric characters.

The first digit categorizes the function code group alphabetically and the subsequent 2 or 3 digits identify each code within the group by number.

Function codes are comprised of 14 groups:

Basic Functions (F codes),
Terminal Functions (E codes),
Control Functions (C codes),
Motor 1 Parameters (P codes),
High-performance Functions (H codes) (H1 codes),
Motor 2 Parameters (A codes),
Speed Control 3 Parameters (b codes),
Speed Control 4 Parameters (r codes),
Application Functions (J codes), (J1 codes)
Application Functions 2 (d codes), (d1 codes), (d2 codes),
Customizable Logic Functions (U codes), (U1 codes),
Link Functions (y codes),
Option Functions (o codes), (o1 codes), (o2 codes), and
Keypad Functions (K codes)

The function of each function code is determined according to the data to be set. The following is a supplementary explanation of the function code tables. For details of the Option Functions (o code, o1 code and o2 code), refer to the instruction manual of each option.

5.2 Function Code Tables

5.2.1 How to read the function code tables

■ Differences by type

The availability, selection range, etc., of certain function codes on the FRENIC-Ace Ethernet built-in type (E3N) differ from other types (E3S/E3E).

Check the symbols in the “Type” column (“Y”: settable function code / “N”: not settable (not displayed)) of each table for the availability of a given function code for each inverter type. In addition, differences in data selection ranges between the [E3S/E3E] types and the [E3N] type are listed in the “Control method and Data setting range” column.

“Type” column

Function code	Name	Control method and Data setting range	Type E3S/E3E	Type E3N
F00	Data protection	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: No data protection, no digital setting protection 1: With data protection, no digital setting protection 2: No data protection, with digital setting protection 3: With data protection, with digital setting protection	Y	N
F01	Frequency setting 1	V/f PGV/f SLV PGV PMSLV PMPGV TRQ [E3S/E3E] 0: Keypad operation (⌃/⌄ keys) 1: Analog voltage input (Terminal [12]) (from 0 to ±10 VDC) 2: Analog current input (Terminal [C1] C1 function) (4(0) to 20 mA DC) 3: Analog voltage input (Terminal [12]) + analog current input (Terminal [C1]) 5: Analog voltage input (Terminal [12]) + analog current input (Terminal [C1]) 7: UP/DOWN control 8: Keypad operation (⌃/⌄ keys) (with balanceless/bumpless function) 10: Pattern operation 11: Frequency setting with digital input interface card OPC-DIO (option) 12: Pulse string input [E3N] 1: Analog voltage input (Terminal [12]) (from 0 to ±10 VDC) 2: Analog current input (Terminal [C1] C1 function) (4(0) to 20 mA DC)	Y	Y

Headings for distinguishing the different selection ranges between

Note: For the Ethernet built-in type (E3N), use FRENIC-Loader4 to display function codes and change function code data. (Function codes cannot be displayed or changed directly from the inverter main body. In addition, this inverter type cannot be connected to the remote operation keypad TP-E2 or the multi-function keypad TP-A2SW.)

■ Differences in initial setting values by destination

Note: For inverter type FRN****E3☐-2G/4G/7G (FRENIC-Ace Global Model), the destination (the region in which the inverter will be used) must be set the first time the power is turned on. Function codes cannot be changed unless the destination has been set. For details on how to set the destination, refer to Chapter 4 “4.4 Destination setting”.

By setting the destination, basic function codes such as rated voltage, rated frequency, etc. are initialized to the general values for that region.

The initial values for each region are displayed in the “Factory default” column of the corresponding function code using the following symbols:

“A (for Asia), C (for China), E (for Europe), U (for Americas), K (for Korea), J (for Japan)”.

Display example:

For Maximum output frequency 1 (F03) and Base frequency 1 (F04):

“Factory default” column

F03	Maximum output frequency 1	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 5.0 to 599.0 Hz	Y	Y	N	Y	200V class C, E: 50.0 A, U, K, J: 60.0 400V class A, C, E: 50.0 U, K, J: 60.0
F04	Base frequency 1	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 5.0 to 599.0 Hz	Y	Y	N	Y	200V class C, E, J: 50.0 A, U, K: 60.0 400V class A, C, E, J: 50.0 U, K: 60.0

■ Change, apply, and save function code data during operation

Function codes are categorized into those for which data change is enabled during operation of the inverter and those for which such change is disabled. The meaning of the symbols in the "Change during operation" columns of the function code tables is described in the following table.

Symbol	Change during operation	Application and saving of data
Y*	Allowed	When data is changed by the / keys, the changed data is immediately applied to the operation of the inverter. However, at this stage, the changed value is not saved to the inverter. In order to save it to the inverter, press the key. If you exit the changed state with the key without saving with the key, the data before the change is applied to the operation of the inverter.
Y	Allowed	Even if data is changed by the / keys, the changed data will not be applied to the operation of the inverter as is; by pressing the key, the changed value is applied to the operation of the inverter and is also saved to the inverter.
N	Not allowed	-

Note The E3N type cannot be connected to the remote operation keypad TP-E2 or the multi-function keypad TP-A2SW.
Use FRENIC-Loader4 to copy data.

■ Copying data

Function code data can be copied all at once (Programming mode menu number 7: "Data Copying") with the optional remote keypad (TP-E2) or optional multi-function keypad (TP-A2SW). By using this function, it is possible to read out all function code data and write the same data to a different inverter.

However, if the specifications of the copy source and copy destination inverters are not identical, some function codes may not be copied due to security reasons. Configure the settings individually as necessary for the function codes that are not copied. The behavior of the function codes regarding data copying is indicated in the "Data copying" column in the function code tables on the following pages.

- Y: Data is copied.
- Y1: When inverter capacity is different, copying will not be performed.
- Y2: When voltage series is different, copying will not be performed.
- N : Data is not copied.

Note The E3N type cannot be connected to the remote operation keypad TP-E2 or the multi-function keypad TP-A2SW.
Use FRENIC-Loader4 to copy data.

■ Negative logic setting of data

Digital input terminals and transistor/contact output terminals can become signals for which negative logic is specified by function code data setting. Negative logic is a function to reverse the ON and OFF states of input or output, and switch Active ON (function enabled with ON: positive logic) and Active OFF (function enabled with OFF: negative logic). However, negative logic may not be enabled depending on the function of the signal.

Negative logic signals can be switched by setting the data with 1000 added to the function code data of the function to be set. For example, the following example shows when coast-to-a-stop command "BX" is selected by function code E01.

Function code data	Tuning
7	"BX" is ON and coast-to-a-stop (Active ON)
1007	"BX" is OFF and coast-to-a-stop (Active OFF)

■ Control methods

The FRENIC-Ace runs under any of the following control methods. Some function codes apply exclusively to the specific control method.

The enable or disable status is indicated with an icon for each control method within the Data setting range field in the function code list tables.

Icon example: Under V/f control: Enable V/f Disable V/f

Function code table Data setting range field	Control target (H18)	Control method (F42)
V/f	Speed (H18 = 0)	V/f control (F42 = 0) Dynamic torque vector control (F42 = 1) V/f control with slip compensation (F42 = 2)
PGV/f		V/f control with sensor (F42 = 3) Dynamic torque vector control with sensor (F42 = 4)
SLV		Sensorless vector control (F42 = 5)
PGV		Vector control with sensor (F42 = 6)
PM SLV		Sensorless vector control (PMSM) (F42 = 15)
PM PGV		Vector control with sensor (PMSM) (F42 = 16)
TRQ	Torque (H18 = 2, 3)	Vector control (F42 = 5, 6, 16)

For details on control methods, refer to "Function code F42."

Note: The FRENIC-Ace is a general-purpose inverter whose operation is customized by frequency-based function codes, like conventional inverters. Under the speed control method, however, the control target is motor speed, not frequency, so convert the frequency to the motor speed according to the following expression.

Conversion formula: Motor speed (r/min) = 120 x frequency (Hz)/number of poles

Tip: Control method icon group display

The function code list tables contain locations where control method icons are displayed in groups as shown below.

Display example: Electronic thermal overload relay (F10 to F12) control icon display

F10	Electronic thermal 1 (Motor protection) (Select motor characteristics)	V/f PGV/f SLV PGV PM SLV PM PGV TRQ 1: Enable (for a general-purpose motor with self-cooling fan) 2: Enable (for an inverter-driven motor with separately powered cooling fan)	Y
F11	(Operation level)	0.00 A (disable), current value of 1 to 135% of inverter rated current set with A unit	Y
F12	(Thermal time constant)	0.5 to 75.0 min	Y

In this example, F11 and F12 indicate that the same V/f PGV/f SLV PGV PM SLV PM PGV TRQ control methods as F10 are valid.

Function code group: Excluding certain exceptions, all control methods (V/f PGV/f SLV PGV PM SLV PM PGV TRQ) for U codes, U1 code, y codes, o codes, o1 codes, o2 codes, and K codes are valid, and therefore the control icons have been omitted from the table.

5.2.2 Function code tables

The tables of function codes to be used in FRENIC-Ace are shown below.

[1] F codes: Basic Functions

Factory default…A (for Asia), C (for China), E (for Europe), U (for Americas), K (for Korea), J (for Japan)

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
F00	Data protection	V/f PGV/f SLV PGV PM SLV PM PGV TRQ 0: No data protection, no digital setting protection 1: With data protection, no digital setting protection 2: No data protection, with digital setting protection 3: With data protection, with digital setting protection	Y	N	Y	Y	0	5-63
F01	Frequency setting 1	V/f PGV/f SLV PGV PM SLV PM PGV TRQ [E3S/E3E] 0: Keypad operation (▲/▼ keys) 1: Analog voltage input (Terminal [12]) (from 0 to ±10 VDC) 2: Analog current input (Terminal [C1] C1 function) (4(0) to 20 mA DC) 3: Analog voltage input (Terminal [12]) + analog current input (Terminal [C1]) 5: Analog voltage input (Terminal [12]) + analog current input (Terminal [C1]) 7: UP/DOWN control 8: Keypad operation (▲/▼ keys) (with balanceless/bumpless function) 10: Pattern operation 11: Frequency setting with digital input interface card OPC-DIO (option) 12: Pulse string input [E3N] 1: Analog voltage input (Terminal [12]) (from 0 to ±10 VDC) 2: Analog current input (Terminal [C1] C1 function) (4(0) to 20 mA DC) 3: Analog voltage input (Terminal [12]) + analog current input (Terminal [C1]) 5: Analog voltage input (Terminal [12]) + analog current input (Terminal [C1]) 7: UP/DOWN control 10: Pattern operation	Y	Y	N	Y	E3S/E: 0 E3N: 1	5-64
F02	Operation method	V/f PGV/f SLV PGV PM SLV PM PGV TRQ [E3S/E3E] 0: Keypad operation (Rotation direction input: terminal block) 1: External signal (digital input) 2: Keypad operation (forward rotation) 3: Keypad operation (reverse rotation) [E3N] Based on function code y98	Y	N	N	Y	2	5-77
F03	Maximum output frequency 1	V/f PGV/f SLV PGV PM SLV PM PGV TRQ 5.0 to 599.0 Hz	Y	Y	N	Y	200V class C, E: 50.0 A, U, K, J: 60.0 400V class A, C, E: 50.0 U, K, J: 60.0	5-79
F04	Base frequency 1	V/f PGV/f SLV PGV PM SLV PM PGV TRQ 5.0 to 599.0 Hz	Y	Y	N	Y	200V class C, E, J: 50.0 A, U, K: 60.0 400V class A, C, E, J: 50.0 U, K: 60.0	5-80
F05	Base frequency voltage 1	V/f PGV/f SLV PGV PM SLV PM PGV TRQ 0: AVR disable (output voltage proportional to power voltage) 80 to 240 V: AVR enable (200V series) 160 to 500 V: AVR enable (400V series)	Y	Y	N	Y2	200V class C, K, J: 200V A: 220V E, A: 230V 400V class C: 380V E, K, J: 400V A: 415V U: 460V	
F06	Maximum output voltage 1	V/f PGV/f SLV PGV PM SLV PM PGV TRQ 80 to 240 V: AVR enable (200V series) 160 to 500 V: AVR enable (400V series)	Y	Y	N	Y2		
F07	Acceleration time 1	V/f PGV/f PGV SLV PM SLV PM PGV TRQ 0.00 to 6000 s * 0.00 is for acceleration and deceleration time cancel (when performing soft-start and stop externally)	Y	Y	Y	Y	J: 6.00 A, C, E, U, K: 6.00 FRN0115E3☐-2G / FRN0059E3☐-4G or more：20.0	5-82
F08	Deceleration time 1		Y	Y	Y	Y		

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
F09	Torque boost 1	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.0 to 20.0% (% value against Base frequency voltage 1)	Y	Y	Y*	Y	U: 0.00% A, C, E, K, J: Refer to note "*1" outside the table.	5-86
F10	Electronic thermal 1 (Motor protection) (Select motor characteristics)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 1: Enable (for a general-purpose motor with self-cooling fan) 2: Enable (for an inverter-driven motor with separately powered cooling fan)	Y	Y	Y	Y	1	
F11	(Operation level)	0.00 A (disable), current value of 1 to 135% of inverter rated current set with A unit	Y	Y	Y	Y1 Y2	*2	
F12	(Thermal time constant)	0.5 to 75.0 min	Y	Y	Y	Y	5.0	
F14	Momentary power failure restart (mode selection)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Trip immediately 1: Trip after a recovery from power failure 2: Trip after momentary deceleration is stopped 3: Continue to run (for heavy inertia load or general load) 4: Restart from frequency at power failure (for general loads) 5: Restart from starting frequency	Y	Y	Y	Y	E,U: 0 A,C,K,J: 1	5-90
F15	Frequency limiter (Upper limit)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ	Y	Y	Y	Y	70.0	5-98
F16	(Lower limit)	0.0 to 599.0 Hz			Y	Y	0.0	
F18	Bias (Frequency setting 1)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ -100.00 to 100.00%	Y	Y	Y*	Y	0.00	5-98
F20	DC braking 1 (Starting frequency)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.0 to 60.0 Hz	Y	Y	Y	Y	0.0	5-99
F21	(Operation level)	HHD mode (F80 = 0): 0 to 100% HND mode (F80 = 1): 0 to 80% HD mode (F80 = 3): 0 to 80 % ND mode (F80 = 4): 0 to 60% HND mode (F80 = 4): 0 to 60%	Y	Y	Y	Y	0	
F22	(Braking time)	0.00 (disable): 0.01 to 30.00 s	Y	Y	Y	Y	0.00	
F23	Starting frequency 1	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.0 to 60.0 Hz	Y	Y	Y	Y	0.5	5-102
F24	(Holding time)	0.00 to 10.00 s 1.0 s is set automatically when the setting F42 ≠ 15, 16 is changed to F42= 15, 16. 0.5 s is set automatically when the setting F42 = 15, 16 is changed to F42≠ 15, 16.	Y	Y	Y	Y	0.00	
F25	Stop frequency	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.0 to 60.0 Hz	Y	Y	Y	Y	0.2	
F26	Motor sound (Carrier frequency)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ HHD Mode (F80 = 0) 0.75 to 16 kHz HND Mode (F80 = 1) 0.75 to 16 kHz (FRN0001 to 0010E3☐-2G, FRN0030 to 0088E3☐-2G) (FRN0002 to 0059E3☐-4G) 0.75 to 10 kHz (FRN0072E3☐-4G) HD Mode (F80 = 3) 0.75 to 16 kHz (FRN0002 to 0059E3☐-4G) 0.75 to 10 kHz (FRN0072E3☐-4G) ND Mode (F80 = 4) 0.75 to 10 kHz (FRN0002 to 0059E3☐-4G) 0.75 to 6 kHz (FRN0072E3☐-4G) HND mode (F80 = 4) 0.75 to 10 kHz (FRN0012, 0020, 0115E3☐-2G) 0.75 to 10 kHz (FRN0001 to 0012E3☐-7G)	Y	Y	Y*	Y	2	5-106
F27	(Tone)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Level 0 (disable) 1: Level 1 2: Level 2 3: Level 3	Y	Y	Y*	Y	0	

*1 Standard values depend on motor capacity. Refer to "Table 5.2-1 Factory default setting values by capacity."
*2 The motor rated current is automatically set. Refer to "Table 5.2-2 Motor constant" (function code P03) .
*5 Terminal [FM] on the E3N type.

Function code	Name	Control method and Data setting range	Type E3S/E3E	Type E3N	Change when running	Data copying	Default value	Related page
F29	Terminal [FM1] *5 (Mode selection)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Voltage output (0 to +10 VDC) 1: Current output (4 to 20 mA DC) 2: Current output (0 to 20 mA DC) 3: Pulse output	Y	Y	Y	Y	0	5-107
F30	(Output gain)	0 to 300%	Y	Y	Y*	Y	100	
F31	(Function selection)	[E3S/E3E] 0: Output frequency 1 (before slip compensation) 1: Output frequency 2 (after slip compensation) 2: Output current 3: Output voltage 4: Output torque 5: Load rate 6: Input power 7: PID feedback value 8: Actual speed/estimated speed 9: DC link bus voltage 10: Universal AO 13: Motor output 14: Analog output test (+) 15: PID command (SV) 16: PID output (MV) 17: Master-follower angle deviation 18: Inverter cooling fin temperature 21: PG feedback value 22: Torque current command 26: Reference frequency (before acceleration/deceleration calculation) 111 to 124: Customizable logic output signal 1 to 14 [E3N] 0: Output frequency 1 (before slip compensation) 1: Output frequency 2 (after slip compensation) 2: Output current 3: Output voltage 4: Output torque 5: Load rate 6: Input power 7: PID feedback value 8: Actual speed/estimated speed 9: DC link bus voltage 10: Universal AO 13: Motor output 14: Analog output test (+) 15: PID command (SV) 16: PID output (MV) 18: Inverter cooling fin temperature 22: Torque current command 26: Reference frequency (before acceleration/deceleration calculation) 111 to 124: Customizable logic output signal 1 to 14	Y	Y	Y	Y	0	
F32	Terminal [FM2] (Mode selection)	0: Voltage output (0 to +10 VDC) 1: Current output (4 to 20 mA DC) 2: Current output (0 to 20 mA DC)	Y	N	Y	Y	0	5-107 5-126
F33	Terminal [FM1] *5 (Pulse rate)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 25 to 32000 p/s (pulse count at 100%)	Y	Y	Y*	Y	1440	5-107
F34	Terminal [FM2] (Output gain)	0 to 300%	Y	N	Y*	Y	100	
F35	(Function selection)	Same as F31	Y	N	Y	Y	2	
F37	Load Selection/Auto Torque Boost/Auto Energy-Saving Operation 1	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Quadratic-torque load 1: Constant torque load 2: Auto torque boost 3: Auto energy-saving operation (quadratic-torque load) 4: Auto energy-saving operation (constant torque load) 5: Auto energy-saving operation (auto torque boost)	Y	Y	N	Y	1	5-111
F38	Stop frequency (Detection method)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Actual speed/estimated speed 1: Reference speed	Y	N	N	Y	0	5-113
F39	(Holding time)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.00 to 10.00 s	Y	Y	Y	Y	0.00	
F40	Torque limiter 1-1	V/f PGV/f SLV PGV PMSLV PMPGV TRQ -300 to 0 to 300%; 999 (disable)	Y	Y	Y	Y	999	5-114
F41	Torque limiter 1-2				Y	Y	999	

*5 Terminal [FM] on the E3N type.

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
F42	Control method selection 1	V/f PGV/f SLV PGV PMSLV PMPGV TRQ [E3S/E3E] 0: V/f control with slip compensation inactive 1: Dynamic torque vector control 2: V/f control with slip compensation active 3: V/f control with sensor 4: Dynamic torque vector control with sensor 5: Sensorless vector control 6: Vector control with sensor 15: Sensorless vector control (PMSM) 16: Vector control with sensor (PMSM) [E3N] 0: V/f control with slip compensation inactive 1: Dynamic torque vector control 2: V/f control with slip compensation active 5: Sensorless vector control 15: Sensorless vector control (PMSM)	Y	Y	N	Y	0	5-120
F43	Current limiter (Mode selection)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Disable 1: Enable at constant speed (disable during ACC/DEC) 2: Enable during ACC/constant speed operation (disable during DEC)	Y	Y	Y	Y	2	5-124
F44	(Operation level)	20 to 200% (rated current of the inverter for 100%) (Inverter rated current is dependent on F80.)	Y	Y	Y	Y	*3	
F50	Electronic thermal (Braking resistors protection) (Discharging capacity)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 1 to 9000 (kWs) OFF (cancel)	Y	Y	Y	Y1 Y2	OFF	5-125
F51	(Permissible average loss)	0.001 to 99.99 kW	Y	Y	Y	Y1 Y2	0.001	
F52	(Braking resistance value)	0.00: Resistance value not required (FRENIC-Multi compatible operation) 0.01 to 999 Ω	Y	Y	Y	Y1 Y2	0.00	
F58	Terminal [FM1] (Filter)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.00 to 5.00 s	Y	Y	Y	Y	0.00	5-107 5-126
F59	(Bias)	-100.0 to 100.0%	Y	Y	Y*	Y	0.0	
F62	Terminal [FMP] (Filter)	0.00 to 5.00 s	Y	N	Y	Y	0.00	
F63	(Bias)	-100.0 to 100.0%	Y	N	Y*	Y	0.0	
F80	Switching between ND, HD, HND and HHD drive modes	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: HHD mode 1: HND mode (except model to apply “4 :HND mode” as below) 3: HD mode 4: ND mode 4: HND mode (Only FRN0012, 0020E3☐-2G / FRN0001 to 0012E3☐-7G) ND/HD mode is not supported for 200V class series.	Y	Y	N	Y	J: 0 A, C, E, U, K: E3E-7G: 0 E3☐-2G: 1 or 4 E3△-7G: 4 E3☐-4G: 4	5-127

*5 Terminal [FM] on the E3N type.

*3 The initial values differ depending on the destination set the first time the power is turned on, as shown in the following chart.

F44 default value	Destination setting: J	Destination setting: A, C, E, U, K
180%	FRN0001 to 0069E3△-2G FRN0002 to 0044E3☐-4G FRN0001 to 0012E3△-7G FRN0001 to 0011E3E-7G	FRN0001 to 0011E3E-7G
160%	FRN0088 to 0115E3△-2G FRN0059 to 0072E3☐-4G	—
130%	—	FRN0001 to 0115E3△-2G FRN0002 to 0072E3☐-4G FRN0001 to 0012E3△-7G

☐: S (Basic type) or N (Ethernet built-in type) or E (EMC filter built-in type) △: S (Basic type) or N (Ethernet built-in type)

[2] E codes: Terminal Functions

Factory default…A (for Asia), C (for China), E (for Europe), U (for Americas), K (for Korea), J (for Japan)

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
E01	Terminal [X1](Function selection)	Refer to E01 to E09 in Table 5.2-3 Control input terminal setting list table.	Y	Y	N	Y	0	5-129
E02	Terminal [X2]		Y	Y	N	Y	1	
E03	Terminal [X3]		Y	Y	N	Y	2	
E04	Terminal [X4]		Y	N	N	Y	7	
E05	Terminal [X5]		Y	N	N	Y	8	

Table 5.2-3 Control input terminal setting list table (Y indicates those selections that can be selected, and N indicates those that cannot be selected.)

Function code and name				Control method and Data setting range	Type	
E01 to E05	E70	E98, E99	o101 to o113		E3S/E3E	E3N
Terminal [X1] to [X5]	For remote keypad TP-E2 M/Shift key	Terminal [FWD], [REV]	Terminal [I1] to [113] (for OPC-DIO)			
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0(1000): Select multistep frequency (0 to 1 steps) "SS1"	Y	Y
				1(1001): Select multistep frequency (0 to 3 steps) "SS2"	Y	Y
				2(1002): Select multistep frequency (0 to 7 steps) "SS4"	Y	Y
				3(1003): Select multistep frequency (1 to 15 steps) "SS8"	Y	Y
Y	Y	Y	Y	4(1004): Select ACC/DEC time (2 steps) "RT1"	Y	Y
				5(1005): Select ACC/DEC time (4 steps) "RT2"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 6(1006): Select self-hold "HLD"	Y	Y
Y	Y	Y	Y	7(1007): Coast-to-a-stop command "BX"	Y	Y
Y	N	Y	Y	8(1008): Alarm (error) reset "RST"	Y	Y
Y	N	Y	Y	9(1009): External alarm "THR" (9 = Active OFF/1009 = Active ON)	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV 10(1010): Jogging operation "JOG"	Y	Y
Y	Y	Y	Y	11(1011): Frequency setting 2/Frequency setting 1 "Hz2/Hz1"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 12(1012): Select motor 2 "M2"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV 13: DC braking command "DCBRK" PMSLV is valid only when P30 = 0	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 14(1014): Torque limiter level 2/1 "TL2/TL1"	Y	Y
Y	N	Y	Y	V/f PGV/f SLV PGV 15: Switch to commercial power (50 Hz) "SW50"	Y	Y
				16: Switch to commercial power (60 Hz) "SW60"	Y	Y
Y	N	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV 17(1017): UP command "UP"	Y	Y
				18(1018): DOWN command "DOWN"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 19(1019): Allow function code editing "WE-KP"	Y	N
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV 20(1020): Cancel PID control "Hz/PID"	Y	Y
Y	Y	Y	Y	21(1021): Switch normal/inverse operation "IVS"	Y	Y
Y	N	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 22(1022): Interlock "IL"	Y	Y
Y	Y	Y	Y	SLV PGV PMPGV TRQ 23(1023): Cancel torque control "Hz/TRQ"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 24(1024): Select link operation (RS-485, BUS option) "LE"	Y	Y
Y	N	Y	Y	25(1025): Universal DI "U-DI"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV 26(1026): Select auto search for idling motor speed at starting "STM"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 30(1030): Forced stop "STOP" (30 = Active OFF/1030 = Active ON)	Y	Y
Y	Y	Y	Y	SLV PGV TRQ	Y	Y

Chap 5 FUNCTION CODES

Function code and name				Control method and Data setting range	Type	
E01 to E05	E70	E98, E99	o101 to o113			
Terminal [X1] to [X5]	For remote keypad TP-E2 M/Shift key	Terminal [FWD], [REV]	Terminal [I1] to [113] (for OPC-DIO)		E3S/E3E	E3N
				32(1032): Pre-excitation "EXITE"		
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 33(1033): Reset PID integral and differential terms "PID-RST"	Y	Y
				34(1034): Hold PID integral term "PID-HLD"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 35(1035): Local (keypad) command selection "LOC"	Y	N
Y	Y	Y	Y	38(1038): Run enable "RE"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 39: Condensation prevention "DWP"	Y	Y
Y	N	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 42(1042): Activate the limit switch at start point "LS"	Y	N
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 43 (1043): Start/Reset "S/R"	Y	N
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 44 (1044) Switch to the serial pulse receiving mode "SPRM"	Y	N
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 45 (1045) Enter the return mode "RTN"	Y	N
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 46(1046): Enable overload stop "OLS"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 47(1047): Servo lock command "LOCK"	Y	N
Y[※1]	N	N	N	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 48: Pulse string input "PIN" [*1] Terminal [X5] only (E05)	Y	N
Y[※2]	N	Y	Y	49(1049): Pulse string sign terminal "SIGN" [*2] Other than terminal [X5] (E01 to E04)	Y	N
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 58(1058): UP/DOWN frequency clear "STZ"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 59(1059): Battery/UPS operation selection "BATRY/UPS"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 60(1060): Torque bias command "TB1"	Y	Y
				61(1061): Torque bias command 2 "TB2"	Y	Y
				62(1062): Hold torque bias "H-TB"	Y	Y
Y	N	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 65(1065): Check brake "BRKE"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 70(1070): Cancel line speed control "Hz/LSC"	Y	N
				71(1071): Hold line speed control frequency in the memory "LSC-HLD"	Y	N
Y	N	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 72(1072): Count the run time of commercial power-driven (motor 1) "CRUN-M1"	Y	Y
				73(1073): Count the run time of commercial power-driven (motor 2) "CRUN-M2"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 76(1076): Select droop control "DROOP"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 78(1078): Select speed control parameters 1 "MPRM1"	Y	Y
				79(1079): Select speed control parameters 2 "MPRM2"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 80(1080): Cancel customizable logic "CLC"	Y	Y
				81(1081): Clear all customizable logic timers "CLTC"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 82(1082): Cancel anti-regenerative control "AR-CCL"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 83(1083): PG input switching "PG-SEL"	Y	N
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 84(1084): Acceleration/deceleration cancel (bypass) "BPS"	Y	Y
Y	N	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 94: Forward JOG "FJOG"	Y	Y
				95: Reverse JOG "RJOG"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 97(1097): Rotation direction command "DIR"	Y	Y
N	N	Y	N	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 98: Forward rotation/stop command "FWD"	Y	Y
				99: Reverse rotation/stop command "REV"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ	Y	Y

Function code and name				Control method and Data setting range	Type	
E01 to E05	E70	E98, E99	o101 to o113			
Terminal [X1] to [X5]	For remote keypad TP-E2 M/Shift key	Terminal [FWD], [REV]	Terminal [I1] to [113] (for OPC-DIO)		E3S/E3E	E3N
				100: No assignment "NONE"		
Y	Y	Y	Y	SLV PGV PMSLV PMPGV 119 (1119): Speed regulator P operation "P-SEL"	Y	N
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 121(1121) to 129(1129): Customizable logic input 1 to 9 "CLI1" to "CLI9"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV 134:Forced operation command "FMS"	Y	Y
Y	Y	Y	Y	PGV/f PGV PMPGV 135(1135): Displacement/absolute position switching "INC/ABS"	Y	N
Y	Y	Y	Y	PGV/f PGV 136(1136): Orientation command "ORT"	Y	N
Y	Y	Y	Y	142(1142): Position preset command "P-PRESET"	Y	N
				144(1144): Positioning data change command "POS-SET"	Y	N
				145(1145): Positioning data selection 1 "POS-SEL1"	Y	N
				146(1146): Positioning data selection 2 "POS-SEL2"	Y	N
				147(1147): Positioning data selection 4 "POS-SEL4"	Y	N
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV 171(1171): PID control multistage command 1 "PID-SS1"	Y	Y
				172(1172): PID control multistage command 2 "PID-SS2"	Y	Y
				* Inside the ( ) is the negative logic signal. (OFF at short-circuit)		

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
E10	Acceleration time 2	V/f PGV/f PGV SLV PMSLV PMPGV 0.00 to 6000 s * 0.00 is for acceleration and deceleration time cancel (when performing soft-start and stop externally)	Y	Y	Y	Y	J: 6.00 A, C, E, U, K: 6.00 FRN0115E3□-2G / FRN0059E3□-4G or more: 20.0	5-149
E11	Deceleration time 2		Y	Y	Y	Y		
E12	Acceleration time 3		Y	Y	Y	Y		
E13	Deceleration time 3		Y	Y	Y	Y		
E14	Acceleration time 4		Y	Y	Y	Y		
E15	Deceleration time 4		Y	Y	Y	Y		
E16	Torque limiter 2-1	V/f PGV/f SLV PGV PMSLV PMPGV TRQ -300 to 0 to 300%; 999 (disable)	Y	Y	Y	Y	999	
E17	Torque limiter 2-2		Y	Y	Y	Y	999	
E20	Terminal [Y1] (Function selection)	Refer to E20 to E27 in Table 5.2-4 Control output terminal setting list table.	Y	Y	N	Y	0	
E21	Terminal [Y2]		Y	N	N	Y	7	
E27	Terminals [30A/B/C] (Ry output)		Y	Y	N	Y	99	

Table 5.2-4 Control output terminal setting list table (Y indicates those selections that can be selected, and N indicates those that cannot be selected.)

Function code and name				Control method and Data setting range	Type	
E20 to E21, E27	E71	o01 to o03	o121 to o128		E3S/E3E	E3N
Terminal [Y1] to [Y2], [30A/B/C]	For remote keypad TP-E2 M-LED indicator	Terminal [Y6A/C] to [Y8A/C] (for OPC-CP-RY)	Terminal [O1] to [O8] (for OPC-DIO)			
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0(1000): Inverter running "RUN"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV 1(1001): Frequency (speed) arrival "FAR"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 2(1002): Frequency (speed) detection "FDT"	Y	Y
Y	Y	Y	Y	3(1003): Undervoltage detected (Inverter stopped) "LU"	Y	Y
Y	Y	Y	Y	4(1004): Torque polarity detection "B/D"	Y	Y
Y	Y	Y	Y	5(1005): Inverter output limiting "IOL"	Y	Y
Y	Y	Y	Y	6(1006): Auto-restarting after momentary power failure "IPF"	Y	Y
Y	Y	Y	Y	7(1007): Motor overload early warning "OL"	Y	Y
Y	Y	Y	Y	8(1008): Keypad operation "KP"	Y	N
Y	Y	Y	Y	10(1010): Inverter ready to run "RDY"	Y	Y
Y	N	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 15(1015): AX terminal functions "AX"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV 16(1016): Pattern operation stage transition "TU"	Y	Y
				17(1017): Pattern operation cycle completed "TO"	Y	Y
				18(1018): Pattern operation stage No. 1 "STG1"	Y	Y
				19(1019): Pattern operation stage No. 2 "STG2"	Y	Y
				20(1020): Pattern operation stage No. 4 "STG4"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV 21(1021): Frequency (speed) arrival 2 "FAR2"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 22(1022): Inverter output limiting (with delay) "IOL2"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 25(1025): Cooling fan ON-OFF control "FAN"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 26(1026): Auto-resetting "TRY"	Y	Y
Y	N	N	N	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 27(1027): Universal DO "U-DO"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 28(1028): Cooling fin overheat early warning "OH"	Y	Y
Y	Y	Y	Y	PGV/f PGV 29(1029): Master-follower synchronization complete "SY"	Y	N
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 30(1030): Lifetime alarm "LIFE"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 31(1031): Frequency (speed) detection 2 "FDT2"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV 33(1033): Reference loss detection "REF OFF"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 35(1035): Inverter outputting "RUN2"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV 36(1036): Overload prevention controlling "OLP"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 37(1037): Current detection "ID"	Y	Y
				38(1038): Current detection 2 "ID2"	Y	Y
				39(1039): Current detection 3 "ID3"	Y	Y
				41(1041): Low current detection "IDL"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV 42(1042): PID alarm output "PID-ALM"	Y	Y
				43(1043): Under PID control "PID-CTL"	Y	Y
				44(1044): Under PID low liquid level stop "PID-STP"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 45(1045): Low torque detection "U-TL"	Y	Y
				46(1046): Torque detection 1 "TD1"	Y	Y
				47(1047): Torque detection 2 "TD2"	Y	Y

Function code and name				Control method and Data setting range	Type	
E20 to E21, E27	E71	o01 to o03	o121 to o128		E3S/E3E	E3N
Terminal [Y1] to [Y2], [30A/B/C]	For remote keypad TP-E2 M-LED indicator	Terminal [Y6A/C] to [Y8A/C] (for OPC-CP-RY)	Terminal [O1] to [O8] (for OPC-DIO)			
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 48(1048): Motor 1 selected “SWM1”	Y	Y
				49(1049): Motor 2 selected “SWM2”	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 52(1052): Performing forward rotation “FRUN”	Y	Y
				53(1053): Performing reverse rotation “RRUN”	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 54(1054): In remote mode "RMT"	Y	N
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 55(1055): Run command entered "AX2"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 56(1056): Motor overheat detected by thermistor "THM"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 57(1057): Machine brake signal control "BRKS"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 58(1058): Frequency (speed) detection 3 “FDT3”	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 59(1059): Current input disconnection detection (terminal [C1] and [C2]) “C1OFF”	Y	Y
Y	Y	Y	Y	PGV/f SLV PGV PMSLV PMPGV TRQ 70(1070): Speed valid "DNZS"	Y	Y
Y	Y	Y	Y	PGV/f SLV PGV PMSLV PMPGV 71(1071): Speed agreement "DSAG"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV 72(1072): Frequency (speed) arrival 3 “FAR3”	Y	Y
Y	Y	Y	Y	PGV/f PGV PMPGV 76(1076): Speed agreement/PG error “PG-ERR”	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 77(1077): Low DC link bus voltage detection “U-EDC”	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 79(1079): During deceleration in momentary power failure “IPF2”	Y	Y
Y	Y	Y	Y	PGV/f PGV PMPGV 80 (1080): Stop position override alarm “OT”	Y	N
Y	Y	Y	Y	PGV/f PGV PMPGV 81(1081): Positioning "TO"	Y	N
Y	Y	Y	Y	PGV/f PGV PMPGV 82(1082): Positioning complete "PSET"	Y	N
Y	Y	Y	Y	PGV/f PMPGV 83 (1083): Current position pulse overflow "POF"	Y	N
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 84(1084): Maintenance timer "MNT"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV 87(1087): Frequency arrival and frequency detection "FARFDT"	Y	Y
Y	N	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 90(1090): Alarm content 1 “AL1”	Y	Y
				91(1091): Alarm content 2 “AL2”	Y	Y
				92(1092): Alarm content 4 “AL4”	Y	Y
				93(1093): Alarm content 8 “AL8”	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV 95(1095): Performing forced operation "FMRUN"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 98(1098): Warning “L-ALM”	Y	Y
				99(1099): Alarm output (for any alarm) "ALM"	Y	Y
N	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 100:No assignment "NONE"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 101(1101): EN terminal detection circuit error "DECF"	Y	Y
				102(1102): EN terminal input OFF "ENOFF"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 105(1105): Braking transistor error "DBAL"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 111(1111) to 124(1124): Customizable logic output signal 1 to 14 “CLO1” to “CLO14”	Y	Y
Y	N	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 125 (1125): Integral power pulse output “POUT”	Y	Y

Function code and name				Control method and Data setting range	Type	
E20 to E21, E27	E71	o01 to o03	o121 to o128		E3S/E3E	E3N
Terminal [Y1] to [Y2], [30A/B/C]	For remote keypad TP-E2 M-LED indicator	Terminal [Y6A/C] to [Y8A/C] (for OPC-CP-RY)	Terminal [O1] to [O8] (for OPC-DIO)			
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 131(1131): Performing speed limiting "S-LIM"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 132(1132): Torque limiting "T-LIM"	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 133(1133): Low current detection “IDL2”	Y	Y
Y	Y	Y	Y	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 251(1251): Shift key ON/OFF status "MTGL"	Y	N
				* Inside the ( ) is the negative logic signal. (OFF at short-circuit)		

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
E29	Frequency arrival delay (FAR2)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.01 to 10.00 s	Y	Y	Y	Y	0.10	5-161
E30	Frequency arrival detection range (Detection range)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.0 to 10.0 Hz	Y	Y	Y	Y	2.5	
E31	Frequency detection (Operation level)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.0 to 599.0 Hz	Y	Y	Y	Y	200V class C, E: 50.0 A, U, K, J: 60.0 400V class A, C, E: 50.0 U, K, J: 60.0	5-163
E32	(Hysteresis range)		Y	Y	Y	Y	1.0	
E34	Overload early warning/Current detection (Operation level)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.00 A (disable), current value of 1 to 200% of inverter rated current set with A units	Y	Y	Y	Y1 Y2	*4	
E35	(Timer time)	0.01 to 600.00 s	Y	Y	Y	Y	10.00	
E36	Frequency detection 2 (Operation level)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.0 to 599.0 Hz	Y	Y	Y	Y	200V class C,E: 50.0 A, U, K, J: 60.0 400V class A, C, E: 50.0 U, K, J: 60.0	5-164
E37	Current detection 2/Low current detection (Operation level)	Same as F34	Y	Y	Y	Y1 Y2	*4	5-165
E38	(Timer time)	Same as F35	Y	Y	Y	Y	10.00	
E39	Constant feed time coefficient 1/Speed display auxiliary coefficient 1	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.000 to 9999	Y	Y	Y	Y	1.000	
E42	LED display filter	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.0 to 5.0 s	Y	N	Y	Y	0.5	

*4 The motor rated current is automatically set. Refer to “Table 5.2-2 Motor constant” (function code P03).

Function code	Name	Control method and Data setting range	Type		Change when running	Data copying	Default value	Related page
			E3S/E3E	E3N				
E43	LED monitor (Item selection)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Speed monitor (Selectable with E48) 3: Output current 4: Output voltage 8: Calculated torque 9: Input power 10: PID command value 12: PID feedback value 13: Timer value 14: PID output 15: Load rate 16: Motor output 17: Analog input monitor 21: Current position 22: Positioning deviation 23: Torque current (%) 24: Magnetic flux command value (%) 25: Input watt-hour 28: Stop target position 29: PID deviation 30: Torque bias 32: Customizable logic output	Y	N	Y	Y	0	5-166
E44	(Display when stopped)	0: Specified value 1: Output value	Y	N	Y	Y	0	5-168
E48	LED monitor details (Speed monitor selection)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Output frequency 1 (before slip compensation) 1: Output frequency 2 (after slip compensation) 2: Reference frequency 3: Motor speed 4: Load shaft speed 5: Feed speed (line speed) 6: Constant feed time 7: Speed (%)	Y	N	Y	Y	0	
E49	Torque command monitor (Polarity selection)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Torque polarity 1: Plus for driving, Minus for braking	Y	Y	Y	Y	1	
E50	Display coefficient for speed monitor	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.01 to 600.00	Y	Y	Y	Y	30.00	5-169
E51	Display coefficient for “Input watt-hour” data	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.000 (cancel/reset) 0.001 to 9999	Y	Y	Y	Y	0.010	5-170
E52	Keypad menu selection	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Function code data setting mode (Menu 0, Menu 1, and Menu 7) 1: Function code data check mode (Menu 2 and Menu 7) 2: Full-menu mode	Y	N	Y	Y	2	
E54	Frequency detection 3 (Operation level)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.0 to 599.0 Hz	Y	Y	Y	Y	200V class C, E: 50.0 A, U, K, J: 60.0 400V class A, C, E: 50.0 U, K, J: 60.0	
E55	Current detection 3 (Operation level)	Same as E34	Y	Y	Y	Y1 Y2	*5	
E56	(Timer time)	Same as E35	Y	Y	Y	Y	10.00	
E57	Integral power pulse output unit	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Pulse output every 0.1 kWh 1: Pulse output every 1 kWh 2: Pulse output every 10 kWh 3: Pulse output every 100 kWh 4: Pulse output every 1000 kWh	Y	Y	Y	Y	1	5-171

*5 The motor rated current is automatically set. Refer to “Table 5.2-2 Motor constant” (function code P03).

Function code	Name	Control method and Data setting range	Type		Change when running	Data copying	Default value	Related page
			E3S/E3E	E3N				
E61	Terminal [12] (Extension function selection)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: None 1: Auxiliary frequency setting 1 2: Auxiliary frequency setting 2 3: PID command 5: PID feedback value 6: Ratio setting 7: Analog torque limiter A 8: Analog torque limiter B 9: Torque bias 10: Torque command 11: Torque current command 12: Acceleration/deceleration time ratio setting 13: Upper limit frequency 14: Lower limit frequency 15: Auxiliary frequency setting 3 16: Auxiliary frequency setting 4 17: Speed limit for forward (FWD) rotation 18: Speed limit for reverse (REV) rotation 20: Analog input monitor	Y	Y	N	Y	0	5-171
E62	Terminal [C1] (C1 function) (Extension function selection)		Y	Y	N	Y	0	
E63	Terminal [C1] (V2 function) (Extension function selection)		Y	Y	N	Y	0	
E64	Saving of digital reference frequency	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Auto saving (main power is turned OFF) 1: Save by turning FUNC/DATA key ON	Y	N	Y	Y	0	5-173
E65	Reference loss detection (Continued operation frequency)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Stop deceleration, 20 to 120%, 999: Cancel	Y	Y	Y	Y	999	5-174
E70	Shift key (Function selection)	Refer to E70 in Table 5.2-3 Control input terminal setting list table.	Y	N	N	Y	100	5-175
E71	M-LED indicator (Function selection)	Refer to E71 in Table 5.2-4 Control output terminal setting list table.	Y	N	N	Y	100	
E76	DC link bus low-voltage detection level	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 200 to 400 V (200V series) 400 to 800 V (400V series)	Y	Y	Y	Y2	235/470	
E78	Torque detection 1 (Operation level)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0 to 300%	Y	Y	Y	Y	100	5-176
E79	(Timer time)	0.01 to 600.00 s	Y	Y	Y	Y	10.00	
E80	Torque detection 2/low torque detection (Operation level)	Same as E78	Y	Y	Y	Y	20	
E81	(Timer time)	Same as E79	Y	Y	Y	Y	20.00	
E98	Terminal [FWD] (Function selection)	Refer to E98 and E99 in Table 5.2-3 Control input terminal setting list table.	Y	Y	N	Y	98	
E99	Terminal [REV] (Function selection)		Y	Y	N	Y	99	

[3] C codes: Control Functions

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
C01	Jump frequency 1	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.0 to 599.0 Hz	Y	Y	Y	Y	0.0	5-177
C02	2		Y	Y	Y	Y	0.0	
C03	3		Y	Y	Y	Y	0.0	
C04	(Skip range)	0.0 to 30.0 Hz	Y	Y	Y	Y	3.0	
C05	Multistep frequency 1	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.00 to 599.00 Hz	Y	Y	Y*	Y	0.00	5-178
C06	2		Y	Y	Y*	Y	0.00	
C07	3		Y	Y	Y*	Y	0.00	
C08	4		Y	Y	Y*	Y	0.00	
C09	5		Y	Y	Y*	Y	0.00	
C10	6		Y	Y	Y*	Y	0.00	
C11	7		Y	Y	Y*	Y	0.00	
C12	8		Y	Y	Y*	Y	0.00	
C13	9		Y	Y	Y*	Y	0.00	
C14	10		Y	Y	Y*	Y	0.00	
C15	11		Y	Y	Y*	Y	0.00	
C16	12		Y	Y	Y*	Y	0.00	
C17	13		Y	Y	Y*	Y	0.00	
C18	14		Y	Y	Y*	Y	0.00	
C19	15		Y	Y	Y*	Y	0.00	
C20	Jogging frequency	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.00 to 599.00 Hz	Y	Y	Y*	Y	0.00	5-179
C21	Pattern operation/Timed operation (Mode selection)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ [E3S/E3E] 0: 1 cycle operation 1: Repetition operation 2: Constant speed operation after 1 cycle operation 3: Timed operation [E3N] 0: 1 cycle operation 1: Repetition operation 2: Constant speed operation after 1 cycle operation	Y	Y	N	Y	0	5-180
C22	(Stage 1)	Special setting. Press FUNC/DATA key three times. 1st: Set run time 0.0 to 6000 s and press FUNC/DATA key. 2nd: Set rotational direction F (forward) or r (reverse) and press FUNC/DATA key. 3rd: Set acceleration/deceleration time 1 to 4 and press FUNC/DATA key.	Y	Y	Y	Y	1st time: 0.00 2nd time: F 3rd time: 1	
C23	(Stage 2)		Y	Y	Y	Y		
C24	(Stage 3)		Y	Y	Y	Y		
C25	(Stage 4)		Y	Y	Y	Y		
C26	(Stage 5)		Y	Y	Y	Y		
C27	(Stage 6)		Y	Y	Y	Y		
C28	(Stage 7)		Y	Y	Y	Y		
C30	Frequency setting 2	Same as F01	Y	Y	N	Y	2	5-183
C31	Analog input adjustment (Terminal [12]) (Offset)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ -5.0 to 5.0%	Y	Y	Y*	Y	0.0	
C32	(Gain)	0.00 to 400.00%	Y	Y	Y*	Y	100.00	
C33	(Filter)	0.00 to 5.00 s	Y	Y	Y	Y	0.05	
C34	(Gain base point)	0.00 to 100.00%	Y	Y	Y*	Y	100.00	
C35	(Polarity selection)	0: Bipolar 1: Unipolar	Y	Y	N	Y	1	
C36	Analog input adjustment (Terminal [C1]) (C1 function) (Offset)	Same as C31	Y	Y	Y*	Y	0.0	
C37	(Gain)	Same as C32	Y	Y	Y*	Y	100.00	
C38	(Filter)	Same as C33	Y	Y	Y	Y	0.05	
C39	(Gain base point)	Same as C34	Y	Y	Y*	Y	100.00	
C40	(Mode selection)	0: 4 to 20 mA Unipolar 1: 0 to 20 mA Unipolar 10: 4 to 20 mA Bipolar 11: 0 to 20 mA Bipolar	Y	Y	N	Y	0	
C41	Analog input adjustment (Terminal [C1]) (V2 function) (Offset)	Same as C31	Y	Y	Y*	Y	0.0	
C42	(Gain)	Same as C32	Y	Y	Y*	Y	100.00	
C43	(Filter)	Same as C33	Y	Y	Y	Y	0.05	
C44	(Gain base point)	Same as C34	Y	Y	Y*	Y	100.00	
C45	(Polarity selection)	Same as C35	Y	Y	N	Y	1	
C50	Bias (for frequency setting 1) (Bias base point)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.00 to 100.00%	Y	Y	Y*	Y	0.00	5-186

FUNCTION CODES

Chap 5

Function code	Name	Control method and Data setting range	Type E3S/E3E	Type E3N	Change when running	Data copying	Default value	Related page
C51	Bias (PID command) (Bias value)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ -100.0 to 0.00 to 100.00%	Y	Y	Y*	Y	0.00	-
C52	(Bias base point)	0.00 to 100.00%	Y	Y	Y*	Y	0.00	-
C53	(Forward/reverse operation selection) (Frequency setting 1)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Forward operation 1: Reverse operation	Y	Y	Y	Y	0	5-186
C54	(Frequency setting 2)		Y	Y	Y	Y	0	
C55	Analog input adjustment (Terminal [12]) (Bias)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ -200.0 to 0.00 to 200.00%	Y	Y	Y*	Y	0.00	5-183
C56	(Bias base point)	0.00 to 100.00%	Y	Y	Y*	Y	0.00	
C58	(Display unit)	Same as J105 (0 cannot be set.)	Y	Y	Y	Y	2	5-186
C59	(Maximum scale)	-999.0 to 0.00 to 9990.0	Y	Y	N	Y	100.00	5-187
C60	(Minimum scale)	-999.0 to 0.00 to 9990.0	Y	Y	N	Y	0.00	
C61	Analog input adjustment (Terminal [C1] (C1 function) (Bias)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ -200.0 to 0.00 to 200.00%	Y	Y	Y*	Y	0.00	5-183
C62	(Bias base point)	0.00 to 100.00%	Y	Y	Y*	Y	0.00	
C64	(Display unit)	Same as J105 (0 cannot be set.)	Y	Y	Y	Y	2	5-186
C65	(Maximum scale)	-999.0 to 0.00 to 9990.0	Y	Y	N	Y	100.00	5-187
C66	(Minimum scale)	-999.0 to 0.00 to 9990.0	Y	Y	N	Y	0.00	
C67	Analog input adjustment (Terminal [C1]) (V2 function) (Bias)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ -200.0 to 0.00 to 200.00%	Y	Y	Y*	Y	0.00	5-183
C68	(Bias base point)	0.00 to 100.00%	Y	Y	Y*	Y	0.00	
C70	(Display unit)	Same as J105 (0 cannot be set.)	Y	Y	Y	Y	2	5-186
C71	(Maximum scale)	-999.0 to 0.00 to 9990.0	Y	Y	N	Y	100.00	5-187
C72	(Minimum scale)	-999.0 to 0.00 to 9990.0	Y	Y	N	Y	0.00	
C89	Frequency compensation 1 through communication (Numerator)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ -32768 to 32767 (Keypad display is 8000 to 7FFF (Hexadecimal)) (Interpreted as 1 when the value is set to 0)	Y	Y	Y	Y	0001	
C90	Frequency compensation 2 through communication (Denominator)		Y	Y	Y	Y	0001	
C94	Jump frequency 4	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.0 to 599.0 Hz	Y	Y	Y	Y	0.0	5-177 5-187
C95	5		Y	Y	Y	Y	0.0	
C96	6		Y	Y	Y	Y	0.0	
C99	Digital reference frequency	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.00 to Maximum output frequency (1 to 2)	Y	N	Y*	Y	0.00	5-187

[4] P codes: Motor 1 Parameters

Factory default…A (for Asia), C (for China), E (for Europe), U (for Americas), K (for Korea), J (for Japan)

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
P01	Motor 1 (Poles)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 2 to 128 poles	Y	Y	N	Y1Y2	4	5-188
P02	(Capacity)	0.01 to 1000 kW (except when P99 = 1) 0.01 to 1000 HP (when P99 = 1)	Y	Y	N	Y1Y2	*6	
P03	(Rated current)	0.00 to 2000 A	Y	Y	N	Y1Y2	*6	
P04	(Auto tuning)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Disable 1: Tuning with the motor stopped 2: Tuning with the motor running 4: PMSM magnetic pole position offset tuning 5: Tuning with the motor stopped (%R1, %X only)	Y	Y	N	N	0	5-189
P05	(Online tuning)	V/f 0: Disable, 1: Enable	Y	Y	Y	Y	0	5-190
P06	(No-load current)	V/f PGV/f SLV PGV TRQ 0.00 to 2000 A	Y	Y	N	Y1Y2	*6	5-191
P07	(%R1)	0.00 to 50.00%	Y	Y	Y	Y1Y2	*6	
P08	(%X)	0.00 to 50.00%	Y	Y	Y	Y1Y2	*6	
P09	(Slip compensation gain for driving)	V/f SLV PGV TRQ 0.0 to 200.0%	Y	Y	Y*	Y	100.0	
P10	(Slip compensation response time)	V/f 0.01 to 10.00 s	Y	Y	Y	Y1Y2	0.50	
P11	(Slip compensation gain for braking)	V/f SLV PGV TRQ 0.0 to 200.0%	Y	Y	Y*	Y	100.0	
P12	(Rated slip frequency)	V/f PGV/f SLV PGV TRQ 0.00 to 15.00 Hz	Y	Y	N	Y1Y2	*6	5-192
P13	(Iron loss coefficient 1)	V/f PGV/f SLV PGV TRQ 0.00 to 20.00%	Y	Y	Y	Y1Y2	*6	
P16	(Magnetic saturation coefficient 1)	0.0 to 300.0%	Y	Y	Y	Y1Y2	*6	
P17	(Magnetic saturation coefficient 2)	0.0 to 300.0%	Y	Y	Y	Y1Y2	*6	
P18	(Magnetic saturation coefficient 3)	0.0 to 300.0%	Y	Y	Y	Y1Y2	*6	
P19	(Magnetic saturation coefficient 4)	0.0 to 300.0%	Y	Y	Y	Y1Y2	*6	
P20	(Magnetic saturation coefficient 5)	0.0 to 300.0%	Y	Y	Y	Y1Y2	*6	
P30	(Synchronous motor magnetic pole position detection method selection)	PMSLV PMPGV 0: Current draw 1: For IPMSM (Interior permanent magnet synchronous motor) 2: For SPMSM (Surface permanent magnet synchronous motor) 3: Current draw method for IPMSM 4: High-frequency superimposing method for IPMSM	Y	Y	N	Y1Y2	1	5-193
P40	(For adjustment by manufacturer) *7	0 to 100	Y	Y	N	Y1Y2	15	5-194
P41	(For adjustment by manufacturer) *7	-50.0 to 50.0	Y	Y	Y	Y1Y2	1.0	
P53	(%X correction factor 1)	V/f PGV/f SLV PGV TRQ 0 to 300%	Y	Y	Y	Y1Y2	100	
P55	(Torque current under vector control)	SLV PGV TRQ 0.00 to 2000 A	Y	Y	N	Y1Y2	*6	5-195
P56	(Induced voltage factor under vector control)	50 to 100%	Y	Y	N	Y1Y2	*6	
P57	(For adjustment by manufacturer) *7	0.000 to 20.000	Y	Y	Y	Y1Y2	*6	
P60	(For PMSM) (Armature resistance)	PMSLV PMPGV TRQ 0.000 to 50.000 Ω (phase)	Y	Y	N	Y1Y2	*8	
P61	(d-axis inductance)	0.00 to 500.00 mH (phase)	Y	Y	N	Y1Y2	*8	
P62	(q-axis inductance)	0.00 to 500.00 mH (phase)	Y	Y	N	Y1Y2	*8	
P63	(Induced voltage)	0 to 240 V (200 V class); 0 to 500 V (400V class)	Y	Y	N	Y1Y2	*8	
P64	(Iron loss)	0.0 to 20.0% (Iron loss at rated capacity and base speed of the motor)	Y	Y	Y	Y1Y2	*8	
P65	(q-axis inductance magnetic saturation correction)	0.0 to 100.0% (100% = No magnetic saturation); 999	Y	Y	Y	Y1Y2	999	
P74	(Current command value on startup)	10 to 200% (100% = motor rated current)	Y	Y	Y*	Y1Y2	80 *8	
P82	(For adjustment by manufacturer) *7	0 to 100	Y	Y	N	Y1Y2	100	
P83	(For adjustment by manufacturer) *7	0.0 to 50.0; 999	Y	Y	Y	Y1Y2	999	

*6 Motor constants are set by capacity.
*7 This is a function code for adjustment by the manufacturer. Do not access this function code.
*8 The factory default values are set to the constants of the Fuji standard PMSM GNB series.

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
P84	(For adjustment by manufacturer) *7	0.0 to 100.0; 999	Y	Y	N	Y1Y2	999	5-195
P85	(Flux limitation value)	50.0 to 150.0; 999	Y	Y	Y	Y1Y2	999	
P86	(For adjustment by manufacturer) *9	0.0 to 100.0	Y	Y	N	N	0.0	
P87	(NS discrimination current command value)	0 to 200% (100% = motor rated current)	Y	Y	N	Y1Y2	60	
P88	(For adjustment by manufacturer) *9	0 to 100; 999	Y	Y	N	Y1Y2	999	
P89	(Control switching level)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0; 1 to 100%	Y	Y	N	Y1Y2	0	5-196
P90	(Overcurrent protection level)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.00 (cancel); 0.01 to 4000 A	Y	Y	N	Y1Y2	*10	
P95	(Magnetic pole position sensor offset)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.0 to 359.9 degree; 999 (offset not set)	Y	N	Y	Y	999	
P99	Motor 1 selection	V/f PGV/f SLV PGV PMSLV PMPGV TRQ The setting range is 0 to 5 when F42 = 0 to 6, and 20 to 23 when F42 = 15 or 16. 0: Motor characteristics 0 (Fuji standard motors, 8-series) 1: Motor characteristics 1 (Representative HP motor models) 3: Motor characteristics 3 (Refer to the description of function code P99 when using Fuji standard IM, 6-series) 4: Other 5: Motor characteristics 5 (Fuji premium efficiency motors) 20: Other (PMSM) 21: Motor characteristics (Fuji PMSM (GNB2 series)) 23: Motor characteristics (Fuji PMSM (GNP1 series))	Y	Y	N	Y1Y2	U: 1 A, C, E, K, J: 5	

*9 This is a function code for adjustment by the manufacturer. Do not access this function code.
*10 The factory default values are set to the constants of the Fuji standard PMSM GNB series

[5] H codes: High-performance Functions

Factory default…A (for Asia), C (for China), E (for Europe), U (for Americas), K (for Korea), J (for Japan)

Function code	Name	Control method and Data setting range	Type E3S/E3E	Type E3N	Change when running	Data copying	Default value	Related page
H02	Data initialization (Initial value selection)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Fuji standard initial value 1: User-set initial value (setting value saved by using H193, H194)	Y	Y	Y	Y	0	5-198
H03	Data initialization	0: Manual setting value 1: Initialization (based on H02 setting) 2: Motor 1 constant initialization 3: Motor 2 constant initialization 11: Limited initialization (initialization excluding communication function codes) 12: Limited initialization (initialization of customizable logic U codes) 13: Limited initialization (clearing of favorites)	Y	Y	N	N	0	
H04	Retry (Count)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Disable, 1 to 20: Number of retries	Y	Y	Y	Y	0	5-201
H05	(Waiting time)	0.5 to 20.0 s	Y	Y	Y	Y	5.0	
H06	Cooling fan ON-OFF control	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Disable (Always Fan ON) 1: Enable (ON/OFF control active)	Y	Y	Y	Y	0	5-202
H07	Curvilinear acceleration/deceleration	V/f PGV/f SLV PGV PMSLV PMPGV 0: Disable (Linear acceleration/deceleration) 1: S-curve acceleration/deceleration (Weak) 2: S-curve acceleration/deceleration (Arbitrary: According to H57 to H60) 3: Curvilinear acceleration/ deceleration	Y	Y	Y	Y	0	
H08	Rotational direction limitation	V/f PGV/f SLV PGV PMSLV PMPGV 0: Disable 1: Enable (Reverse rotation inhibited) 2: Enable (Forward rotation inhibited)	Y	Y	N	Y	0	
H09	Startup characteristics (Auto search mode)	V/f PGV/f 0: Disable 1: Enable (Only at momentary power failure restart) 2: Enable (At normal start and at momentary power failure restart)	Y	Y	N	Y	0	5-203
H11	Deceleration mode	V/f PGV/f SLV PGV PMSLV PMPGV 0: Normal deceleration 1: Coast-to-a-stop	Y	Y	Y	Y	0	5-204
H12	Instantaneous overcurrent limit (Operation selection)	V/f PGV/f 0: Disable, 1: Enable	Y	Y	Y	Y	1	
H13	Momentary power failure restart (Waiting time)	V/f PGV/f SLV PGV PMSLV PMV 0.1 to 20.0 s	Y	Y	Y	Y1 Y2	*11	5-205
H14	(Frequency fall rate)	V/f PGV/f 0.00: Selected deceleration time, 0.01 to 100.00Hz/s, 999 (According to current limiter)	Y	Y	Y	Y	999	
H15	(Continued operation level)	V/f PGV/f SLV PGV PMSLV PMPGV 200 to 300 V (200V series) 400 to 600 V (400V series)	Y	Y	Y	Y2	235 470	
H16	(Allowable momentary power failure time)	0.0 to 30.0s, 999 (Dependent on inverter automatic judgment)	Y	Y	Y	Y	999	
H18	Torque control (Operation selection)	SLV PGV PMPGV TRQ 0: Disable (Speed control) 2: Enable (Torque current command) 3: Enable (Torque command)	Y	Y	N	Y	0	
H26	Motor 1, 2 (Thermistor operation selection)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Disable 1: PTC: OH4 trip and stop the inverter 2: PTC: Output signal “THM” and continue to run	Y	Y	Y	Y	0	5-208
H27	(Thermistor operation level)	0.00 to 5.00 V	Y	Y	Y	Y	1.60	
H28	Droop control	V/f PGV/f SLV PGV PMSLV PMPGV -60.0 to 0.0 Hz	Y	Y	Y	Y	0.0	5-210
H30	Link functions (Operation selection)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ **Frequency setting/torque command — Run command** 0: F01/C30 — F02 1: RS-485 communication (Port 1) — F02 2: F01/C30 — RS-485 communication (Port 1) 3: RS-485 communication (Port 1) — RS-485 communication (Port 1) 4: RS-485 communication (Port 2) — F02 5: RS-485 communication (Port 2) — RS-485 communication (Port 1) 6: F01/C30 — RS-485 communication (Port 2) 7: RS-485 communication (Port 1) — RS-485 communication (Port 2) 8: RS-485 communication (Port 2) — RS-485 communication (Port 2)	Y	N	Y	Y	0	5-211
H31	(Actual terminal operation selection)	0: Disable 1: Enable	Y	Y	N	Y	0	

*11 Standard values depend on motor capacity Refer to “Table 5.2-1 Factory default setting values by capacity.”

FUNCTION CODES

Chap 5

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
H42	Capacitance of DC link bus capacitor	V/f PGV/f SLV PGV PMSLV PMPGV TRQ For adjustment when carrying out replacement, 0 to 65535	Y	Y	Y	N	-	5-213
H43	Cumulative run time of the cooling fan	V/f PGV/f SLV PGV PMSLV PMPGV TRQ For adjustment when carrying out replacement, 0 to 9999 (updated in 10-hour units) Displays the cumulative run time for the cooling fan	Y	Y	Y	N	0	
H44	Startup count 1	V/f PGV/f SLV PGV PMSLV PMPGV TRQ For adjustment when carrying out replacement, 0 to 65535 times	Y	Y	Y	N	0	5-217
H45	Simulated failure	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Disable 1: Occurrence of simulated failure	Y	Y	Y	N	0	
H46	Startup characteristics (Auto search time 2)	V/f PGV/f SLV TRQ 0.1 to 20.0 s	Y	Y	Y	Y1 Y2	*12	
H47	Initial capacitance of DC link bus capacitor	V/f PGV/f SLV PGV PMSLV PMPGV TRQ For adjustment when carrying out replacement, 0 to 65535	Y	Y	Y	N	-	
H48	Cumulative run time of capacitors on PCBs	V/f PGV/f SLV PGV PMSLV PMPGV TRQ For adjustment when carrying out replacement, 0 to 9999 (updated in 10-hour units) Change in cumulative motor run time (Reset is enabled)	Y	Y	Y	N	0	5-213 5-217
H49	Startup characteristics (Auto search time 1)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.0 to 10.0 s	Y	Y	Y	Y	0.0	5-217
H50	Non-linear V/f1 (Frequency)	V/f PGV/f 0.0 (Cancel), 0.1 to 599.0 Hz	Y	Y	N	Y	0.0	5-218
H51	(Voltage)	0 to 240 V:AVR operation (200V series) 0 to 500 V:AVR operation (400V series)	Y	Y	N	Y2	0	
H52	Non-linear V/f2 (Frequency)	Same as H50	Y	Y	N	Y	0.0	
H53	(Voltage)	Same as H51	Y	Y	N	Y2	0	
H54	Acceleration time (Jogging operation)	V/f PGV/f PGV SLV PMSLV PMPGV 0.00 to 6000 s * 0.00 cancels acceleration and deceleration time (when performing soft-start and stop externally)	Y	Y	Y	Y	J: 6.00 A, C, E, U, K: 6.00 FRN0115E3□-2G / FRN0059E3□-4G or more: 20.0	
H55	Deceleration time (Jogging operation)		Y	Y	Y	Y		
H56	Deceleration time for forced stop	V/f PGV/f SLV PGV PMSLV PMPGV 0.00 to 6000 s	Y	Y	Y	Y		
H57	1S-curve acceleration range (when starting)	V/f PGV/f SLV PGV PMSLV PMPGV 0 to 100%	Y	Y	Y	Y	10	
H58	2S-curve acceleration range (when finished)		Y	Y	Y	Y	10	
H59	1S-curve deceleration range (when starting)		Y	Y	Y	Y	10	
H60	2S-curve deceleration range (when finished)		Y	Y	Y	Y	10	
H61	UP/DOWN control initial value selection	V/f PGV/f SLV PGV PMSLV PMPGV 0: Initial value is 0.00 Hz (E2S compatible operation) . 1: Initial value is last UP/DOWN command value before releasing the run command (E2S compatible operation) . 2: Initial value is 0.00 Hz. 3: Initial value is frequency set by previous UP/DOWN command.	Y	Y	N	Y	1	
H62	UP/DOWN control (extension function selection)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ Same as E61 (However, 5 and 19 cannot be selected.)	Y	Y	N	Y	0	
H63	Lower limit limiter (Operation selection)	V/f PGV/f SLV PGV PMSLV PMPGV 0: Limit by F16 (Frequency limiter (Lower limit)) and continue to run 1: If the output frequency is less than the one limited by F16 (Frequency limiter (Lower limit)), decelerate to a stop.	Y	Y	Y	Y	0	
H64	(Minimum frequency when performing limiting operation)	V/f PGV/f SLV PGV PMSLV PMPGV 0.0: Depends on F16 (Frequency limiter (Lower limit)) 0.1 to 599.0 Hz *13	Y	Y	Y	Y	1.6	
H65	Non-linear V/f3 (Frequency)	V/f PGV/f 0.0 (Cancel), 0.1 to 599.0 Hz	Y	Y	N	Y	0.0	
H66	(Voltage)	0 to 240 V:AVR operation (200V series) 0 to 500 V:AVR operation (400V series)	Y	Y	N	Y2	0	
H67	Auto energy-saving operation (Mode selection)	V/f PGV/f SLV PGV 0: Enable only during constant speed 1: Enable for all modes	Y	Y	Y	Y	0	

*12 Motor constants are set by capacity.
*13 Under sensorless vector control for F42 = 15, 16 (PMSM), when set to less than 10% of F04 (base frequency), the internal operation of H64 is limited to the P89 setting (%) of F04.

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
H68	Slip compensation 1 (Operating condition selection)	[V/f] 0: Enable during acceleration/deceleration, enable at base frequency or higher 1: Disable during acceleration/deceleration, enable at base frequency or higher 2: Enable during acceleration/deceleration, disable at base frequency or higher 3: Disable during acceleration/deceleration, disable at base frequency or higher	Y	Y	N	Y	0	5-218
H69	Anti-regenerative control (Operation selection)	[V/f] [PGV/f] [SLV] [PGV] [PMSLV] [PMPGV] 0: Disable 2: Torque limit (Forced stop after three times the deceleration time has passed) 3: DC link bus constant control (Forced stop after three times the deceleration time has passed) 4: Torque limit without forced stop 5: DC link bus constant control without force-to-stop	Y	Y	Y	Y	0	5-219
H70	Overload prevention control	[V/f] [PGV/f] [SLV] [PGV] [PMSLV] [PMPGV] 0.00: Follow the deceleration time selected 0.01 to 100.00 Hz/s, 999 (cancel)	Y	Y	Y	Y	999	5-220
H71	Deceleration characteristics	[V/f] [PGV/f] [PGV] 0: Disable, 1: Enable 2: Enable (AVR cancel)	Y	Y	Y	Y	0	
H72	Main power supply cutoff detection (Operation selection)	[V/f] [PGV/f] [SLV] [PGV] [PMSLV] [PMPGV] [TRQ] 0: Disable, 1: Enable	Y	Y	Y	Y	1	5-221
H73	Torque limiter (Operating condition selection)	[V/f] [PGV/f] [SLV] [PGV] [PMSLV] [PMPGV] [TRQ] 0: Enable during acceleration/deceleration, enable during constant speed 1: Disable during acceleration/deceleration, enable during constant speed 2: Enable during acceleration/deceleration, disable during constant speed	Y	Y	N	Y	0	
H74	Torque control (Control target)	[SLV] [PGV] [PMSLV] [PMPGV] [TRQ] 0: Torque limiter 1: Torque current limiter 2: Power limiter	Y	Y	N	Y	1	
H75	(Target quadrant)	0: Drive/braking 1: 4 quadrants identical 2: Upper limit/ lower limit 3: 4 quadrants independent	Y	Y	N	Y	0	
H76	Torque limiter (Braking) (Increasing frequency limiter)	[V/f] [PGV/f] 0.0 to 599.0 Hz	Y	Y	Y	Y	5.0	
H77	Life of DC link bus capacitor (Remaining time)	[V/f] [PGV/f] [SLV] [PGV] [PMSLV] [PMPGV] [TRQ] 0 to 8760 (updated in units of ten hours)	Y	Y	Y	N	8760	
H78	Maintenance interval (M1)	0 (Disable): 1 to 9999 (updated in units of ten hours)	Y	Y	Y	N	8760	
H79	Preset startup count for maintenance (M1)	0000 (Disable): 0001 to FFFF times (in hexadecimal)	Y	Y	Y	N	0000	5-222
H80	Current fluctuation damping gain for motor 1	[V/f] [PGV/f] 0.00 to 1.00	Y	Y	Y	Y	0.20	5-223
H81	Warning selection 1	[V/f] [PGV/f] [SLV] [PGV] [PMSLV] [PMPGV] [TRQ] 0000 to FFFF (in hexadecimal)	Y	Y	Y	Y	0000	5-224
H82	Warning selection 2		Y	Y	Y	Y	0000	
H83	Warning selection 3		Y	Y	Y	Y	0000	
H84	Pre-excitation (Level)	[SLV] [PGV] [TRQ] 100 to 400% (Motor rated magnetizing current for 100% equivalent to P06)	Y	Y	Y	Y	100	5-227
H85	(Time)	0.00: Disable 0.01 to 30.00 s	Y	Y	Y	Y	0.00	
H86	(For adjustment by manufacturer) *14	0 to 2	Y	Y	Y	Y	0	5-228
H89	Electronic thermal 1 to 4 (Motor protection) (Data retention)	0: The integrated value for electronic thermal overload relays 1 to 4 is cleared when the power is turned OFF and ON again. 1: Retains the integrated value for electronic thermal overload relays 1 to 4 even when the power is OFF.	Y	Y	Y	Y	1	
H90	(For adjustment by manufacturer) *14	0,1	Y	Y	Y	Y	0	
H91	Current input wire break detection	[V/f] [PGV/f] [SLV] [PGV] [PMSLV] [PMPGV] 0.0 (Alarm disable): 0.1 to 60.0 s	Y	Y	Y	Y	0.0	
H92	Continued operation (P)	[V/f] [PGV/f] [SLV] [PGV] [PMSLV] [PMPGV] 0.000 to 10.000 times 999: Standard value	Y	Y	Y	Y1 Y2	999	
H93	(I)	0.010 to 10.000 s 999: Standard value	Y	Y	Y	Y1 Y2	999	
H94	Cumulative motor run time 1	[V/f] [PGV/f] [SLV] [PGV] [PMSLV] [PMPGV] [TRQ] 0 to 9999 (updated in units of ten hours) Change in cumulative motor run time (Reset is enabled)	Y	Y	N	N	-	5-221 5-228

*14 This is a function code for adjustment by the manufacturer. Do not access this function code.

Function code	Name	Control method and Data setting range	Type E3S/E3E	Type E3N	Change when running	Data copying	Default value	Related page
H95	DC braking (Select motor characteristics)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Slow response 1: Quick response	Y	Y	Y	Y	1	5-99 5-228
H96	STOP key priority/Start check function	V/f PGV/f SLV PGV PMSLV PMPGV TRQ [E3S/E3E] 0: STOP key priority disable/ Start check function disable 1: STOP key priority enable/ Start check function disable 2: STOP key priority disable/ Start check function enable 3: STOP key priority enable/ Start check function enable [E3N] 0: STOP key priority disable/ Start check function disable 2: STOP key priority disable/ Start check function enable	Y	Y	Y	Y	A, C, E, K, J: 0 U: E3S/E: 3 E3N: 2	5-229
H97	Clear alarm data	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Disable 1: Clear alarm data (Automatically returns to 0 after clearing data.)	Y	Y	Y	N	0	5-230
H98	Protection/maintenance functions (Operation selection)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0 to 255 (Data is displayed in decimal notation; meaning of bits 0: disable, 1: enable) Bit 0: Lower the carrier frequency automatically (0: Disable; 1: Enable) *15 Bit 1: Input phase loss protection (0: Disable; 1: Enable) Bit 2: Output phase loss protection (0: Disable; 1: Enable) Bit 3: DC link bus capacitor life judgment selection (0: Factory default referenced; 1: User measurement value referenced) Bit 4: DC link bus capacitor life judgment (0: Disable; 1: Enable) Bit 5: Charging resistance overheat detection protection (0: Enable; 1: Disable) Bit 6: Braking transistor error detection (0: Disable; 1: Enable)	Y	Y	Y	Y	83	
H99	Password function password 2 setting/comparison	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0000 to FFFF (in hexadecimal)	Y	Y	Y	N	0000	5-232

*15 Under sensorless vector control for F42 = 15,16 (PMSM), the automatic carrier frequency reduction function does not work.

[6] H1 codes: High-performance Functions

Factory default…A (for Asia), C (for China), E (for Europe), U (for Americas), K (for Korea), J (for Japan)

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
H101	Destination	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Not selected 1: Japan 2: Asia 3: China 4: Europe 5: America 7: Korea	Y	Y	N	Y	Before destination setting: 0 (E3N-G: 2)	5-235
H111	UPS operation level	120 to 220 VDC: (200V class) 240 to 440 VDC: (400V class) Limited internally depending on the inverter capacity.	Y	Y	Y	Y	220/440	5-235
H114	Anti-regenerative control (Operation level)	V/f PGV/f 0.0 to 50.0%, 999 (Auto)	Y	Y	Y	Y	999	5-219 5-235
H116	Forced operation (Operation selection)	V/f PGV/f SLV PGV PMSLV PMPGV 0: [FMS] ON (Mode 1) 1: [FMS] ON/OFF toggle method (Mode 1) 2: [FMS] ON latch method (Mode 1) 10: [FMS] ON (Mode 2) 11: [FMS] ON/OFF toggle method (Mode 2) 12: [FMS] ON latch method (Mode 2) 20: [FMS] ON (Mode 3) 21: [FMS] ON/OFF toggle method (Mode 3) 22: [FMS] ON latch method (Mode 3)	Y	Y	N	Y	0	5-235
H117	(Confirmation time)	0.0 to 10.0 s	Y	Y	Y	Y	3.0	
H118	(Reference frequency)	0.0 (Inherit): Based on normal reference frequency such as F01 0.1 to 599.0 Hz	Y	Y	Y	Y	0.0	
H119	(Rotation direction)	0: Based on normal run command such as F02 2: Forward rotation 3: Reverse rotation	Y	Y	N	Y	0	
H120	(Startup method)	0: Based on normal startup method 1: Auto search (Speed search)	Y	Y	Y	Y	0	
H121	(Waiting time)	0.0 to 20.0 s	Y	Y	Y	Y	5.0	
H130	For special adjustment (Torque limiting)	V/f PGV/f 0.000 to 2.000; 999	Y	Y	Y	Y	999	5-237
H131	(Torque limiting)	0.000; 0.001 to 9.999; 999	Y	Y	Y	Y	999	
H133	(Anti-regenerative control)	0.000 to 2.000; 999	Y	Y	Y	Y	999	
H134	(Anti-regenerative control)	0.000; 0.001 to 9.999; 999	Y	Y	Y	Y	999	
H147	Speed control (JOG) (Feed forward gain)	SLV PGV PMSLV PMPGV 0.00 to 99.99 s	Y	Y	Y*	Y	0.00	5-237 5-286
H154	Torque bias(Function selection)	SLV PGV PMPGV [E3S/E3E] 0: Disable 1: Digital torque bias 2: Analog torque bias 3: RS-485 communications link (port 1) 4: RS-485 communications link (port 2) 5: Field bus communication [E3N] 0: Disable 1: Digital torque bias 2: Analog torque bias 5: Field bus communication	Y	Y	N	Y	0	5-238
H155	(Level 1)	-300 to +300%	Y	Y	Y	Y	0	
H156	(Level 2)	-300 to +300%	Y	Y	Y	Y	0	
H157	(Level 3)	-300 to +300%	Y	Y	Y	Y	0	
H158	(Mechanical loss compensation)	0 to 300%	Y	Y	Y	Y	0	
H159	(Startup timer)	0.00 to 1.00 s	Y	Y	N	Y	0.00	
H161	(Shutdown timer)	0.00 to 1.00 s	Y	Y	N	Y	0.00	
H162	(Limiter)	0 to 300%	Y	Y	N	Y	200	
H173	Magnetic flux level at light load	PGV 10 to 100%	Y	Y	Y	Y	100	5-240
H180	Brake control signal (Check-time for brake operation)	V/f PGV/f SLV PGV PMSLV PMPGV 0.00 to 10.00 s	Y	Y	Y	Y	1.00	5-240 5-263
H185	(For adjustment by manufacturer) *16	0,1	Y	Y	N	Y	0	–

*16 This is a function code for adjustment by the manufacturer. Do not access this function code.

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
H193	User-set initial value (Save)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Disable 1: Save enable	Y	Y	N	N	0	5-200 5-240
H194	(Protection)	0: Save enable 1: Protected (save disable)	Y	Y	Y	Y	0	
H195	DC braking (Braking time at startup)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.00 (disable): 0.01 to 30.00 s PMSLV is valid only when P30 = 0	Y	Y	Y	Y	0.00	5-99 5-240
H196	(For adjustment by manufacturer) *17	0.001 to 9.999, 999	Y	Y	Y	Y	999	5-240
H197	User password 1 (Protective operation selection)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ [E3S/E3E] 0: All function codes are disclosed, but changes are not allowed. 1: Only the function codes registered in Favorites can be disclosed/changed. 2: Only the function codes for customizable logic settings are not disclosed/not changed. [E3N] 0: All function codes are disclosed, but changes are not allowed. 2: Only the function codes for customizable logic settings are not disclosed/not changed.	Y	Y	Y	Y	0	5-232 5-240
H198	User password 1 (Setting/comparison)	0000 to FFFF (in hexadecimal)	Y	Y	Y	N	0000	
H199	User password protection active	0: Disable 1: Protection	Y	Y	Y	N	0	

*17 This is a function code for adjustment by the manufacturer. Do not access this function code.

[7]   A codes: Motor 2 Parameters

Factory default…A (for Asia), C (for China), E (for Europe), U (for Americas), K (for Korea), J (for Japan)

Function code	Name	Control method and Data setting range	Type E3S/E3E	Type E3N	Change when running	Data copying	Default value	Related page
A01	Maximum output frequency 2	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 5.0 to 599.0 Hz	Y	Y	N	Y	200V class C, E: 50.0 A, U, K, J: 60.0 400V class A, C, E: 50.0 U, K, J: 60.0	5-241 to 5-242
A02	Base frequency 2	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 5.0 to 599.0 Hz	Y	Y	N	Y	200V class C, E, J: 50.0 A, U, K: 60.0 400V class A, C, E, J: 50.0 U, K: 60.0	
A03	Voltage at base frequency 2	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: AVR disable (output voltage proportional to power supply voltage) 80 to 240 V: AVR operation (200V series) 160 to 500 V: AVR operation (400V series)	Y	Y	N	Y2	200V class C, K, J: 200V A: 220V E, A: 230V	
A04	Maximum output voltage 2	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 80 to 240 V: AVR operation (200V series) 160 to 500 (V): AVR operation (400V series)	Y	Y	N	Y2	400V class C: 380V E, K, J: 400V A: 415V U: 460V	
A05	Torque boost 2	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.0 to 20.0% (% value against base frequency voltage 2)	Y	Y	Y*	Y	U: 0.00% *18	
A06	Electronic thermal 2 (Motor protection) (Select motor characteristics)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 1: Enable (for a general-purpose motor with self-cooling fan) 2: Enable (for an inverter-driven motor with separately powered cooling fan)	Y	Y	Y	Y	1	
A07	(Operation level)	0.00 A (disable), current value of 1 to 135% of inverter rated current set with A unit	Y	Y	Y	Y1Y2	*19	
A08	(Thermal time constant)	0.5 to 75.0 min	Y	Y	Y	Y	5.0	
A09	DC braking 2 (Braking starting frequency)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.0 to 60.0 Hz	Y	Y	Y	Y	0.0	
A10	(Operation level)	HHD mode (F80 = 0): 0 to 100% HND mode (F80 = 1): 0 to 80% HD mode (F80 = 3): 0 to 80 % ND mode (F80 = 4): 0 to 60% HND mode (F80 = 4): 0 to 60%	Y	Y	Y	Y	0	
A11	(Braking time)	0.00 (disable): 0.01 to 30.00 s	Y	Y	Y	Y	0.00	
A12	Starting frequency 2	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.0 to 60.0 Hz	Y	Y	Y	Y	0.5	
A13	Load selection/ Auto torque boost/ Auto energy-saving operation 2	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Quadratic-torque load 1: Constant torque load 2: Auto torque boost 3: Auto energy-saving operation (quadratic-torque load) 4: Auto energy-saving operation (constant torque load) 5: Auto energy-saving operation (auto torque boost)	Y	Y	N	Y	1	
A14	Control method selection 2	V/f PGV/f SLV PGV PMSLV PMPGV TRQ [E3S/E3E] 0: V/f control with slip compensation inactive 1: Dynamic torque vector control 2: V/f control with slip compensation active 3: V/f control with sensor 4: Dynamic torque vector control with sensor 5: Sensorless vector control 6: Vector control with sensor [E3N] 0: V/f control with slip compensation inactive 1: Dynamic torque vector control 2: V/f control with slip compensation active 5: Sensorless vector control	Y	Y	N	Y	0	

*18 Standard values depend on motor capacity Refer to “Table 5.2-1 Factory default setting values by capacity”.
*19 The motor rated current is automatically set. Refer to “Table 5.2-2 Motor constant” (function code P03).

FUNCTION CODES
Chap 5

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
A15	Motor 2 (Poles)	V/f PGV/f SLV PGV TRQ 2 to 128 poles	Y	Y	N	Y1 Y2	4	
A16	(Rated capacity)	0.01 to 1000 kW (except when P39 = 1) 0.01 to 1000 HP (when P39 = 1)	Y	Y	N	Y1 Y2	*20	
A17	(Rated current)	0.00 to 2000 A	Y	Y	N	Y1 Y2	*20	
A18	(Auto tuning)	V/f PGV/f SLV PGV 0: Disable 1: Tuning with the motor stopped 2: Tuning with the motor running 5: Tuning with the motor stopped (%R1, %X only)	Y	Y	N	N	0	
A19	(Online tuning)	V/f 0: Disable, 1: Enable	Y	Y	Y	Y	0	
A20	(No-load current)	V/f PGV/f SLV PGV TRQ 0.00 to 2000 A	Y	Y	N	Y1 Y2	*21	
A21	(%R1)	0.00 to 50.00%	Y	Y	Y	Y1 Y2	*21	
A22	(%X)	0.00 to 50.00%	Y	Y	Y	Y1 Y2	*21	
A23	(Slip compensation gain for driving)	V/f SLV PGV TRQ 0.0 to 200.0%	Y	Y	Y*	Y	100.0	
A24	(Slip compensation response time)	V/f 0.01 to 10.00 s	Y	Y	Y	Y1 Y2	0.50	
A25	(Slip compensation gain for braking)	V/f SLV PGV TRQ 0.0 to 200.0%	Y	Y	Y*	Y	100.0	
A26	(Rated slip frequency)	V/f PGV/f SLV PGV TRQ 0.00 to 15.00 Hz	Y	Y	N	Y1 Y2	*21	
A27	(Iron loss coefficient 1)	V/f PGV/f SLV PGV TRQ 0.00 to 20.00%	Y	Y	Y	Y1 Y2	*21	
A30	(Magnetic saturation coefficient 1)	0.0 to 300.0%	Y	Y	Y	Y1 Y2	*21	–
A31	(Magnetic saturation coefficient 2)	0.0 to 300.0%	Y	Y	Y	Y1 Y2	*21	
A32	(Magnetic saturation coefficient 3)	0.0 to 300.0%	Y	Y	Y	Y1 Y2	*21	
A33	(Magnetic saturation coefficient 4)	0.0 to 300.0%	Y	Y	Y	Y1 Y2	*21	
A34	(Magnetic saturation coefficient 5)	0.0 to 300.0%	Y	Y	Y	Y1 Y2	*21	
A39	Motor 2 selection	V/f PGV/f SLV PGV TRQ 0: Motor characteristics 0 (Fuji standard motors, 8-series) 1: Motor characteristics 1 (Representative HP motor models) 3: Motor characteristics 3 (Refer to the description of function code P99 when using Fuji standard IM, 6-series) 4: Other 5: Motor characteristics 5 (Fuji premium efficiency motors)	Y	Y	N	Y1 Y2	U: 1 A, C, E, K, J: 5	5-241 to 5-242
A40	Slip compensation 2 (Operating condition selection)	V/f 0: Enable during acceleration/deceleration, enable at base frequency or higher 1: Disable during acceleration/deceleration, enable at base frequency or higher 2: Enable during acceleration/deceleration, disable at base frequency or higher 3: Disable during acceleration/deceleration, disable at base frequency or higher	Y	Y	N	Y	0	
A41	Current fluctuation damping gain for motor 2	V/f PGV/f 0.00 to 1.00	Y	Y	Y	Y	0.20	5-223
A43	Speed control 2 (Speed command filter)	PGV/f SLV PGV PMSLV PMPGV 0.000 to 5.000 s	Y	Y	Y	Y	0.020	5-282
A44	(Speed detection filter)	PGV/f SLV PGV PMSLV PMPGV TRQ 0.000 to 0.100 s	Y	Y	Y*	Y	0.005	
A45	P (Gain)	PGV/f SLV PGV PMSLV PMPGV TRQ 0.1 to 200.0 times	Y	Y	Y*	Y	10.0	
A46	I (Integral time)	PGV/f SLV PGV PMSLV PMPGV TRQ 0.001 to 9.999 s, 999: Cancel integral time	Y	Y	Y*	Y	0.100	
A47	FF (Gain)	SLV PGV PMSLV PMPGV 0.00 to 99.99 s	Y	Y	Y*	Y	0.00	
A48	(Output filter)	SLV PGV PMSLV PMPGV TRQ 0.000 to 0.100 s	Y	Y	Y	Y	0.000	

*20 Motor constants are set by capacity.
*21 Motor constants are set by capacity.

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
A49	(Notch filter resonance frequency)	SLV PGV PMSLV PMPGV TRQ 1 to 500 Hz	Y	Y	Y	Y	200	5-285
A50	(Notch filter attenuation level)	SLV PGV PMSLV PMPGV TRQ 0 to 40 dB	Y	Y	Y	Y	0	
A51	Cumulative run time of motor 2	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0 to 9999 (updated in units of ten hours) Change in cumulative motor run time (Reset is enabled)	Y	Y	N	N	0	5-241 to 5-242
A52	Startup count 2	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0 to 65535 times For adjustment when carrying out replacement	Y	Y	Y	N	0	
A53	Motor 2 (%X correction coefficient 1)	V/f PGV/f SLV PGV TRQ 0 to 300%	Y	Y	Y	Y1Y2	100	
A55	(Torque current under vector control)	SLV PGV TRQ 0.00 to 2000 A	Y	Y	N	Y1Y2	*22	–
A56	(Induced voltage factor under vector control)	50 to 100%	Y	Y	N	Y1Y2	*22	
A57	(For adjustment by manufacturer) *23	0.000 to 20.000	Y	Y	Y	Y1Y2	*22	
A58	Speed control 2 (Notch filter width)	SLV PGV PMSLV PMPGV TRQ 0 to 3 (0: Narrow to 3: Wide)	Y	Y	Y	Y	2	5-285
A60	Speed display coefficient 2	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.00 to 600.00 0.00: Use E50	Y	Y	Y	Y	0.00	5-169
A61	Constant feed time coefficient 2/Speed display auxiliary coefficient 2	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.000 to 9999	Y	Y	Y	Y	1.000	–
A62	Starting frequency 2 (Holding time)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.00 to 10.00 s	Y	Y	Y	Y	0.00	
A63	Stop frequency 2	V/f PGV/f SLV PGV PMSLV PMPGV 0.0 to 60.0 Hz; 999 (Based on F25 setting)	Y	Y	Y	Y	999	
A64	(Detection method)	PGV PMPGV 0: Actual speed/estimated speed 1: Speed command value 100: Based on F38 setting	Y	N	N	Y	100	
A65	(Holding time)	V/f PGV/f SLV PGV PMSLV PMPGV 0.00 to 10.00 s	Y	Y	Y	Y	0.00	
A98	(Function selection)	0 to 255 bit0: Current limiter (F43, F44) (0: Disable; 1: Enable) bit1: Rotation direction limiter (H08) (0: Disable; 1: Enable) bit2: Non-linear V/f (H50 to H53, H65, H66) (0: Disable; 1: Enable) bit3: PID control (J01 to J62, H91) (0: Disable; 1: Enable) bit4: Braking signal (0: Disable; 1: Enable) bit5: Braking timer at startup (H195) (0: Disable; 1: Enable) bit6 to 7: Reserved	Y	Y	N	Y	0	5-242

*22 Motor constants are set by capacity.
*23 This is a function code for adjustment by the manufacturer. Do not access this function code.

[8] b codes: Speed Control 3 Parameters

Function code	Name	Control method and Data setting range	Type E3S/E3E	Type E3N	Change when running	Data copying	Default value	Related page
b43	Speed control 3 (Speed command filter)	Same as A43	Y	Y	Y	Y	0.020	5-282
b44	(Speed detection filter)	Same as A44	Y	Y	Y*	Y	0.005	
b45	(P gain)	Same as A45	Y	Y	Y*	Y	10.0	
b46	(I integral time)	Same as A46	Y	Y	Y*	Y	0.100	
b47	(FF Gain)	Same as A47	Y	Y	Y*	Y	0.00	
b48	(Output filter)	Same as A48	Y	Y	Y	Y	0.000	
b49	(Notch filter resonance frequency)	Same as A49	Y	Y	Y	Y	200	5-285
b50	(Notch filter attenuation level)	Same as A50	Y	Y	Y	Y	0	
b58	Speed control 3 (Notch filter width)	Same as A58	Y	Y	Y	Y	2	

[9] r codes: Speed Control 4 Parameters

Function Code	Name	Control method and Data setting range	Type		Change when running	Data copying	Default value	Related page
			E3S/E3E	E3N				
r43	Speed control 4 (Speed command filter)	Same as A43	Y	Y	Y	Y	0.020	5-282
r44	(Speed detection filter)	Same as A44	Y	Y	Y*	Y	0.005	
r45	(P gain)	Same as A45	Y	Y	Y*	Y	10.0	
r46	(I integral time)	Same as A46	Y	Y	Y*	Y	0.100	
r47	(FF Gain)	Same as A47	Y	Y	Y*	Y	0.00	
r48	(Output filter)	Same as A48	Y	Y	Y	Y	0.000	
r49	(Notch filter resonance frequency)	Same as A49	Y	Y	Y	Y	200	5-285
r50	(Notch filter attenuation level)	Same as A50	Y	Y	Y	Y	0	
r58	Speed control 4 (Notch filter width)	Same as A58	Y	Y	Y	Y	2	

[10] J codes: Application Functions

Function code	Name	Control method and Data setting range	Type		Change when running	Data copying	Default value	Related page
			E3S/E3E	E3N				
J01	PID control (Operation selection)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Disable 1: Process (forward operation) 2: Process (reverse operation) 3: Speed control (dancer)	Y	Y	N	Y	0	5-244
J02	(Remote command)	[E3S/E3E] 0: Keypad operation (⊙/⊙ keys) 1: PID command 1 (Analog input terminals [12], [C1], [V2]) 3: UP/DOWN 4: Communication [E3N] 1: PID command 1 (Analog input terminals [12], [C1], [V2]) 3: UP/DOWN 4: Communication	Y	Y	N	Y	E3S/E: 0 E3N: 4	5-246
J03	P (Gain)	0.000 to 30.000 times	Y	Y	Y	Y	0.100	5-251
J04	I (Integral time)	0.0 to 3600.0 s	Y	Y	Y	Y	0.0	
J05	D (Differential time)	0.00 to 600.00 s	Y	Y	Y	Y	0.00	
J06	(Feedback filter)	0.00 to 900.0 s *24	Y	Y	Y	Y	0.5	
J08	(Pressurization starting frequency)	0.0 to 599.0 Hz	Y	Y	Y	Y	0.0	5-255
J09	(Pressurizing time)	0 to 60 s	Y	Y	Y	Y	0	
J10	(Anti-reset wind-up)	0 to 200%	Y	Y	Y	Y	200	5-257
J11	(Alarm output selection)	0: Absolute value warning 1: Absolute value warning (with hold) 2: Absolute value warning (with latch) 3: Absolute value warning (with hold, latch) 4: Deviation warning 5: Deviation warning (with hold) 6: Deviation warning (with latch) 7: Deviation warning (with hold, latch)	Y	Y	Y	Y	0	
J12	(Upper limit alarm (AH))	-100% to 100%	Y	Y	Y	Y	100	
J13	(Lower limit alarm (AL))	-100% to 100%	Y	Y	Y	Y	0	
J15	(Low liquid level stop/start frequency level)	0.00 (disable): 1.0 to 599.0 Hz	Y	Y	Y	Y	0.0	5-258
J16	(Low liquid level stop elapsed time)	0 to 60 s	Y	Y	Y	Y	30	
J17	(Starting frequency)	0.0 to 599.0 Hz	Y	Y	Y	Y	0.0	
J18	(Upper limit of PID output)	-150% to 150%, 999 (based on F15)	Y	Y	Y	Y	999	5-259
J19	(Lower limit of PID output)	-150% to 150%, 999 (based on F16)	Y	Y	Y	Y	999	
J21	Condensation prevention (Duty)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 1 to 50%	Y	Y	Y	Y	1	
J23	PID control (Low liquid level stop/start feedback deviation)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.0 to 100.0%	Y	Y	Y	Y	0.0	
J24	Low liquid level stop/start delay time	0 to 3600 s	Y	Y	Y	Y	0	
J57	(Dancer standard position)	-100 to 0 to 100%	Y	Y	Y	Y	0	5-260
J58	(Detection range of dancer standard position error)	0: Cancel PID constant switching 1 to 100%: Manual setting value	Y	Y	Y	Y	0	
J59	P (Gain) 2	0.000 to 30.000 times	Y	Y	Y	Y	0.100	
J60	I (Integral time) 2	0.0 to 3600.0 s	Y	Y	Y	Y	0.0	
J61	D (Differential time) 2	0.00 to 600.00 s	Y	Y	Y	Y	0.00	
J62	(PID control block selection)	0 to 3 Bit 0: PID output characteristics 0 = Plus (Adder) 1 = Minus (Subtracter) Bit 1: Output rate compensation selection 0 = The compensation amount is the rate compensation (rate in relation to the main setting) 1 = The compensation amount is the speed command compensation (rate in relation to the maximum output frequency)	Y	Y	N	Y	0	
J63	Overload stop (Detection value)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0: Torque, 1: Current	Y	Y	Y	Y	0	5-261
J64	(Detection level)	20 to 200%	Y	Y	Y	Y	100	
J65	(Operation selection)	0: Disable 1: Decelerate to stop 2: Coast-to-a-stop V/f PGV/f SLV PGV PMSLV PMPGV TRQ 3: Contacting the stopper	Y	Y	N	Y	0	

*24 When speed control (dancer) is selected (J01 ≠ 3 → = 3), the setting value automatically changes to 0.0 s. To specify the filter time constant in detail, apply an analog input filter as J06 = 0.0 (C33, C38 and C43). When speed control (dancer) is not selected (J01 = 3 → ≠ 3), the J06 setting value automatically changes to 0.5 s. Set J06 after setting J01.

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
J66	(Operation mode)	V/f PGV/f SLV PGV PMSLV PMPGV 0: Constant speed & decelerating 1: Constant speed 2: All modes	Y	Y	Y	Y	0	5-261
J67	(Timer time)	0.00 to 600.00 s	Y	Y	Y	Y	0.00	
J68	Brake control signal (Brake-release current)	V/f PGV/f SLV PGV PMPGV 0.00 to 300.00%	Y	Y	Y	Y	100.00	5-263
J69	(Brake-release frequency/speed)	V/f PGV/f 0.0 to 25.0 Hz	Y	Y	Y	Y	1.0	
J70	(Brake-release timer)	V/f PGV/f SLV PGV PMPGV 0.000 to 5.000 s	Y	Y	Y	Y	1.000	
J71	(Brake-apply frequency/speed)	V/f PGV/f SLV PGV PMPGV 0.0 to 25.0 Hz	Y	Y	Y	Y	1.0	
J72	(Brake-apply timer)	V/f PGV/f SLV PGV PMPGV 0.000 to 5.000 s	Y	Y	Y	Y	1.000	
J73	Positioning control (Start timer)	PGV/f PGV PMPGV 0.0 to 1000.0 s	Y	N	Y	Y	0.0	5-267
J74	(Start point: upper digit)	PGV/f PGV PMPGV -999(83E7) to 999(03E7) -999(83E7) to -1(8001) 0(0000) to 999(03E7)	Y	N	Y	Y	0	
J75	(Start point: lower digit)	PGV/f PGV PMPGV 0(0000) to 9999(270F); P = -1(FFFF)	Y	N	Y	Y	0	
J76	(Z point: upper digit)	PGV/f PGV PMPGV -999(83E7) to 999(03E7) -999(83E7) to -1(8001) 0(0000) to 999(03E7)	Y	N	Y	Y	0	
J77	(Z point: lower digit)	PGV/f PGV PMPGV 0(0000) to 9999(270F); P = -1(FFFF)	Y	N	Y	Y	0	
J78	(Creep speed switching point: upper digit)	PGV/f PGV PMPGV 0 to 999	Y	N	Y	Y	0	
J79	(Creep speed switching point: lower digit)	PGV/f PGV PMPGV 0 to 9999	Y	N	Y	Y	0	
J80	(Creep speed)	PGV/f PGV PMPGV 0 to 500 Hz	Y	N	Y	Y	0.0	
J81	(Stop target point: upper digit)	PGV/f PGV PMPGV -999(83E7) to 999(03E7) -999(83E7) to -1(8001) 0(0000) to 999(03E7)	Y	N	Y	Y	0	
J82	(Stop target point: lower digit)	PGV/f PGV PMPGV 0(0000) to 9999(270F)	Y	N	Y	Y	0	
J83	(Stop target point permissible range)	PGV/f PGV PMPGV 0 to 9999	Y	N	Y	Y	0	
J84	(End timer)	PGV/f PGV PMPGV 0.0 to 1000.0 s	Y	N	Y	Y	0.0	
J85	(Coasting compensation)	PGV/f PGV PMPGV 0 to 9999	Y	N	Y	Y	0	
J86	(Stop position command method)	PGV/f PGV PMPGV 0: Sign/pulse 1: Forward/reverse pulse	Y	N	Y	Y	0	
J87	(Z point compensation direction)	PGV/f PGV PMPGV 0: Allowed in the forward direction only 1: Allowed in the reverse direction only 2: Allowed in both the forward and reverse directions	Y	N	N	Y	0	
J88	(Current position pulse pole)	PGV/f PGV PMPGV 0: Detection direction 1: Reverse the detection direction sign	Y	N	N	Y	0	
J90	Overload stop (Contacting the stopper) (Torque limiter P (Gain))	V/f PGV/f 0.000 to 2.000, 999	Y	Y	Y	Y	999	5-261
J91	(Torque limiter I (Integral time))	0.001 to 9.999 s, 999	Y	Y	Y	Y	999	
J92	(Current command level)	50.0 to 150.0%	Y	Y	Y	Y	100.0	

FUNCTION CODES
Chap 5

Function code	Name	Control method and Data setting range	Type E3S/E3E	Type E3N	Change when running	Data copying	Default value	Related page
J95	Brake control signal (Brake-release torque)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.00 to 300.00%	Y	Y	Y	Y	100.00	5-263
J96	(Operation selection)	0 to 127 Bit 0: Speed detection/speed command selection (0: speed detection value, 1: speed command value) Bit 1: Reserved Bit 2: Not used Bit 3: Not used Bit 4: Brake-apply condition selection (0: Disable run command OFF, 1: Enable run command OFF) Bit 5: Not used Bit 6: Brake-release condition selection while positioning control is stopped (0: Brake applied while stopped, 1: Brake released while stopped)	Y	Y	Y	Y	0	
J97	Servo lock (Gain)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.000 to 9.999 times	Y	N	Y	Y	0.010	5-278
J98	(Completion timer)	0.000 to 1.000 s	Y	N	Y	Y	0.100	
J99	(Completion range)	0 to 9999 pulse	Y	N	Y	Y	10	

[11] J1 codes: Application Functions

Among J1 code control methods, V/f PGV/f SLV PGV PM SLV PM PGV TRQ control methods are enabled.

Function code	Name	Control method and Data setting range	Type		Change when running	Data copying	Default value	Related page
			E3S/E3E	E3N				
J105	PID control (Display unit)	0: Based on the unit and scale of the PID control feedback value 1: No unit 2: % 4: r/min 7: kW 8: HP 10: mm/s 11: mm/m 12: mm/h 13: m/s 14: m/min 15: m/h 16: FPS 17: FPM 18: FPH 19: SPM [Flow] 20: m3/s 21: m3/min 22: m3/h 23: L/s 24: L/min 25: L/h 26: GPS 27: GPM 28: GPH 29: CFS 30: CFM 31: CFH 32: kg/s 33: kg/m 34: kg/h 35: lb/s 36: lb/m 37: lb/h 38: AF/Y [Pressure] 40: Pa 41: kPa 42: MPa 43: mbar 44: bar 45: mmHg 46: PSI 47: mWG 48: inWG 49: inHg 50: WC 51: Ft WG 52: ATM [Temperature] 60: K 61: °C 62: °F [Distance] 65: Nm 66: lb Ft 70: mm 71: cm 72: m 73: km 74: in 75: Ft 76: Yd 77: mi [Concentration] 80: ppm [Other measurements] 90: m3 91: L 92: GAL 93: OZ	Y	Y	N	Y	0	5-280
J106	PID control (Maximum scale)	-999.0 to 0.00 to 9990.0	Y	Y	N	Y	100.00	5-281
J107	(Minimum scale)	-999.0 to 0.00 to 9990.0	Y	Y	N	Y	0.00	
J136	PID control (Multistep commands 1)	-999.0 to 0.00 to 9990.0	Y	Y	Y	Y	0.00	
J137	(Multistep commands 2)	-999.0 to 0.00 to 9990.0	Y	Y	Y	Y	0.00	
J138	(Multistep commands 3)	-999.0 to 0.00 to 9990.0	Y	Y	Y	Y	0.00	

[12] d codes: Application Functions 2

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
d01	Speed control 1 (Speed command filter)	PGV/f SLV PGV PMSLV PMPGV 0.000 to 5.000 s 0.200 s is set automatically when the setting is F42 = 15, 16.	Y	Y	Y	Y	0.020	5-282
d02	(Speed detection filter)	PGV/f SLV PGV PMSLV PMPGV TRQ 0.000 to 0.100 s 0.025 s is set automatically when the setting is F42 = 15, 16.	Y	Y	Y*	Y	0.005	
d03	P (Gain)	PGV/f SLV PGV PMSLV PMPGV TRQ 0.1 to 200.0 times 2.0 times is set automatically when the setting is F42 = 15, 16.	Y	Y	Y*	Y	10.0	
d04	I (Integral time)	PGV/f SLV PGV PMSLV PMPGV TRQ 0.001 to 9.999 s, 999: Cancel integral time 0.600 s is set automatically when the setting is F42 = 15, 16.	Y	Y	Y*	Y	0.100	
d05	(FF Gain)	SLV PGV PMSLV PMPGV 0.00 to 99.99 s	Y	Y	Y*	Y	0.00	
d06	(Output filter)	SLV PGV PMSLV PMPGV TRQ 0.000 to 0.100 s 0.000 s is set automatically when the setting is F42 = 15, 16.	Y	Y	Y	Y	0.000	
d07	(Notch filter resonance frequency)	PGV PMPGV TRQ 1 to 500 Hz	Y	Y	Y	Y	200	5-285
d08	(Notch filter attenuation level)	PGV PMPGV TRQ 0 to 40 dB	Y	Y	Y	Y	0	
d09	Speed control (JOG) (Speed command filter)	PGV/f SLV PGV PMSLV PMPGV 0.000 to 5.000 s	Y	Y	Y	Y	0.020	5-286
d10	(Speed detection filter)	0.000 to 0.100 s	Y	Y	Y*	Y	0.005	
d11	P (Gain)	0.1 to 200.0 times	Y	Y	Y*	Y	10.0	
d12	I (Integral time)	0.001 to 9.999 s, 999: Cancel integral time	Y	Y	Y*	Y	0.100	
d13	(Output filter)	0.000 to 0.100 s	Y	Y	Y	Y	0.000	
d14	PG option Ch2 (Pulse string input) (Pulse input format)	PGV/f PGV PMPGV TRQ 0: Pulse string sign/pulse string input 1: Forward and reverse pulse 2: A, B phase 90° phase difference (B phase lead) 3: A, B phase 90° phase difference (A phase lead)	Y	N	N	Y	2	
d15	(Encoder pulse count)	0014 to EA60 (Hexadecimal), 20 to 60000 (Decimal)	Y	N	N	Y	0400 (1024)	
d16	(Pulse scaling factor 1)	1 to 32767	Y	N	Y	Y	1	
d17	(Pulse scaling factor 2)	1 to 32767	Y	N	Y	Y	1	
d18	(Filter time constant)	0.000 to 5.000 s	Y	N	Y	Y	0.005	
d21	Speed agreement/PG error (Detection range)	PGV/f SLV PGV PMSLV PMPGV 0.0 to 50.0%	Y	Y	Y	Y	10.0	5-288
d22	(Detection timer)	0.00 to 10.00 s	Y	Y	Y	Y	0.50	
d23	PG error selection	PGV/f SLV PGV PMSLV PMPGV 0: Continued operation 1 1: Alarm stoppage 1 2: Alarm stoppage 2 3: Continued operation 2 4: Alarm stoppage 3 5: Alarm stoppage 4	Y	Y	N	Y	2	
d24	Zero speed control	SLV PGV PMPGV 0: Zero speed control disabled at startup 1: Zero speed control enabled at startup 2: Zero speed control disabled	Y	Y	N	Y	0	5-289
d25	ASR switching time	PGV/f SLV PGV PMSLV PMPGV TRQ 0.000 to 1.000 s	Y	Y	Y	Y	0.000	
d29	Speed control 1 (Notch filter width)	SLV PGV PMSLV PMPGV TRQ 0 to 3 (0: Narrow to 3: Wide)	Y	Y	Y	Y	2	5-285 5-289
d32	Speed limit / Overspeed level (Level 1)	SLV PGV PMPGV TRQ 0 to 110%	Y	Y	Y	Y	100	5-289
d33	(Level 2)	0 to 110%	Y	Y	Y	Y	100	
d35	Overspeed detection level	PGV/f SLV PGV PMSLV PMPGV TRQ 0 to 120%, 999: based on d32 d33	Y	Y	Y	Y	999	
d41	Application control selection	PGV/f PGV PMPGV 0: Disable (normal control) 1: Enable (Line speed control) 2: Enable synchronous operation (start at the same time (without Z phase)) 3: Master-follower operation (start after synchronization) 4: Enable synchronous operation (start at the same time (with Z phase))	Y	N	N	Y	0	5-290

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
d51	(For adjustment by manufacturer) *25	-500 to 500	Y	Y	N	Y	*26	5-293
d52	(For adjustment by manufacturer) *25	-500 to 500	Y	Y	N	Y	*26	
d55	(For adjustment by manufacturer) *25	0000～00FF (Hexadecimal display)	Y	Y	N	Y	0000	
d56	(For adjustment by manufacturer) *25	0.00 to 50.00%	Y	N	N	Y	20.00	
d57	(For adjustment by manufacturer) *25	0000～00FF (Hexadecimal display)	Y	N	N	Y	0000	
d59	PG option Ch1/Terminal [X] (Pulse string input) (Pulse input format)	**V/f** **PGV/f** **SLV** **PGV** **PMSLV** **PMPGV** TRQ 0: Pulse string sign/pulse string input 1: Forward and reverse pulse 2: A, B phase 90° phase difference (B phase lead) 3: A, B phase 90° phase difference (A phase lead)	Y	N	N	Y	0	
d60	(Encoder pulse count)	0014 to EA60 (Hexadecimal), 20 to 60000 (Decimal)	Y	N	N	Y	0400 (1024)	
d61	(Filter time constant)	0.000 to 5.000 s	Y	N	Y	Y	0.005	
d62	(Pulse compensation coefficient 1)	1 to 32767	Y	N	Y	Y	1	
d63	(Pulse compensation coefficient 2)	1 to 32767	Y	N	Y	Y	1	
d67	Starting characteristic (Auto search mode: for sensorless vector control)	V/f PGV/f **SLV** PGV **PMSLV** PMPGV **TRQ** 0: Disable (Do not set to 0 when performing a restart after momentary power failure. Otherwise, it may damage the motor.) 1: Enable (Only at restart after momentary power failure) 2: Enable (At normal start and at restart after momentary power failure) 2 is set automatically when the setting is F42 = 15.	Y	Y	N	Y	1	5-203 5-293
d68	(For adjustment by manufacturer) *25	0.0 to 10.0	Y	Y	N	Y	4.0	5-293
d69	(For adjustment by manufacturer) *25	30.0 to 100.0	Y	Y	Y	Y	30.0	
d70	Speed control limiter	V/f **PGV/f** SLV PGV PMSLV PMPGV TRQ 0.00 to 100.00%	Y	N	Y	Y	100.00	
d71	Master-follower operation (Main speed regulator gain)	V/f **PGV/f** SLV **PGV** PMSLV PMPGV TRQ 0.00 to 1.50 times	Y	N	Y	Y	1.00	5-294
d72	(APR P gain)	0.00 to 200.00 times	Y	N	Y	Y	15.00	
d73	(APR output + side limiter)	20 to 200%: Limiter level 999: Disable	Y	N	Y	Y	999	
d74	(APR output - side limiter)	20 to 200%: Limiter level 999: Disable	Y	N	Y	Y	999	
d75	(Z phase alignment gain)	0.00 to 10.00 times	Y	N	Y	Y	1.00	
d76	(Offset angle between master and follower)	0 to 359 deg	Y	N	Y	Y	0	
d77	(Synchronous completion detection angle)	0 to 359 deg	Y	N	Y	Y	15	
d78	(Excessive deviation detection level)	0 to 65535 (10-pulse units)	Y	N	Y	Y	65535	
d79	(For adjustment by manufacturer) *25	0, 80 to 240 (200V series), 160 to 500 (400V series), 999	Y	Y	N	Y2	999	5-323
d80	Motor 1 (PMSM magnetic pole position pull-in frequency)	V/f PGV/f SLV PGV PMSLV **PMPGV** **TRQ** 0.1 to 10.0 Hz	Y	N	Y	Y	1.0	
d81	(For adjustment by manufacturer) *25	0 to 1	Y	Y	Y	Y	1	
d82	Magnetic flux weakening control	V/f PGV/f **SLV** PGV PMSLV PMPGV **TRQ** 0: Disable 1: Enable	Y	Y	Y	Y	1	
d83	Magnetic flux weakening lower limit	V/f PGV/f **SLV** PGV PMSLV PMPGV **TRQ** 10 to 70%	Y	Y	Y	Y	40	
d84	(For adjustment by manufacturer) *25	0 to 20	Y	Y	Y	Y	5	
d85	(For adjustment by manufacturer) *25	0 to 200	Y	Y	Y	Y	95	
d86	Acceleration/deceleration output filter	**V/f** PGV/f SLV PGV PMSLV PMPGV TRQ 0.000 to 5.000 s	Y	Y	Y	Y	0.000	
d88	(For adjustment by manufacturer) *25	0.00 to 10.00, 999	Y	Y	Y	Y	999	
d89	Motor 1 (PMSM high-efficiency control)	V/f PGV/f SLV PGV PMSLV **PMPGV** **TRQ** 0 to 1	Y	Y	N	Y	1	
d90	Magnetic flux level during deceleration	**V/f** **PGV/f** SLV **PGV** PMSLV PMPGV TRQ 100 to 300%	Y	Y	Y	Y	120	5-220 5-323
d91	For special adjustment	0.00 to 2.00, 999	Y	Y	Y	Y	999	5-323
d92	For special adjustment	0, 0.01 to 3.00	Y	Y	Y	Y	0.00	
d93	(For adjustment by manufacturer) *25	0.00 to 10.00, 999	Y	Y	Y	Y	999	
d94	(For adjustment by manufacturer) *25	0.00 to 10.00, 999	Y	Y	Y	Y	999	
d95	(For adjustment by manufacturer) *25	0.00 to 10.00, 999	Y	Y	Y	Y	999	
d96	(For adjustment by manufacturer) *25	-50.0 to 50.0, 999	Y	Y	Y	Y	999	
d97	(For adjustment by manufacturer) *25	-50.0 to 50.0, 999	Y	Y	Y	Y	999	
d98	For special adjustment	0 to 65535	Y	Y	Y	Y	0	

*25 This is a function code for adjustment by the manufacturer. Do not access this function code.
*26 Factory defaults are set depending on motor capacity. FRN0001E3☐-2G to FRN0020E3☐-2G / FRN0002E3☐-4G to FRN0012E3☐-4G:5, FRN0030E3☐-2G to FRN0069E3☐-2G / FRN0022E3☐-4G to FRN0044E3☐-4G:10, FRN0088E3☐-2G to FRN0115E3☐-2G / FRN0059E3☐-4G to FRN0072E3☐-4G:20

Function code	Name	Control method and Data setting range	Type E3S/E3E	Type E3N	Change when running	Data copying	Default value	Related page
d99	Extension function 1	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0000 to FFFF (in hexadecimal) Bit 0: (For adjustment by manufacturer) *27 Bit 1: (For adjustment by manufacturer) *27 Bit 2: (For adjustment by manufacturer) *27 Bit 3: JOG operation from communication (0: Disable, 1: Enable) Bit 4: (For adjustment by manufacturer) *27 Bit 5, 6, 7: Not used Bit 8: (For adjustment by manufacturer) *27 Bit 9: (For adjustment by manufacturer) *27 Bit 10: (For adjustment by manufacturer) *27	Y	Y	Y	Y	0000	5-323

*27 This is a function code for adjustment by the manufacturer. Do not access this function code.

[13] d1 codes: Application Functions 2

Function code	Name	Control method and Data setting range	Type E3S/E3E	Type E3N	Change when running	Data copying	Default value	Related page
d120	Brake control signal (Brake-release current) (REV)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ Use 0.00 to 300.00%, 999: use J68	Y	Y	Y	Y	999	5-263 5-324
d121	Brake signal (Brake-release frequency/speed) (REV)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ Use 0.0 to 25.0 Hz, 999: use J69	Y	Y	Y	Y	999	
d122	Brake control signal (Brake-release timer) (REV)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ Use 0.0 to 5.000 s, 999: use J70	Y	Y	Y	Y	999	
d123	Brake signal - Brake-release torque (REV)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ Use 0.00 to 300.00%, 999: use J95	Y	Y	Y	Y	999	
d124	Brake signal (Brake-apply/speed) (REV)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ Use 0.0 to 25.0 Hz, 999: use J71	Y	Y	Y	Y	999	
d125	Brake signal (Brake-apply timer) (REV)	V/f PGV/f SLV PGV PMSLV PMPGV TRQ 0.000 to 5.000 s, 999	Y	Y	Y	Y	999	
d132	(For adjustment by manufacturer) *28	0.000 to 1.000	Y	Y	Y	Y1Y2	0.500	5-324
d190	(For adjustment by manufacturer) *28	0 to 150	Y	Y	Y	Y	0	
d192	(For adjustment by manufacturer) *28	0.00 to 10.00	Y	Y	Y	Y	0.30	
d198	(For adjustment by manufacturer) *28	0 to 65535	Y	Y	Y	Y	0	

*28 This is a function code for adjustment by the manufacturer. Do not access this function code.

[14] d2 codes: Application Functions 2

Among d2 control methods, V/f PGV/f SLV PGV PMSLV PMPGV TRQ are enabled.

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
d204	Position regulator gain (high speed range)	0.1 to 300.0	Y	N	Y*	Y	1.0	5-325
d206	Electronic gear ratio (Denominator)	1 to 65535	Y	N	N	Y	1	
d207	(Numerator)		Y	Y	N	Y	1	
d208	Orientation mode selection	0: With shortcut (run command direction and reverse rotation) 1: Without shortcut (run command direction)	Y	N	N	Y	1	
d209	Homing mode selection	0000～00FF (Hexadecimal display) bit 0 to 6: Reserved Bit 7: Z-phase compensation 0: Disable 1: Enable	Y	N	N	Y	0000	
d213	Homing frequency/orientation frequency	0.1 to 599.0 Hz	Y	N	Y	Y	5.0	
d215	Homing deceleration time/orientation deceleration time	0.00 to 6000 s	Y	N	Y	Y	6.00	
d217	Homing shift teaching	0: Disable 1: Enable (calculates the mechanical origin and Z-phase during orientation from the distance from Z-phase and the preset value, and writes the result to d242, d243)	Y	N	Y	Y	0	
d223	Excessive deviation detection value (higher order digits)	0 to 9999 (user value) * Disable when 0 for both d223, d224	Y	N	Y	Y	0	
d224	(lower order digits)		Y	N	Y	Y	0	
d237	Positioning data selection (INC/ABS switching)	0: Handle positioning data as absolute position (ABS) 1: Handle positioning data as travel (INC)	Y	N	Y	Y	0	
d238	Positioning data selection agreement timer	0.000 to 0.100 s	Y	N	Y	Y	0.000	
d239	Positioning complete range	0 to 9999 (user value)	Y	N	Y	Y	1	
d240	Preset position (higher order digits)	-9999 to 9999 (user value)	Y	N	Y	Y	0	
d241	(lower order digits)	0 to 9999 (user value)	Y	N	Y	Y	0	
d242	Homing shift value (higher order digits)	0 to 9999 (user value)	Y	N	Y	Y	0	
d243	(lower order digits)		Y	N	Y	Y	0	
d244	Positioning data 1 (higher order digits)	-9999 to 9999 (user value)	Y	N	Y	Y	0	
d245	(lower order digits)	0 to 9999 (user value)	Y	N	Y	Y	0	
d246	Positioning data 2 (higher order digits)	Same as d244	Y	N	Y	Y	0	
d247	(lower order digits)	Same as d245	Y	N	Y	Y	0	
d248	Positioning data 3 (higher order digits)	Same as d244	Y	N	Y	Y	0	
d249	(lower order digits)	Same as d245	Y	N	Y	Y	0	
d250	Positioning data 4 (higher order digits)	Same as d244	Y	N	Y	Y	0	
d251	(lower order digits)	Same as d245	Y	N	Y	Y	0	
d252	Positioning data 5 (higher order digits)	Same as d244	Y	N	Y	Y	0	
d253	(lower order digits)	Same as d245	Y	N	Y	Y	0	
d254	Positioning data 6 (higher order digits)	Same as d244	Y	N	Y	Y	0	
d255	(lower order digits)	Same as d245	Y	N	Y	Y	0	
d256	Positioning data 7 (higher order digits)	Same as d244	Y	N	Y	Y	0	
d257	(lower order digits)	Same as d245	Y	N	Y	Y	0	
d258	Positioning data 8 (higher order digits)	Same as d244	Y	N	Y	Y	0	
d259	(lower order digits)	Same as d245	Y	N	Y	Y	0	
d277	Positioning data communication command selection	0: Disable positioning data communication command 1: Enable positioning data communication command	Y	N	Y	Y	0	
d296	Command current position monitor (higher order digits)	Same as d244	Y	N	-	N	-	
d297	(lower order digits)	Same as d245	Y	N	-	N	-	
d298	Feedback current position monitor (higher order digits)	Same as d244	Y	N	-	N	-	
d299	(lower order digits)	Same as d245	Y	N	-	N	-	

[15] U codes: Customizable Logic

Among U code control methods, with some exceptions, all control methods (V/f PGV/f SLV PGV PMSLV PMPGV TRQ) are enabled.

Function code	Name	Control method and Data setting range	Type E3S/E3E	Type E3N	Change when running	Data copying	Default value	Related page
U00	Customizable logic (Operation selection)	0: Disable 1: Enable (Customizable logic operation) The ECL alarm occurs when changing from 1 to 0 during operation.	Y	Y	Y	Y	0	5-336
U01	Customizable logic Step 1 (Block selection)	[Digital] 0: No function assigned 10 to 16: Through output + General-purpose timer (*) 20 to 26: AND operation + general-purpose timer (*) 30 to 36: OR operation + general-purpose timer (*) 40 to 46: Exclusive XOR operation + general-purpose timer (*) 50 to 55: Set priority flip-flop + general-purpose timer (*) 60 to 65: Reset priority flip-flop + general-purpose timer (*) 70, 72, 73: Rising edge detector + general-purpose timer (*) 80, 82, 83: Falling edge detector + general-purpose timer (*) 90, 92, 93: Rising & falling edges detector + general-purpose timer (*) 100 to 106: Hold + general-purpose timer (*) 110: Increment counter 120: Decrement counter 130: Timer with reset input 140 to 145: D flip-flop + general-purpose timer (*) 150 to 155: T flip-flop + general-purpose timer (*) *General-purpose timer function (lowest digits 0 to 5) _0: No timer _1: On-delay timer _2: Off-delay timer _3: Pulse (One-shot) _4: Re-triggerable timer _5: Pulse string output _6: On/Off-delay timer [Analog] 2001: Adder 2002: Subtracter 2003: Multiplier 2004: Divider 2005: Limiter 2006: Absolute value 2007: Inverting adder 2008: Variable limiter 2009: Linear function 2010: Remainder 2011: Limiter 2 2013: Dead zone 2014: Fixed adder 2015: Fixed subtracter 2016: Fixed multiplier 2017: Fixed divider 2051 to 2058: Comparator 1 to 8 2059: Equivalent comparator 2 2060: Comparator 9 2071: Window comparator 1 2072: Window comparator 2 2101: High selector 2102: Low selector 2103: Average 2151: Function code (Read from S13) 2201: Inverse scale transformation 2202: Scale transformation 3001: Quadratic function 3002: Square root function [Digital + analog] 4001: Hold 4002: Inverting adder switching 4003: Selector 1 4004: Selector 2 4005: LPF (Low pass filter) 4006: Rate limiter 4007: Integrator 1 4008: Integrator 2 4009: Integrator 3 4010: Integrator 4 4011: Pulse length measurement 4012: Totalizer 4013: Peak hold (Max.) 4014: Peak hold (Min.) 4016: Decoder 5000: Selector 3 5100: Selector 4 6001: Reading of function codes 6002: Writing of function codes 6003: Temporary rewriting of function codes 6004: Function codes link 6005: Reading of selected function code 6011: bit extraction (S code) 6012: bit extraction (M code) 6013: bit extraction (W code) 6014: bit extraction (X code) 6015: bit extraction (Z code) 6101: PID dancer output gain frequency	Y	Y	N	Y	0	

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
U02	Customizable logic Step 1 (Input 1)	Some signals are disabled depending on the control method. For details, refer to E20 or E61.	Y	Y	N	Y	100	5-336
U03	(Input 2)	[E3S/E3E] [Digital]	Y	Y	N	Y	100	
		0(1000): Inverter running "RUN"						
		1(1001): Frequency (speed) arrival "FAR"						
		2(1002): Frequency (speed) detection “FDT2						
		3(1003): Undervoltage detected (Inverter stopped) "LU"						
		4(1004): Torque polarity detection “B/D”						
		5(1005): Inverter output limiting "IOL"						
		6(1006): Auto-restarting after momentary power failure "IPF"						
		7(1007): Motor overload early warning "OL"						
		8(1008): Keypad operation "KP"						
		10(1010): Inverter ready to run "RDY"						
		15(1015): AX terminal functions "AX"						
		16(1016): Pattern operation stage transition "TU"						
		17(1017): Pattern operation cycle completed "TO"						
		18(1018): Pattern operation stage No. 1 “STG1”						
		19(1019): Pattern operation stage No. 2 “STG2”						
		20(1020): Pattern operation stage No. 4 “STG4”						
		21(1021): Frequency (speed) arrival 2 “FAR2”						
		22(1022): Inverter output limiting (with delay) “IOL2”						
		25(1025): Cooling fan ON-OFF control "FAN"						
		26(1026): Auto-resetting "TRY"						
		28(1028): Cooling fin overheat early warning "OH"						
		29(1029): Master-follower synchronization complete "SY"						
		30(1030): Lifetime alarm "LIFE"						
		31(1031): Frequency (speed) detection 2 “FDT2”						
		33(1033): Reference loss detection “REF OFF”						
		35(1035): Inverter outputting “RUN2”						
		36(1036): Overload prevention controlling "OLP"						
		37(1037): Current detection "ID"						
		38(1038): Current detection 2 “ID2”						
		39(1039): Current detection 3 “ID3”						
		41(1041): Low current detection "IDL"						
		42(1042): PID alarm output “PID-ALM”						
		43(1043): Under PID control “PID-CTL”						
		44(1044): Under PID low liquid level stop “PID-STP”						
		45(1045): Low torque detection “U-TL”						
		46(1046): Torque detection 1 “TD1”						
		47(1047): Torque detection 2 “TD2”						
		48(1048): Motor 1 selected “SWM1”						
		47(1047): Motor 2 selected “SWM2”						
		52(1052): Performing forward rotation “FRUN”						
		53(1053): Performing reverse rotation “RRUN”						
		54(1054): In remote mode "RMT"						
		55(1055): Run command entered "AX2"						
		56(1056): Motor overheat detected by thermistor "THM"						
		57(1057): Machine brake signal control "BRKS"						
		58(1058): Frequency (speed) detection 3 “FDT3”						
		59(1059): C1 terminal disconnection detection “C1OFF”						
		70(1070): Speed valid "DNZS"						
		71(1071): Speed agreement "DSAG"						
		72(1072): Frequency (speed) arrival 3 “FAR3”						
		76(1076): Speed agreement/PG error detection “PG-ERR”						
		77(1077): Low DC link bus voltage detection “U-EDC”						
		79(1079): During deceleration in momentary power failure “IPF2”						
		80(1080): Stop position override alarm “OT”						
		81(1081): Positioning "TO"						
		82(1082): Positioning complete "PSET"						
		83(1083): Current position overflow "POF"						
		84(1084): Maintenance timer "MNT"						
		87(1087): Frequency arrival and frequency detection "FARFDT"						
		89(1089): Magnetic pole position detection complete signal "PTD"						
		90(1090): Alarm content 1 “AL1”						
		91(1091): Alarm content 2 “AL2”						
		92(1092): Alarm content 4 “AL4”						
		93(1093): Alarm content 8 “AL8”						
		95(1095): Performing forced operation "FMRUN"						
		98(1098): Warning “L-ALM”						
		99(1099): Batch alarm "ALM"						
		100: No assignment "NONE"						
		101(1101): EN terminal detection circuit error "DECF"						
		102(1102): EN terminal input OFF "ENOFF"						
		105(1105): Braking transistor error "DBAL"						
		125(1125): Integral power pulse output "POUT"						
		131(1131): Performing speed limiting "S-LIM"						
		132(1132): Torque limiting "T-LIM"						
		133(1133): Low current detection 2 “IDL2”						
		251(1251): Shift key ON/OFF status "MTGL"						
		2001 to 2260 (3001 to 3260): Customizable logic: Step 1 to 260 output “SO01” to “SO260”						
		4001(5001): X1 terminal input “X1”						
		4002(5002): X2 terminal input “X2”						
		4003(5003): X3 terminal input “X3”						
		4004(5004): X4 terminal input “X4”						
		4005(5005): X5 terminal input “X5”						
		4010(5010): FWD terminal input "FWD"						
		4011(5011): REV terminal input "REV"						
		4021(5021): I1 terminal input “I1”						
		4022(5022): I2 terminal input “I2”						
		4023(5023): I3 terminal input “I3”						
		4024(5024): I4 terminal input “I4”						
		4025(5025): I5 terminal input “I5”						
		4026(5026): I6 terminal input “I6”						
		4027(5027): I7 terminal input “I7”						
		4028(5028): I8 terminal input “I8”						

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
		4029(5029): I9 terminal input "I9" 4030(5030): I10 terminal input "I10" 4031(5031): I11 terminal input "I11" 4032(5032): I12 terminal input "I12" 4033(5033): I13 terminal input "I13" 4041(5041): CLI1 terminal input "CLI1" 4042(5042): CLI2 terminal input "CLI2" 4043(5043): CLI3 terminal input "CLI3" 4044(5044): CLI4 terminal input "CLI4" 4045(5045): CLI5 terminal input "CLI5" 4046(5046): CLI6 terminal input "CLI6" 4047(5047): CLI7 terminal input "CLI7" 4048(5048): CLI8 terminal input "CLI8" 4049(5049): CLI9 terminal input "CLI9" 4081(5081): Key input RUN/FWD "KP-RUN/KP-FWD" 4082(5082): Key input REV "KP-REV" 4083(5083): Key input STOP "KP-STOP" 4084(5084): Key input UP "KP-UP" 4085(5085): Key input DOWN "KP-DOWN" 4088(5088): Key input SHIFT "KP-SHIFT" 4091(5091): Key input RESET "KP-RESET" 4101(5101): X1 terminal input (Terminal block) "X1-TERM" 4102(5102): X2 terminal input (Terminal block) "X2-TERM" 4103(5103): X3 terminal input (Terminal block) "X3-TERM" 4104(5104): X4 terminal input (Terminal block) "X4-TERM" 4105(5105): X5 terminal input (Terminal block) "X5-TERM" 4110(5110): FWD terminal input (Terminal block) "FWD-TERM" 4111(5111): REV terminal input (Terminal block) "REV-TERM" 6000(7000): Final run command RUN "FL_RUN" 6001(7001): Final run command FWD "FL_FWD" 6002(7002): Final run command REV "FL_REV" 6003(7003): Accelerating "DACC" 6004(7004): Decelerating "DDEC" 6005(7005): During anti-regenerative "REGA" 6006(7006): Within dancer position reference point "DR_REF" 6007(7007): Presence of an alarm factor "ALM_ACT" 6100: TRUE(1) fixed input 6101: FALSE(0) fixed input * Inside the ( ) is the negative logic signal. (OFF at short-circuit) [Analog] 8000: Output frequency 1 (before slip compensation) 8001: Output frequency 2 (after slip compensation) 8002: Output current 8003: Output voltage 8004: Output torque 8005: Load rate 8006: Input power 8007: PID feedback value 8008: Actual speed/estimated speed 8009: DC link bus voltage 8013: Motor output 8015: PID command (SV) 8016: PID output (MV) 8017: Master-follower angle deviation 8018: Inverter cooling fin temperature 8021: PG feedback value 8022: Torque current command 8023: PID deviation 8026: Reference frequency (before acceleration/deceleration calculation) 9001: Analog [12] terminal input signal "12" 9002: Analog [C1] terminal input signal (C1 function) "C1" 9003: Analog [C1] terminal input signal (V2 function) "V2" 9004: Analog [32] terminal input signal "32" 9005: Analog [C2] terminal input signal "C2" 9010: UP/DOWN values "UP/DOWN" [E3N] [Digital] 0(1000): Inverter running "RUN" 1(1001): Frequency (speed) arrival "FAR" 2(1002): Frequency (speed) detection "FDT2 3(1003): Undervoltage detected (Inverter stopped) "LU" 4(1004): Torque polarity detection "B/D" 5(1005): Inverter output limiting "IOL" 6(1006): Auto-restarting after momentary power failure "IPF" 7(1007): Motor overload early warning "OL" 8(1008): Keypad operation "KP" 10(1010): Inverter ready to run "RDY" 15(1015): AX terminal functions "AX" 16(1016): Pattern operation stage transition "TU" 17(1017): Pattern operation cycle completed "TO" 18(1018): Pattern operation stage No. 1 "STG1" 19(1019): Pattern operation stage No. 2 "STG2" 20(1020): Pattern operation stage No. 4 "STG4" 21(1021): Frequency (speed) arrival 2 "FAR2" 22(1022): Inverter output limiting (with delay) "IOL2" 25(1025): Cooling fan ON-OFF control "FAN" 26(1026): Auto-resetting "TRY" 28(1028): Cooling fin overheat early warning "OH" 29(1029): Master-follower synchronization complete "SY" 30(1030): Lifetime alarm "LIFE" 31(1031): Frequency (speed) detection 2 "FDT2" 33(1033): Reference loss detection "REF OFF" 35(1035): Inverter outputting "RUN2" 36(1036): Overload prevention controlling "OLP" 37(1037): Current detection "ID"						5-336

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
		38(1038): Current detection 2 "ID2" 39(1039): Current detection 3 "ID3" 41(1041): Low current detection "IDL" 42(1042): PID alarm output "PID-ALM" 43(1043): Under PID control "PID-CTL" 44(1044): Under PID low liquid level stop "PID-STP" 45(1045): Low torque detection "U-TL" 46(1046): Torque detection 1 "TD1" 47(1047): Torque detection 2 "TD2" 48(1048): Motor 1 selected "SWM1" 47(1047): Motor 2 selected "SWM2" 52(1052): Performing forward rotation "FRUN" 53(1053): Performing reverse rotation "RRUN" 54(1054): In remote mode "RMT" 55(1055): Run command entered "AX2" 56(1056): Motor overheat detected by thermistor "THM" 57(1057): Machine brake signal control "BRKS" 58(1058): Frequency (speed) detection 3 "FDT3" 59(1059): C1 terminal disconnection detection "C1OFF" 70(1070): Speed valid "DNZS" 71(1071): Speed agreement "DSAG" 72(1072): Frequency (speed) arrival 3 "FAR3" 76(1076): Speed agreement/PG error detection "PG-ERR" 77(1077): Low DC link bus voltage detection "U-EDC" 79(1079): During deceleration in momentary power failure "IPF2" 80(1080): Stop position override alarm "OT" 81(1081): Positioning "TO" 82(1082): Positioning complete "PSET" 83(1083): Current position overflow "POF" 84(1084): Maintenance timer "MNT" 87(1087): Frequency arrival and frequency detection "FARFDT" 89(1089): Magnetic pole position detection complete signal "PTD" 90(1090): Alarm content 1 "AL1" 91(1091): Alarm content 2 "AL2" 92(1092): Alarm content 4 "AL4" 93(1093): Alarm content 8 "AL8" 95(1095): Performing forced operation "FMRUN" 98(1098): Warning "L-ALM" 99(1099): Batch alarm "ALM" 100: No assignment "NONE" 101(1101): EN terminal detection circuit error "DECF" 102(1102): EN terminal input OFF "ENOFF" 105(1105): Braking transistor error "DBAL" 125(1125): Integral power pulse output "POUT" 131(1131): Performing speed limiting "S-LIM" 132(1132): Torque limiting "T-LIM" 133(1133): Low current detection 2 "IDL2" 2001 to 2260 (3001 to 3260): Customizable logic: Step 1 to 260 output "SO01" to "SO260" 4001(5001): X1 terminal input "X1" 4002(5002): X2 terminal input "X2" 4003(5003): X3 terminal input "X3" 4010(5010): FWD terminal input "FWD" 4011(5011): REV terminal input "REV" 4041(5041): CLI1 terminal input "CLI1" 4042(5042): CLI2 terminal input "CLI2" 4043(5043): CLI3 terminal input "CLI3" 4044(5044): CLI4 terminal input "CLI4" 4045(5045): CLI5 terminal input "CLI5" 4046(5046): CLI6 terminal input "CLI6" 4047(5047): CLI7 terminal input "CLI7" 4048(5048): CLI8 terminal input "CLI8" 4049(5049): CLI9 terminal input "CLI9" 4101(5101): X1 terminal input (Terminal block) "X1-TERM" 4102(5102): X2 terminal input (Terminal block) "X2-TERM" 4103(5103): X3 terminal input (Terminal block) "X3-TERM" 4110(5110): FWD terminal input (Terminal block) "FWD-TERM" 4111(5111): REV terminal input (Terminal block) "REV-TERM" 6000(7000): Final run command RUN "FL_RUN" 6001(7001): Final run command FWD "FL_FWD" 6002(7002): Final run command REV "FL_REV" 6003(7003): Accelerating "DACC" 6004(7004): Decelerating "DDEC" 6005(7005): Anti-regenerative "REGA" 6006(7006): Within dancer position set point "DR_REF" 6007(7007): Presence of an alarm factor "ALM_ACT" 6100: TRUE(1) fixed input 6101: FALSE(0) fixed input * Inside the ( ) is the negative logic signal. (OFF at short-circuit) [Analog] 8000: Output frequency 1 (before slip compensation) 8001: Output frequency 2 (after slip compensation) 8002: Output current 8003: Output voltage 8004: Output torque 8005: Load rate 8006: Input power 8007: PID feedback value 8008: Actual speed/estimated speed 8009: DC link bus voltage 8013: Motor output 8015: PID command (SV) 8016: PID output (MV) 8018: Inverter cooling fin temperature 8022: Torque current command 8023: PID deviation 8026: Reference frequency (before acceleration/deceleration calculation)						5-336

Function code	Name	Control method and Data setting range	Type E3S/E3E	Type E3N	Change when running	Data copying	Default value	Related page
		9001: Analog [12] terminal input signal "12" 9002: Analog [C1] terminal input signal (C1 function) "C1" 9003: Analog [C1] terminal input signal (V2 function) "V2" 9010: UP/DOWN values "UP/DOWN"						5-336
U04	(Function 1)	-9990 to 0.00 to 9990.0	Y	Y	N	Y	0.00	
U05	(Function 2)		Y	Y	N	Y	0.00	

The assignment of the function codes in the customizable logic steps 1 to 14 is as follows. The setting range is the same as with U01 to U05.

	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8	Step 9	Step 10
Logic circuit	U01	U06	U11	U16	U21	U26	U31	U36	U41	U46
Input 1	U02	U07	U12	U17	U22	U27	U32	U37	U42	U47
Input 2	U03	U08	U13	U18	U23	U28	U33	U38	U43	U48
Function 1	U04	U09	U14	U19	U24	U29	U34	U39	U44	U49
Function 2	U05	U10	U15	U20	U25	U30	U35	U40	U45	U50

	Step 11	Step 12	Step 13	Step 14
Logic circuit	U51	U56	U61	U66
Input 1	U52	U57	U62	U67
Input 2	U53	U58	U63	U68
Function 1	U54	U59	U64	U69
Function 2	U55	U60	U65	U70

Function code	Name	Control method and Data setting range	Type E3S/E3E	Type E3N	Change when running	Data copying	Default value	Related page
U71 to U80	Customizable logic Output signal 1 (Output selection) to Output signal 10 (Output selection)	0: Disable 1 to 260: Output of step 1 to 260 "S001" to "S0260"	Y	Y	N	Y	0	5-336
U81 to U90	Customizable logic Output signal 1 (Function selection) to Output signal 10 (Output selection)	0 to 172 (1000 to 1172): Same as E98, but 19, 80, and 121 to 129 cannot be selected 241 to 245 (1241 to 1245): User-defined alarms 1 to 5 "CA1" to "CA5" 8001 to 8020: E61 selection value to which 8000 has been added	Y	Y	N	Y	100	
U91	Customizable logic: Timer monitor (Step selection)	0: Monitor disabled 1 to 260: Step 1 to 260	Y	Y	Y	N	0	
U92	Customizable logic: calculation coefficient (KA 1 mantissa portion)	-9.999 to 9.999	Y	Y	N	Y	0.000	
U93	(KA 1 exponent portion)	-5 to 5	Y	Y	N	Y	0	
U94	(KB 1 mantissa portion)	-9.999 to 9.999	Y	Y	N	Y	0.000	
U95	(KB 1 exponent portion)	-5 to 5	Y	Y	N	Y	0	
U96	(KC 1 mantissa portion)	-9.999 to 9.999	Y	Y	N	Y	0.000	
U97	(KC 1 exponent portion)	-5 to 5	Y	Y	N	Y	0	
U98	Customizable logic Output monitor (Step selection)	0: Monitor disabled 1 to 260: Step 1 to 260	Y	Y	Y	Y	0	5-363
U99	Customizable logic Output monitor (Display unit selection)	Same as J105 (0 cannot be set)	Y	Y	Y	Y	1	

[16] U1 codes: Customizable Logic

Among U1 code control methods, with some exceptions, all control methods (V/f PGV/f SLV PGV PMSLV PMPGV TRQ) are enabled.

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
U100	Task process cycle setting	0: Auto (Selected automatically from 2, 5, 10, and 20 ms depending on the step number) 2: 2 ms (Up to 20 steps) 5: 5 ms (Up to 50 steps) 10: 10 ms (Up to 100 steps) 20: 20 ms (Up to 260 steps)	Y	Y	N	Y	0	5-336
U101	Customizable logic Conversion operation 1 (X1)	-999.0 to 0.00 to 9990.0	Y	Y	Y	N	0.00	5-336 5-368
U102	Conversion operation 1 (Y1)							
U103	Conversion operation 2 (X2)							
U104	Conversion operation 2 (Y2)							
U105	Conversion operation 3 (X3)							
U106	Conversion operation 3 (Y3)							
U107	Customizable logic automatic conversion coefficient calculation	0: Disabled 1: Calculation execution (Conversion 1)	Y	Y	N	N	0	
U121 to U170	Customizable logic (User parameters 1) to (User parameters 50)	-9990 to 0.00 to 9990.0	Y	Y	Y	Y	0.00	5-336
U171 to U180	Customizable logic (Storage area 1) to (Storage area 10)	-9990 to 0.00 to 9990.0	Y	Y	Y	Y	0.00	
U181 to U184	Customizable logic Output signal 11 (Output selection) to Output signal 14 (Output selection)	0: Disabled 1 to 260: Step output 1 to 260 “SO01” to “SO260”	Y	Y	N	Y	0	
U185 to U188	Customizable logic Output signal 11 (Output selection) to Output signal 14 (Function selection)	0 to 172 (1000 to 1172): Same as E98, but 19, 80, and 121 to 129 cannot be selected 241 to 245 (1241 to 1245): User-defined alarms 1 to 5 “CA1” to “CA5” 8001 to 8020: E61 selection value to which 8000 has been added	Y	Y	N	Y	100	
U190	Customizable logic Step setting (Step number)	1 to 260	Y	Y	Y	N	15	
U191	(Block selection)	Same as U01	Y	Y	N	N	0	
U192	(Input 1)	Same as U02	Y	Y	N	N	100	
U193	(Input 2)	Same as U03	Y	Y	N	N	100	
U194	(Function 1)	Same as U04	Y	Y	N	N	0.00	
U195	(Function 2)	Same as U05	Y	Y	N	N	0.00	
U196	Customizable ROM version higher order 4 digits (For manufacturer)	0 to 9999	Y	Y	N	N	0	–
U197	(For user)	0 to 9999	Y	Y	N	Y	0	–
U198	Customizable ROM version lower order 4 digits (For manufacturer)	0 to 9999	Y	Y	N	N	0	–
U199	(For user)	0 to 9999	Y	Y	N	Y	0	–

[17] y codes: LINK Functions

Among y code control methods, with some exceptions, all control methods (V/f PGV/f SLV PGV PMSLV PMPGV TRQ) are enabled.

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
y01	RS-485 communication 1 (Station address)	0(1) to 255 0: Use BACnet MS/TP	Y	N	N	Y	1	5-372
y02	(Operation selection when error occurs)	0: Immediate Er8 trip 1: Er8 trip after running for the time specified by Timer y03. 2: Er8 trip if communication is not restored after retry while running for the time specified by Timer y03.Continued operation if communication is restored. 3: Continued operation	Y	N	Y	Y	0	
y03	(Timer)	0.0～60.0 s	Y	N	Y	Y	2.0	
y04	(Baud rate)	0: 2400 bps 1: 4800 bps 2: 9600 bps 3: 19200 bps 4: 38400 bps 5: 57600 bps 6: 76800 bps 7: 115200 bps	Y	N	Y	Y	3	
y05	(Data length selection)	0: 8 bits 1: 7 bits	Y	N	Y	Y	0	
y06	(Parity selection)	0: N/A (Stop bit: 2 bits) 1: Even parity (Stop bit: 1 bit) 2: Odd parity (Stop bit: 1 bit) 3: N/A (Stop bit: 1 bit)	Y	N	Y	Y	0	
y07	(Stop bit selection)	0: 2 bits 1: 1 bit	Y	N	Y	Y	0	
y08	(Communication time-out detection timer)	0: No detection 1: 1 to 60 s	Y	N	Y	Y	0	
y09	(Response interval time)	0.00 to 1.00 s	Y	N	Y	Y	0.01	
y10	(Protocol selection)	0: Modbus RTU protocol 1: Reserved 2: Fuji general-purpose inverter protocol 5: BACnet MS/TP protocol	Y	N	Y	Y	0	
y11	RS-485 communication 2 (Station address)	Same as y01	Y	N	N	Y	1	
y12	(Operation selection when error occurs)	0: Immediate ErP trip 1: ErP trip after running for the time specified by Timer y13. 2: ErP trip if communication is not restored after retry while running for the time specified by Timer y13.Continued operation if communication is restored. 3: Continued operation	Y	N	Y	Y	0	
y13	(Timer)	Same as y03	Y	N	Y	Y	2.0	
y14	(Baud rate)	Same as y04	Y	N	Y	Y	3	
y15	(Data length selection)	Same as y05	Y	N	Y	Y	0	
y16	(Parity selection)	Same as y06	Y	N	Y	Y	0	
y17	(Stop bit selection)	Same as y07	Y	N	Y	Y	0	
y18	(Communication time-out detection timer)	Same as y08	Y	N	Y	Y	0	
y19	(Response interval time)	Same as y09	Y	N	Y	Y	0.01	
y20	(Protocol selection)	Same as y10	Y	N	Y	Y	0	
y60	BACNet MS/TP Device instance (higher order digits)	0 to 4194	Y	N	N	Y	37	5-375
y61	(lower order digits)	y01 or y11 (depends on the set CH) 128 to 999	Y	N	N	Y	0	
y62	BACNet MS/TP Network number (Ch2)	0 to 65534	Y	N	N	Y	0	5-375
y63	(Ch2)	0 to 65534	Y	N	N	Y	0	
y85 y86 y87 y88	(For adjustment by manufacturer) *9	0000 to FFFF (in hexadecimal)	Y	Y	Y	Y	0000	
y93	RTU current format switching	0: Format 24 1: Format 19	Y	Y	Y	Y	0	5-376
y94	Link function (X terminal operation selection)	0: Disable 1: Enable	Y	Y	Y	Y	0	5-377
y95	Data clear processing for communications error	0: Do not clear the data when a communications error occurs. (compatible with the conventional inverters) 1: Clear the data of function codes S01, S05, and S19 when a communications error occurs. 2: Clear the bit assigned to run command of function code S06 when a communications error occurs. 3: Clear operations for 1 and 2 above are performed. 4: Clear operations for 1 and 2 above and S02, S03, S13, S15, S20, S21 * The target alarms are Er8, ErP, Er4 and Er5.	Y	Y	Y	Y	0	5-378
y96	Communication compatibility mode	0: Disable 6: Enable (E1 compatibility) 7 : Enable (E2 compatibility)	Y	N	Y	Y	0	5-379
y97	Communication data storage selection	0: Store into nonvolatile memory (Rewritable times are limited) 1: Write into temporary memory (Rewritable times are unlimited) 2: Save all data from temporary memory to nonvolatile memory (After all save, data returns to 1)	Y	Y	Y	Y	E3S/E: 0 E3N: 1	5-381

Function code	Name	Control method and Data setting range	Type E3S/E3E	Type E3N	Change when running	Data copying	Default value	Related page
y98	Bus function (Operation selection)	**Frequency setting/torque command** / **Run command** [E3S/E3E] 0: Based on H30 / Based on H30 1: Command from bus / Based on H30 2: Based on H30 / Command from bus 3: Command from bus / Command from bus [E3N] 0: Based on F01/C30 / Based on terminal 1: Command from bus / Based on terminal 2: Based on F01/C30 / Command from bus 3: Command from bus / Command from bus	Y	Y	Y	Y	E3S/E: 0 E3N: 3	5-381
y99	Loader link function (Operation selection)	**Frequency setting** / **Run command** [E3S/E3E] 0: Based on H30，y98 / Based on H30，y98 1: Command issued from FRENIC-Loader4 / Based on H30，y98 2: Based on H30，y98 / Command issued from FRENIC-Loader4 3: Command issued from FRENIC-Loader4 / Command issued from FRENIC-Loader4 [E3N] 0: Based on y98 / Based on y98 1: Command issued from FRENIC-Loader4 / Based on y98 2: Based on y98 / Command issued from FRENIC-Loader4 3: Command issued from FRENIC-Loader4 / Command issued from FRENIC-Loader4	Y	Y	Y	N	0	

[18] o code: Option Functions

Among o code control methods, with some exceptions, all control methods (V/f PGV/f SLV PGV PMSLV PMPGV TRQ) are enabled.

Function code	Name	Control method and Data setting range	Type		Change when running	Data copying	value	Related page
			E3S/E3E	E3N				
o01	OPC-CP-RY option Terminal [Y6A/C] output	Refer to o01 to o07 in “Table 5.2-4 Control output terminal setting list table”	Y	N	N	Y	100	–
o02	Terminal [Y7A/C] output		Y	N	N	Y	100	
o03	Terminal [Y8A/C] output		Y	N	N	Y	100	
o19	OPC-DIO option (DI polarity)	0: Frequency setting (without polarity) 1: Frequency setting (with polarity) * Enable at o20 = 0, 1 only	Y	N	N	Y	0	
o20	(DI mode selection)	0: 8 bit binary frequency setting 1: 12 bit binary frequency setting 4: BCD 4 digit frequency setting 0.00 to 99.99 Hz 5: BCD 4 digit frequency setting 0.00 to 599.0 Hz 99: General DI function (I1 to I13)	Y	N	N	Y	0	
o21	(DO mode selection)	0: Output frequency 1 (before slip compensation) 1: Output frequency 2 (after slip compensation) 2: Output current 3: Output voltage 4: Output torque 5: Load factor 6: Input power 7: PID feedback value 8: Actual speed/estimated speed 9: DC link circuit voltage 13: Motor output 15: PID command (SV) 16: PID output (MV) 17: Master-follower angle deviation 18: Inverter cooling fin temperature 21: PG feedback value 22: Torque current command value 23: PID deviation 26: Reference frequency (before acceleration/deceleration calculation) 99: Individual signal output	Y	N	Y	Y	0	
o27	Transmission error (Operation selection)	0: Immediate Er5 trip when a communication error occurs. 1: Immediate Er5 trip after running for the time specified by Timer after a communication error occurs. 2: Immediate Er5 trip if a communication error occurs and the communication is not restored after retry while running for the time specified by Timer. 3: Continued operation without Er5 trip even if a communication error occurs. Operation in accordance with the communication command after the communication is restored. 4 to 9: Same as o27 = 0 10: Er5 trip following the deceleration stop due to a communication error. 11: Er5 trip following the deceleration stop after running for the time specified by Timer after a communication error occurs. 12: Deceleration stop if a communication error occurs and the communication is not restored after retry while running for the time specified by Timer. Continued operation in accordance with the communication command if the communication is restored. [When combined with the DeviceNet option] 13: Immediate run command OFF when a communication error occurs. (No Er5 trip) 14: Forced operation in the forward direction when a communication error occurs. (No Er5 trip) 15: Forced operation in the reverse direction when a communication error occurs. (No Er5 trip) [When combined with other options] 13 to 15: Same as o27 = 3	Y	Y	Y	Y	0	
o28	(Timer)	0.0 to 60.0	Y	Y	Y	Y	0.0	
o30 to o39	Bus setting parameter 01 to Bus setting parameter 10	0 to 255 The function of each function code differs depending on the bus option type. For details, refer to the Bus Option Instruction Manual.	Y	Y	N	Y	0	
o40 to o47	Write function code assignment 1 to Write function code assignment 8	0000 to FFFF (in hexadecimal) Data mapped I/O (writing) The supported items and number of supported items differ depending on the bus option type. For details on data setting, refer to the Bus Option Instruction Manual.	Y	N	N	Y	0000	
o48 to o59	Read function code assignment 1 to Read function code assignment 12	0000 to FFFF (in hexadecimal) Data mapped I/O (reading) The supported items and number of supported items differ depending on the bus option type. For details on data setting, refer to the Bus Option Instruction Manual.	Y	N	N	Y	0000	
o60	OPC-AIO option Terminal [32] (Function selection)	Same as E61	Y	N	N	Y	0	
o61	(Offset adjustment)	-5.0 to 5.0%	Y	N	Y*	Y	0.0	
o62	(Gain adjustment)	0.00 to 400.00%	Y	N	Y*	Y	100.00	
o63	(Filter setting)	0.00 to 5.00 s	Y	N	Y	Y	0.05	
o64	(Gain base point)	0.00 to 100.00%	Y	N	Y*	Y	100.00	
o65	(Polarity selection)	0: Bipolar 1: Unipolar	Y	N	N	Y	1	

Function code	Name	Control method and Data setting range	Type E3S/E3E	Type E3N	Change when running	Data copying	value	Related page
o66	(Bias)	-200.0 to 200.00%	Y	N	Y*	Y	0.00	—
o67	(Bias base point)	0.00 to 100.00%	Y	N	Y*	Y	0.00	
o69	(Display unit)	Same as C58	Y	N	N	Y	2	
o70	(Maximum scale)	-999.0 to 0.00 to 9990.0	Y	N	N	Y	100.00	
o71	(Minimum scale)	-999.0 to 0.00 to 9990.0	Y	N	N	Y	0.00	
o75	OPC-AIO option Terminal [C2] (Range selection)	0: 4 to 20 mA Unipolar 1: 0 to 20 mA Unipolar 10: 4 to 20 mA Bipolar 11: 0 to 20 mA Bipolar	Y	N	N	Y	0	
o76	(Function selection)	Same as E61	Y	N	N	Y	0	
o77	(Offset adjustment)	-5.0 to 5.0%	Y	N	Y*	Y	0.0	
o78	(Gain adjustment)	0.00 to 400.00%	Y	N	Y*	Y	100.00	
o79	(Filter setting)	0.00 to 5.00 s	Y	N	Y	Y	0.05	
o81	(Gain base point)	0.00 to 100.00%	Y	N	Y*	Y	100.00	
o82	(Bias)	-200.0 to 200.00%	Y	N	Y*	Y	0.00	
o83	(Bias base point)	0.00 to 100.00%	Y	N	Y*	Y	0.00	
o85	(Display unit)	Same as C58	Y	N	N	Y	2	
o86	(Maximum scale)	-999.0 to 0.00 to 9990.0	Y	N	N	Y	100.00	
o87	(Minimum scale)	-999.0 to 0.00 to 9990.0	Y	N	N	Y	0.00	
o88	OPC-AIO option C1OFF signal/mode selection	0: Signal ON with C1 terminal disconnection 1: Signal ON with C2 terminal disconnection 2: Signal ON with C1 or C2 terminal disconnection	Y	N	N	Y	2	
o90	OPC-AIO option Terminal [Ao] (Function selection)	Same as F31	Y	N	Y	Y	0	
o91	(Output gain)	0 to 300%	Y	N	Y*	Y	100	
o93	OPC-AIO option Terminal [Ao] (Polarity selection)	0: Bipolar 1: Unipolar	Y	N	N	Y	1	
o96	OPC-AIO option Terminal [CS] (Function selection)	Same as F31	Y	N	Y	Y	0	
o97	(Output gain)	0 to 300%	Y	N	Y*	Y	100	

[19] o1 codes: Option Functions

Among o1 code control methods, with some exceptions, all control methods (V/f PGV/f SLV PGV PM SLV PM PGV TRQ) are enabled.

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
o101 to o113	OPC-DIO option Terminal [I1] (Function selection) to Terminal [I13] (Function selection)	Refer to o101 to o113 in "Table 5.2-3 Control input terminal setting list table."	Y	N	N	Y	100	–
o121	Terminal [O1] (Function selection)	Refer to o121 to o128 in "Table 5.2-4 Control output terminal setting list table."	Y	N	N	Y	0	
o122	Terminal [O2] (Function selection)		Y	N	N	Y	2	
o123	Terminal [O3] (Function selection)		Y	N	N	Y	1	
o124	Terminal [O4] (Function selection)		Y	N	N	Y	3	
o125	Terminal [O5] (Function selection)		Y	N	N	Y	5	
o126	Terminal [O6] (Function selection)		Y	N	N	Y	6	
o127	Terminal [O7] (Function selection)		Y	N	N	Y	100	
o128	Terminal [O8] (Function selection)		Y	N	N	Y	100	

[20] o2 codes: Option Functions

Among o2 code control methods, with some exceptions, all control methods (V/f PGV/f SLV PGV PMSLV PMPGV TRQ) are enabled.

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
o201	IP address setting 1	0 to 255	Y	Y	Y	Y	E3S/E: 0 E3N: 192	*29
o202	IP address setting 2		Y	Y	Y	Y	E3S/E: 0 E3N: 168	
o203	IP address setting 3		Y	Y	Y	Y	0	
o204	IP address setting 4		Y	Y	Y	Y	E3S/E: 0 E3N: 10	
o205	Subnet mask setting 1		Y	Y	Y	Y	255	
o206	Subnet mask setting 2							
o207	Subnet mask setting 3							
o208	Subnet mask setting 4						0	
o209 to o212	Default gateway setting 1 to Default gateway setting 4		Y	Y	Y	Y	0	
o213	IP address setting mode	0: Fixed (Set with o201 to o204) 1: Hard switching (Set with o201 to o203 and on the OPC-CP-ETM, or with the rotary switches on the front of the E3N type.) 2: DHCP (Other than PROFINET) 3: DCP (PROFINET)	Y	Y	Y	Y	0	
o214	Protocol Settings	0: None (invalid) 1: PROFINET-RT 2: EtherNet/IP 3: Modbus TCP 4: Reserved	Y	Y	Y	Y	E3S/E/T: 0 E3N: 3	
o215	KEEP-ALIVE startup time	10 to 720 s	Y	Y	Y	Y	60	
o216	Monitoring time setting	0.0 to 60.0 s	Y	Y	Y	Y	0	
o217	For manufacturer	0 to 65535	Y	Y	Y	Y	bAC0	
o218	For manufacturer	0 to 419	Y	Y	Y	Y	0	
o219	For manufacturer	0 to 9999	Y	Y	Y	Y	0	
o221 to o252	Write function code assignment 1 to 32	Set the function code to write from the master to the inverter.	Y	Y	Y	Y	0000	
o253 to o284	Read function code assignment 1 to 32	Set the function code to read from the inverter to the master.	Y	Y	Y	Y	0000	
o299	Ethernet setting reflection	0: Disable 1: Perform a reset (The setting values automatically return to 0.)	Y	Y	N	N	0	

*29 Enable the settings for these function codes either by setting o299 = 1 after setting o201 through o284 (*30), or by turning the inverter power supply OFF and then ON again.
*30 The setting for o216 is immediately applied.

[21] K codes: Keypad Functions

Among K code control methods, with some exceptions, all control methods (V/f PGV/f SLV PGV PMSLV PMPGV TRQ) are enabled.

Factory default…A (for Asia), C (for China), E (for Europe), U (for Americas), K (for Korea), J (for Japan)

Function code	Name	Control method and Data setting range	Type: E3S/E3E	Type: E3N	Change when running	Data copying	Default value	Related page
K01	Multi-function keypad TP-A2SW (Language selection)	0: Japanese 1: English 2: German 3: French 4: Spanish 5: Italian 6: Chinese 7: Korean 8: Russian 9: Greek 10: Turkish 11: Polish 12: Czech 13: Swedish 14: Portuguese 15: Dutch 16: Malay 17: Vietnamese 18: Thai 19: Indonesian	Y	N	Y	Y	A, E, U, K: 1 C: 6 J: 0	5-383
K02	(Backlight OFF time)	0: Always OFF 1 to 30 min	Y	N	Y	Y	5	
K03	(Brightness adjustment)	0 (dark) to 10 (bright)	Y	N	Y*	Y	5	
K04	(Contrast adjustment)	0 (low) to 10 (high)	Y	N	Y*	Y	5	
K08	(Status display)	0: Hide 1: Show all * This also applies to the status display selection of the standard keypad (TP-E2).	Y	N	Y*	Y	1	5-384
K15	(Screen selection)	0: Operation guide display 1: Bar graph display	Y	N	Y	Y	0	
K16	(Sub-monitor 1 display content)	1: Output frequency 1 (before slip compensation) 2: Output frequency 2 (after slip compensation) 3: Reference frequency 4: Motor speed 5: Load shaft speed 6: Feed speed (line speed) 7: Constant feed time 8: Speed (%) 13: Output current 14: Output voltage 18: Calculated torque 19: Input power 20: PID command value 22: PID feedback value 23: Timer value 24: PID output 25: Load rate 26: Motor output 27: Analog input monitor 31: Current position 32: Positioning deviation 33: Torque current (%) 34: Flux command (%) 35: Input watt-hour 38: Stop target position 39: PID deviation 40: Torque bias 42: Customizable logic output	Y	N	Y	Y	13	5-385
K17	(Sub-monitor 2 content)	Same as K16	Y	N	Y	Y	18	
K20	(Bar graph 1 content)	1 to 26 1: Output frequency 1 (before slip compensation) 13: Output current 14: Output voltage 18: Calculated torque 19: Input power 25: Load rate 26: Motor output	Y	N	Y	Y	1	
K21	(Bar graph 2 content)		Y	N	Y	Y	13	
K22	(Bar graph 3 content)		Y	N	Y	Y	18	

Function code	Name	Control method and Data setting range	Type E3S/E3E	Type E3N	Change when running	Data copying	Default value	Related page
K25	Display Unit for Load speed	1: No unit 4: r/min 10: mm/s 11: mm/m 12: mm/h 13: m/s 14: m/min 15: m/h 16: FPS 17: FPM 18: FPH 19: SPM 20: m3/s 21: m3/min 22: m3/h 23: L/s 24: L/min 25: L/h 26: GPS 27: GPM 28: GPH 29: CFS 30: CFM 31: CFH 32: kg/s 33: kg/m 34: kg/h 35: lb/s 36: lb/m 37: lb/h 38: AF/Y The units for the load speed can be displayed when the multi-function keypad (TP-A2SW) is used.	Y	N	Y	Y	4	5-385
K40	For manufacturer	0 to 7	Y	N	Y	Y	0	
K51	Traceback (Data overwrite selection)	0: Allow 1: Prohibit	Y	Y	Y	Y	0	
K52	(Sampling cycle)	0: 1 ms 1: 2 ms 2: 5 ms 3: 10 ms 4: 20 ms 5: 50 ms 6: 100 ms 7: 200 ms 8: 500 us	Y	Y	Y	Y	2	
K53	(CH4 operation selection)	0: Analog signal 1: Digital signal	Y	Y	Y	Y	0	5-386
K54	(Analog Ch1 source selection)	0000 to FFFF (in hexadecimal)	Y	Y	Y	Y	2907	
K55	(Analog Ch2 source selection)		Y	Y	Y	Y	290B	
K56	(Analog Ch3 source selection)		Y	Y	Y	Y	0815	
K57	(Analog Ch4 source selection)		Y	Y	Y	Y	FFFF	
K58	(Digital Ch1 source selection)	0000 to 00FF (Hexadecimal display)	Y	Y	Y	Y	0080	
K59	(Digital Ch2 source selection)		Y	Y	Y	Y	0081	
K60	(Digital Ch3 source selection)		Y	Y	Y	Y	0082	
K61	(Digital Ch4 source selection)		Y	Y	Y	Y	0083	
K62	(Digital Ch5 source selection)		Y	Y	Y	Y	0084	
K63	(Digital Ch6 source selection)		Y	Y	Y	Y	00FF	
K64	(Digital Ch7 source selection)		Y	Y	Y	Y	00FF	
K65	(Digital Ch8 source selection)		Y	Y	Y	Y	00FF	
K91	Multi-function keypad TP-A2SW (< Key shortcut selection)	0: Disable 11 to 99: Each mode	Y	N	Y	Y	0	5-387
K92	(> Key shortcut selection)		Y	N	Y	Y	64	

Table 5.2-1 Factory default setting values by capacity

Fuji premium efficiency motors (When 5 is set to motor 1 to 2 selection P99/A39.)

Motor capacity		Torque boost 1 to 2 *1 F09/A05		Momentary power failure restart H13
[kW]	[HP]	HD/HHD	ND/HND	
0.06	1/10	8.4	6.7	0.5
0.1	1/8	8.4	6.7	
0.2	1/4	8.4	6.7	
0.4	1/2	7.1	4.0	
0.75	1	3.8	2.6	
1.5	2	3.0	2.4	
2.2	3	2.5	2.1	
3.7	5	2.4	2.0	
5.5	7.5	1.9	1.9	
7.5	10	1.8	1.8	
11	15	1.3	1.3	1.0
15	20	1.2	1.2	
18.5	25	0.9	0.9	
22	30	0.9	0.9	

Fuji standard motors, 8-series (When 0 is set for Motor 1 to 2 selection P99/A39.)

Motor capacity		Torque boost 1 to 4 *1 F09/A05		Momentary power failure restart H13
[kW]	[HP]	HD/HHD	ND/HND	
0.06	1/10	8.4	6.7	0.5
0.1	1/8	8.4	6.7	
0.2	1/4	8.4	6.7	
0.4	1/2	7.1	4.0	
0.75	1	6.8	3.5	
1.5	2		4.9	
2.2	3		4.5	
3.7	5	5.5	4.1	
5.5	7.5	4.9	3.4	
7.5	10	4.4	2.7	
11	15	3.5	2.1	1.0
15	20	2.8	1.6	
18.5	25	2.2	1.3	
22	30		1.1	

*1 The torque boost (F09/A05) is overwritten by the corresponding value based on the motor capacity (P02/A16) setting value after the motor capacity (P02/A16) has been changed, after switching between ND, HD, HND, or HHD drive modes (F80), or after data initialization (H03 = 2 to 3: Motor constant initialization).

Table 5.2-2 Motor constant

When Fuji standard motor 8-series, other are selected

(Function code P99/A39 = 0, 3, 4)

■ **Three-phase 200 V series**

Motor capacity setting range (kW) P02/A16	Applicable motor capacity (kW)	Rated current (A) P03/A17	No load current (A) P06/A20	%R1 (%) P07/A21	%X (%) P08/A22	Rated slip P12/A26	Iron loss coefficient 1 P13/A27	Magnetic saturation coefficient 1 P16/A30	Magnetic saturation coefficient 2 P17/A31	Magnetic saturation coefficient 3 P18/A32	Magnetic saturation coefficient 4 P19/A33	Magnetic saturation coefficient 5 P20/A34	Vector control torque current P55/A55	Vector control induced voltage coefficient P56/A56	For adjustment by manufacturer P57/A57	Starting mode (Auto search delay time 2) H46
0.01-0 09	0.06	0.44	0.4	13.79	11.75	1.77	14	93.8	87.5	75	62.5	50	0.2	85	0.027	0.5
0.10-0 19	0.1	0.68	0.55	12.96	12.67	1.77	14	93.3	86.1	74.4	63.6	50.7	0.34		0.024	
0.20-0.39	0.2	1.3	1.06	12.95	12.92	2.33	12.6	89.7	81.9	66.9	54.5	43.3	0.68		0.023	
0.40-0.74	0.4	2.3	1.66	10.2	13.66	2.4	9.88	88.7	81.3	67	55.2	43.8	1.36		0.027	
0.75-1.49	0.75	3.6	2.3	8.67	10.76	2.33	7.4	88.3	77.7	62.6	51.8	41.1	2.55		0.033	
1.50-2.19	1.5	6.1	3.01	6.55	11.21	2	5.85	92.1	82.8	71.1	58.1	46.2	5.09		0.061	
2.20-3.69	2.2	9.2	4.85	6.48	10.97	1.8	5.91	85.1	74.6	61.7	50.3	39.8	7.47		0.051	0.6
3.70-5.49	3.7	15	7.67	5.79	11.25	1.93	5.24	86	76.9	61.3	49.5	39.1	12.57		0.063	0.8
5.50-7.49	5.5	22.5	1 1.00	5.28	14.31	1.4	4.75	88.6	79.2	64.9	52.7	41.8	18.68		0.082	1.0
7.50-10.99	7.5	29	12.5	4.5	14.68	1.57	4.03	87.7	80	67.1	56.1	45.6	25.47		0.095	1.2
1 1.00-14.99	11	42	17.7	3.78	15.09	1.07	3.92	91.3	83.3	69.9	58	47	37.36		0.133	1.3
15.00-18.49	15	55	20	3.25	16.37	1.13	3.32	90.5	83.5	72.1	60.7	49.5	50.94		0.151	2.0
18.50-21.99	18.5	67	21.40	2.92	16.58	0.87	3.34	90.7	83	70.7	59.9	48.7	62.83		0.22	
22.00-29.99	22	78	25.1	2.7	16	0.9	3.28	89.7	81.3	68.9	59.1	48.4	74.72		0.228	
30.00-36.99	30	107	38.9	2.64	14.96	0.8	3.1	90.2	81.6	68.7	57.2	45.8	101.9		0.202	2.3

■ **Three-phase 400 V series**

Motor capacity setting range (kW) P02/A16	Applicable motor capacity (kW)	Rated current (A) P03/A17	No-load current (A) P06/A20	%R1 (%) P07/A21	%X (%) P08/A22	Rated slip P12/A26	Iron loss coefficient 1 P13/A27	Magnetic saturation coefficient 1 P16/A30	Magnetic saturation coefficient 2 P17/A31	Magnetic saturation coefficient 3 P18/A32	Magnetic saturation coefficient 4 P19/A33	Magnetic saturation coefficient 5 P20/A34	Vector control torque current P55/A55	Vector control induced voltage coefficient P56/A56	For adjustment by manufacturer P57/A57	Starting mode (Auto search delay time 2) H46
0.01 to 0.09	0.06	0.22	0.20	13.79	11.75	1.77	14.00	93.8	87.5	75.0	62.5	50.0	0.10		0.027	
0.10 to 0.19	0.1	0.35	0.27	12.96	12.67	1.77	14.00	93.3	86.1	74.4	63.6	50.7	0.17		0.024	
0.20 to 0.39	0.2	0.65	0.53	12.95	12.92	2.33	12.60	89.7	81.9	66.9	54.5	43.3	0.34		0.023	0.5
0.40 to 0.74	0.4	1.15	0.83	10.20	13.66	2.40	9.88	88.7	81.3	67.0	55.2	43.8	0.68		0.027	
0.75 to 1.49	0.75	1.80	1.15	8.67	10.76	2.33	7.40	88.3	77.7	62.6	51.8	41.1	1.27		0.033	
1.50 to 2.19	1.5	3.10	1.51	6.55	11.21	2.00	5.85	92.1	82.8	71.1	58.1	46.2	2.55		0.061	
2.20 to 3.69	2.2	4.60	2.43	6.48	10.97	1.80	5.91	85.1	74.6	61.7	50.3	39.8	3.74		0.051	0.6
3.70 to 5.49	3.7	7.50	3.84	5.79	11.25	1.93	5.24	86.0	76.9	61.3	49.5	39.1	6.28	85	0.063	0.8
5.50 to 7.49	5.5	11.50	5.50	5.28	14.31	1.40	4.75	88.6	79.2	64.9	52.7	41.8	9.34		0.082	1.0
7.50 to 10.99	7.5	14.50	6.25	4.50	14.68	1.57	4.03	87.7	80.0	67.1	56.1	45.6	12.74		0.095	1.2
11.00 to 14.99	11	21.00	8.85	3.78	15.09	1.07	3.92	91.3	83.3	69.9	58.0	47.0	18.68		0.133	1.3
15.00 to 18.49	15	27.50	10.00	3.25	16.37	1.13	3.32	90.5	83.5	72.1	60.7	49.5	25.47		0.151	
18.50 to 21.99	18.5	34.00	10.70	2.92	16.58	0.87	3.34	90.7	83.0	70.7	59.9	48.7	31.41		0.22	2.0
22.00 to 29.99	22	39.00	12.60	2.70	16.00	0.90	3.28	89.7	81.3	68.9	59.1	48.4	37.36		0.228	
30.00 to 36.99	30	54.00	19.50	2.64	14.96	0.80	3.10	90.2	81.6	68.7	57.2	45.8	50.94		0.202	2.3

Chap 5 FUNCTION CODES

When HP display motor is selected by motor selection

(Function code P99/A39 = 1)

■ **200V series**

Motor capacity setting range (HP) P02/A16	Applicable motor capacity (HP)	Rated current (A) P03/A17	No-load current (A) P06/A20	%R1 (%) P07/A21	%X (%) P08/A22	Rated slip P12/A26	Iron loss coefficient 1 P13/A27	Magnetic saturation coefficient 1 P16/A30	Magnetic saturation coefficient 2 P17/A31	Magnetic saturation coefficient 3 P18/A32	Magnetic saturation coefficient 4 P19/A33	Magnetic saturation coefficient 5 P20/A34	Vector control torque current P55/A55	Vector control induced voltage coefficient P56/A56	For adjustment by manufacturer P57/A57	Starting mode (Auto search delay time 2) H46
0.01 to 0.11	0.1	0.44	0.40	13.79	11.75	2.50	14.00	93.8	87.5	75.0	62.5	50.0	0.21	85	0.027	0.5
0.12 to 0.24	0.12	0.68	0.55	12.96	12.67	2.50	14.00	93.3	86.1	74.4	63.6	50.7	0.27		0.024	
0.25 to 0.49	0.25	1.40	1.12	11.02	13.84	2.50	12.60	89.7	81.9	66.9	54.5	43.3	0.53		0.014	
0.50 to 0.99	0.5	2.00	1.22	6.15	8.80	2.50	9.88	88.7	81.3	67.0	55.2	43.8	1.09		0.019	
1.00 to 1.99	1	3.00	1.54	3.96	8.86	2.50	7.40	88.3	77.7	62.6	51.8	41.1	2.21		0.036	
2.00 to 2.99	2	5.80	2.80	4.29	7.74	2.50	5.85	92.1	82.8	71.1	58.1	46.2	4.43		0.035	
3.00 to 4.99	3	7.90	3.57	3.15	20.81	1.17	5.91	85.1	74.6	61.7	50.3	39.8	6.64		0.152	0.6
5.00 to 7.49	5	12.6	4.78	3.34	23.57	1.50	5.24	86.0	76.9	61.3	49.5	39.1	11.07		0.153	0.8
7.50 to 9.99	7.5	18.6	6.23	2.65	28.91	1.17	4.75	88.6	79.2	64.9	52.7	41.8	16.60		0.234	1.0
10.00 to 14.99	10	25.3	8.75	2.43	30.78	1.17	4.03	87.7	80.0	67.1	56.1	45.6	22.15		0.209	1.2
15.00 to 19.99	15	37.3	12.7	2.07	29.13	1.00	3.92	91.3	83.3	69.9	58.0	47.0	33.22		0.256	1.3
20.00 to 24.99	20	49.1	9.20	2.09	29.53	1.00	33.32	90.5	83.5	72.1	60.7	49.5	44.30		0.262	2.0
25.00 to 29.99	25	60.0	16.70	1.75	31.49	1.00	3.34	90.7	83.0	70.7	59.9	48.7	55.37		0.348	
30.00 to 39.99	30	72.4	19.80	1.90	32.55	1.00	3.28	89.7	81.3	68.9	59.1	48.4	66.45		0.33	

■ **400 V series**

Motor capacity setting range (HP) P02/A16	Applicable motor capacity (HP)	Rated current (A) P03/A17	No-load current (A) P06/A20	%R1 (%) P07/A21	%X (%) P08/A22	Rated slip P12/A26	Iron loss coefficient 1 P13/A27	Magnetic saturation coefficient 1 P16/A30	Magnetic saturation coefficient 2 P17/A31	Magnetic saturation coefficient 3 P18/A32	Magnetic saturation coefficient 4 P19/A33	Magnetic saturation coefficient 5 P20/A34	Vector control torque current P55/A55	Vector control induced voltage coefficient P56/A56	For adjustment by manufacturer P57/A57	Starting mode (Auto search delay time 2) H46
0.01 to 0.11	0.1	0.22	0.20	13.79	11.75	2.50	14.00	93.8	87.5	75.0	62.5	50.0	0.10	85	0.027	0.5
0.12 to 0.24	0.12	0.34	0.27	12.96	12.67	2.50	14.00	93.3	86.1	74.4	63.6	50.7	0.13		0.024	
0.25 to 0.49	0.25	0.70	0.56	11.02	13.84	2.50	12.60	89.7	81.9	66.9	54.5	43.3	0.27		0.014	
0.50 to 0.99	0.5	1.00	0.61	6.15	8.80	2.50	9.88	88.7	81.3	67.0	55.2	43.8	0.55		0.019	
1.00 to 1.99	1	1.50	0.77	3.96	8.86	2.50	7.40	88.3	77.7	62.6	51.8	41.1	1.11		0.036	
2.00 to 2.99	2	2.90	1.40	4.29	7.74	2.50	5.85	92.1	82.8	71.1	58.1	46.2	2.21		0.035	
3.00 to 4.99	3	4.00	1.79	3.15	20.81	1.17	5.91	85.1	74.6	61.7	50.3	39.8	3.32		0.152	0.6
5.00 to 7.49	5	6.30	2.39	3.34	23.57	1.50	5.24	86.0	76.9	61.3	49.5	39.1	5.54		0.153	0.8
7.50 to 9.99	7.5	9.30	3.12	2.65	28.91	1.17	4.75	88.6	79.2	64.9	52.7	41.8	8.30		0.234	1.0
10.00 to 14.99	10	12.7	4.37	2.43	30.78	1.17	4.03	87.7	80.0	67.1	56.1	45.6	11.07		0.209	1.2
15.00 to 19.99	15	18.7	6.36	2.07	29.13	1.00	3.92	91.3	83.3	69.9	58.0	47.0	16.61		0.256	1.3
20.00 to 24.99	20	24.6	4.60	2.09	29.53	1.00	3.32	90.5	83.5	72.1	60.7	49.5	22.15		0.262	2.0
25.00 to 29.99	25	30.0	8.33	1.75	31.49	1.00	3.34	90.7	83.0	70.7	59.9	48.7	27.69		0.348	
30.00 to 39.99	30	36.2	9.88	1.90	32.55	1.00	3.28	89.7	81.3	68.9	59.1	48.4	33.22		0.33	

When Fuji premium efficiency motor is selected in motor selection

(Function code P99/A39 = 5)

■ **Three-phase 200 V series**

Motor capacity setting range (kW) P02/A16	Applicable motor capacity (kW)	Rated current (A) P03/A17	No-load current (A) P06/A20	%R1 (%) P07/A21	%X (%) P08/A22	Rated slip P12/A26	Iron loss coefficient 1 P13/A27	Magnetic saturation coefficient 1 P16/A30	Magnetic saturation coefficient 2 P17/A31	Magnetic saturation coefficient 3 P18/A32	Magnetic saturation coefficient 4 P19/A33	Magnetic saturation coefficient 5 P20/A34	Vector control torque current P55/A55	Vector control induced voltage coefficient P56/A56	For adjustment by manufacturer P57/A57	Starting mode (Auto search delay time 2) H46
0.01 to 0.09	0.06	0.44	0.40	13.79	11.75	1.77	14.00	93.8	87.5	75.0	62.5	50.0	0.20	85	0.027	0.5
0.10 to 0.19	0.1	0.68	0.55	12.96	12.67	1.77	14.00	93.3	86.1	74.4	63.6	50.7	0.34		0.024	
0.20 to 0.39	0.2	1.30	1.06	12.95	12.92	2.33	12.60	89.7	81.9	66.9	54.5	43.3	0.68		0.023	
0.40 to 0.74	0.4	2.30	1.66	10.20	13.66	2.40	9.88	88.7	81.3	67.0	55.2	43.8	1.36		0.027	
0.75 to 1.49	0.75	3.50	1.87	5.49	13.71	2.00	4.31	92.5	85.1	71.8	59.1	46.7	2.28	95	0.050	
1.50 to 2.19	1.5	6.90	3.96	5.04	13.70	1.67	4.21	89.6	79.6	66.1	54.1	42.9	4.56		0.085	0.6
2.20 to 3.69	2.2	9.50	5.46	4.07	12.98	1.67	3.94	89.4	79.3	65.8	53.9	42.7	6.69		0.092	
3.70 to 5.49	3.7	15.50	8.50	4.07	13.15	1.17	3.59	92.0	84.2	70.7	58.2	45.9	11.24		0.102	0.8
5.50 to 7.49	5.5	21.00	10.55	3.17	11.47	1.00	2.86	92.0	84.2	70.5	58.3	46.1	16.71		0.137	1.0
7.50 to 10.99	7.5	27.50	11.68	3.01	12.56	1.00	2.36	92.4	84.8	71.5	59.2	46.8	22.79		0.158	1.2
11.00 to 14.99	11	40.00	14.90	2.21	14.28	1.00	2.56	92.5	85.2	72.2	59.8	47.4	33.43		0.207	1.4
15.00 to 18.49	15	54.00	18.50	1.94	14.34	0.83	2.32	92.8	85.7	72.8	60.3	47.9	45.58		0.242	2.0
18.50 to 21.99	18.5	68.00	27.40	1.48	15.10	0.67	1.86	92.9	85.8	73.1	61.0	48.8	56.22		0.240	
22.00 to 29.99	22	84.00	33.60	1.46	15.29	0.83	1.91	92.7	85.5	72.6	60.5	48.5	66.85		0.238	
30.00 to 36.99	30	116.0	45.60	1.40	15.38	0.83	1.91	92.3	84.8	71.8	59.8	47.9	91.16		0.244	2.3

■ Three-phase 400 V series

Motor capacity setting range (kW) P02/A16	Applicable motor capacity (kW)	Rated current (A) P03/A17	No-load current (A) P06/A20	%R1 (%) P07/A21	%X (%) P08/A22	Rated slip P12/A26	Iron loss coefficient 1 P13/A27	Magnetic saturation coefficient 1 P16/A30	Magnetic saturation coefficient 2 P17/A31	Magnetic saturation coefficient 3 P18/A32	Magnetic saturation coefficient 4 P19/A33	Magnetic saturation coefficient 5 P20/A34	Vector control torque current P55/A55	Vector control induced voltage coefficient P56/A56	For adjustment by manufacturer P57/A57	Starting mode (Auto search delay time 2) H46
0.01 to 0.09	0.06	0.22	0.20	13.19	11.75	1.77	14.00	93.8	87.5	75.0	62.5	50.0	0.10	85	0.027	0.5
0.10 to 0.19	0.1	0.35	0.27	12.96	12.67	1.77	14.00	93.3	86.1	74.4	63.6	50.7	0.17		0.024	
0.20 to 0.39	0.2	0.65	0.53	12.95	12.92	2.33	12.60	89.7	81.9	66.9	54.5	43.3	0.34		0.023	
0.40 to 0.74	0.4	1.15	0.83	10.20	13.66	2.40	9.88	88.7	81.3	67.0	55.2	43.8	0.68		0.027	
0.75 to 1.49	0.75	1.80	0.94	5.49	13.71	2.00	4.31	92.5	85.1	71.8	59.1	46.7	1.14	95	0.050	
1.50 to 2.19	1.5	3.50	1.98	5.04	13.70	1.67	4.21	89.6	79.6	66.1	54.1	42.9	2.28		0.085	0.6
2.20 to 3.69	2.2	4.80	2.73	4.07	12.98	1.67	3.94	89.4	79.3	65.8	53.9	42.7	3.34		0.092	
3.70 to 5.49	3.7	7.80	4.25	4.07	13.15	1.17	3.59	92.0	84.2	70.7	58.2	45.9	5.62		0.102	0.8
5.50 to 7.49	5.5	10.50	5.28	3.17	11.47	1.00	2.86	92.0	84.2	70.5	58.3	46.1	8.36		0.137	1.0
7.50 to 10.99	7.5	13.50	5.84	3.01	12.56	1.00	2.36	92.4	84.8	71.5	59.2	46.8	11.40		0.158	1.2
11.00 to 14.99	11	20.00	7.45	2.21	14.28	1.00	2.56	92.5	85.2	72.2	59.8	47.4	16.71		0.207	1.4
15.00 to 18.49	15	27.00	9.25	1.94	14.34	0.83	2.32	92.8	85.7	72.8	60.3	47.9	22.79		0.242	2.0
18.50 to 21.99	18.5	34.00	13.70	1.48	15.10	0.67	1.86	92.9	85.8	73.1	61.0	48.8	28.11		0.240	
22.00 to 29.99	22	42.00	16.80	1.46	15.29	0.83	1.91	92.7	85.5	72.6	60.5	48.5	33.43		0.238	
30.00 to 36.99	30	58.00	22.80	1.40	15.38	0.83	1.91	92.3	84.8	71.8	59.8	47.9	45.58		0.244	2.3

5.3 Description of Function Codes

This section describes details of function code. In principle, explanation is given for each function code in order of group and numerical order. However, function codes that are strongly related to one function are explained together in the first paragraph.

Note

- The following descriptions are for operation using the keypad attached to the inverter main body the keypad (TP-M3)
- For the E3N series, which is not equipped with a keypad on the main body, operate using Ethernet communication or FRENIC-Loader. For details, refer to Chapter 9 “9.3 Ethernet Communication Overview.”
- The availability, selection range, etc., of certain function codes, as well as their related terminal/port functions, differ between the E3S/E3E series and the E3N series. The following descriptions are for the E3S/E3E series. For the E3N series, refer to “5.2.2 Function code tables” for differences related to the function codes, and to the table below for differences related to the terminal/port functions, and replace with the relevant content.

Differences in terminal/port functions (E3S/E3E⇔E3N)

Terminal/port function	E3S/E3E	E3N	Reference
Control circuit terminal input	[X1] to [X5]	[X1] to [X3]	E01 to E05
Control circuit terminal output	[Y1], [Y2]	[Y1]	E20, E21
Analog output terminal	[FM1]	[FM]	F29 to F31, etc.
	[FM2]	None	F32, F34, F35, etc.
RS-485 communication port 1 (RJ-45 connector)	(When CBAD-CP is equipped)	None	y98 (for E3N) * Used for Ethernet communication
RS-485 communication port 2 Control circuit terminal	[DX+], [DX-], [SD]	None	
Ethernet communication port 1/2	None	Yes	
Option card installation	Possible	Not possible	o201 to o299 (for E3N) * Used for Ethernet communication

5.3.1 F codes (Fundamental functions)

F00	Data protection

This is a function to protect currently set data by disabling the ability to make changes in function code data (except F00) and all types of command values (frequency setting, PID command) by ▲/▼ key operation from keypad.

F00 data	Function code change		Keypad operation by (▲/▼ key) Various command setting
	Changes from the keypad	Change from communication	
0	Allowed	Allowed	Allowed
1	Not allowed *	Allowed	Allowed
2	Allowed	Allowed	Not allowed
3	Not allowed *	Allowed	Not allowed

* Function codes cannot be changed from the keypad, however, function code F00 can be changed.

F00 data can be changed using the "STOP key + ▲ key", or "STOP key + ▼ key" double operation.

As a similar function related to data protection, "Allow function code editing (Data change enabled) 'WE-KP'" which can be assigned to a digital input terminal is available ((📖 Function code E01 to E05 data = 19).

By combining data protection F00, protection of function code functions is as follows:

Input signal "WE-KP"	Function code change	
	Changes from the keypad	Change from communication
OFF	Not allowed	Allowed
ON	Follow setting of F00	

Note

- If "enable data change with keypad" [WE-KP] is set to a digital input terminal by mistake, it is not possible to make changes in function codes. In this case, after shortening (ON) the terminal to which temporarily "WE-KP" function is assigned, and the terminal [CM], change to a different function.
- "WE-KP" is the change enable signal for function code, this is not the function to protect frequency setting and PID command by ▲/▼ key operation.

F01	**Frequency setting 1**
	Related function code: **F18 Bias (Frequency setting 1)** **C30 Frequency setting 2** **C31 to C35 Analog input adjustment (Terminal [12])** **C36 to C40 Analog input adjustment (Terminal [C1])** **C41 to C45 Analog input adjustment (Terminal [V2])** **C55 to C56 Analog input adjustment (Terminal [12]) (Bias base point)** **C61 to C62 Analog input adjustment (Terminal [C1]) (Bias base point)** **C67 to C68 Analog input adjustment (Terminal [V2]) (Bias base point)** **C50 Bias (Frequency setting 1) (Bias base point)** **H61 UP/DOWN control initial value selection** **H62 UP/DOWN control (Extension function selection)** **d59, d61 to d63 Command (Pulse string input)**

Select setting method of frequency setting. Select Frequency setting 1 with function code F01, and Frequency setting 2 with C30. Frequency setting 1 and Frequency setting 2 are selected with “Frequency setting 2/Frequency setting 1 “Hz2/ Hz1”,” which is assigned to the digital input terminal. (Function code E01 to E05, data = 39)

Tip

If a frequency setting of even higher priority than F01/C30 (multistep frequency, jogging (inching), frequency setting from communication, etc.) is selected, set the frequency based on the priority (F01/C30 is disabled).
For details on the frequency setting priority, refer to Chapter 8 “8.2.1 Frequency Setting Section.”
(The closer switches are to the block diagram output (frequency command) side, the higher the priority.)

F01, C30 Data	Command source
0	Frequency setting with keypad (refer to the following descriptions to find the setting method)
1	Setting with voltage value to be input for terminal [12] (0 to ±10 VDC, maximum output frequency/±10 VDC)
2	Setting with current value (4 to 20 mA DC, maximum output frequency/20 mA DC) input for terminal [C1] (C1 function) (Set slide switch SW3 on the PCB to the [C1] side.)
3	Setting with result of adding the voltage value to be input for terminal [12] (0 to ±10 VDC, maximum output frequency/±10 VDC) and the current value to be input for terminal [C1] (4 to 20 mA DC, maximum output frequency/20 mA DC) (If the result of addition is equal to or higher than the maximum output frequency, frequency is restricted to the maximum output frequency.)
5	Setting with voltage value to be input for terminal [C1] (V2 function) (0 to +10 VDC, maximum output frequency/+10 VDC) (Set slide switch SW3 on the PCB to the [V2] side).
7	Setting with UP command “UP” and DOWN command “DOWN” assigned to the digital input terminal It is necessary to assign the UP command (Data = 17) and DOWN command (Data = 18) to digital input terminal [X1] to [X5]. (E01 to E05)
8	Frequency setting with keypad (with balanceless/bumpless function)
10	Setting with pattern operation
11	Frequency setting with digital input and output interface card (option) (For details, refer to the Option Instruction Manual.)
12	Setting with pulse string input “PIN” (data = 48) assigned to digital input terminal [X5], or with PG interface card (option) Note: If using terminal [X5] with pulse string input, they may be affected by noise from other wiring. Keep wiring to terminal [X5] and other wiring as far apart as possible.

Setting method of reference frequency

[1] Using the keypad (F01 = 0 or 8)

(1) Set the data of function code F01 to “0” or “8.” When the keypad is set to Programming or Alarm mode, the ∧/∨ keys are disabled to modify the reference frequency. You need to switch to Running mode to enable frequency setting with the ∧/∨ keys.

(2) When ∧/∨ keys are pressed, reference frequency is displayed and the least significant digit of the reference frequency flashes.

(3) To change the reference frequency, press the ∧/∨ key again. The changed reference frequency is automatically saved (function code E64 = 0). If the reference frequency is saved, the next time the power is turned on, operation is possible from the saved reference frequency. Saved setting values are applied to function code C99, and are therefore copied with the keypad or FRENIC-Loader4 copy function.

Tip

- A manual saving method (function code E64 = 1) is available in addition to the above method for saving frequency setting data. After changing the reference frequency, press the FUNC/DATA key to save.
- While the data of function code F01 is set to “0” or “8,” when frequency setting method other than Frequency setting 1 (Frequency setting 2, communication, multistep frequency) is selected as frequency setting, it is not possible to change the reference setting with ∧/∨ keys even if keypad is in Running mode. In this case, pressing ∧/∨ keys displays the currently selected reference frequency.
- When frequency setting is performed with ∧/∨ keys, the least significant digit displayed flashes and the data is changed from the least significant digit and the changing digit gradually shifts to the upper digit.
- To set the reference frequency, first press the ∧/∨ key once to make the least significant digit blink. After that, each time the ▸▸ key is pressed, the cursor moves to the next higher digit where data can be changed. This cursor movement allows you to easily move the cursor to the desired digit and change the data in higher digits. This operation is called cursor movement.
- When the data of function code F01 is set to “8,” balanceless/bumpless function becomes enabled. If changing to frequency setting with the keypad from a frequency setting method other than the keypad, initial values for the new method will be the frequency settings prior to changing. By using this function, even if frequency setting is switched, it is possible to perform operation without shock.

[2] Setting the frequency with analog input (F01 = 1 to 3, 5, 6)

It is possible to arbitrarily specify a frequency setting value for Frequency setting 1 from the analog inputs (voltage value to be input to terminal [12] and [C1] (V2 function), or current value to be input to terminal [C1] (C1 function)) by multiplying them with the gain and adding the bias. The polarity can be selected, and the filter and offset can be adjusted.

Adjustment constants of Frequency setting 1

F01 Data	Input terminal	Input range	Bias		Gain		Polarity Selector	Filter	Offset
			Bias	Reference point	Gain	Reference point			
1	[12]	0 to +10 V, -10 to +10 V	F18	C50	C32	C34	C35	C33	C31
2	[C1] (C1 function)	4 to 20 mA 0 to 20 mA	F18	C50	C37	C39	C40	C38	C36
3	[12] + [C1] (C1 function) (Set by result of addition)	0 to +10 V, -10 to +10 V	F18	C50	C32	C34	C35	C33	C31
		4 to 20 mA 0 to 20 mA	F18	C50	C37	C39	C40	C38	C36
5	[C1] (V2 function)	0 to +10 V	F18	C50	C42	C44	C45	C43	C41

Adjustment constants of Frequency setting 2

C30 Data	Input terminal	Input range	Bias		Gain		Polarity Selector	Filter	Offset
			Bias	Reference point	Gain	Reference point			
1	[12]	0 to +10 V, -10 to +10 V	C55	C56	C32	C34	C35	C33	C31
2	[C1]	4 to 20 mA 0 to 20 mA	C61	C62	C37	C39	C40	C38	C36
3	[12] + [C1] (C1 function) (Set by result of addition)	0 to +10 V, -10 to +10 V	C55	C56	C32	C34	C35	C33	C31
		4 to 20 mA 0 to 20 mA	C61	C62	C37	C39	C40	C38	C36
5	[C1] (V2 function)	0 to +10 V	C67	C68	C42	C44	C45	C43	C41

■ Offsets (C31, C36, C41)

C31, C36, C41, and C74 set offsets for analog input voltage and current. These offsets also apply to signals sent from the external equipment.

■ Filters (C33, C38, C43)

C33, C38, C43, and C76 provide the filter time constants for analog input voltage and current. The larger the time constant, the slower the response. Specify the proper filter time constant taking into account the response speed of the machine (load). If the input voltage fluctuates due to line noise, increase the time constant.

■ Polarity selection for terminal [12] (C35)

C35, C45, and C78 configure the polarity, and therefore the input range for analog input voltage.

C35 data	Terminal [12] input specification
0: Bipolar	-10 to +10 V
1: Unipolar	0 to +10 V (Negative value of voltage is regarded as 0 V)

■ Terminal [C1] (C1 function) range / polarity selection (C40)

C40 data	Terminal input range	Handling when bias value is set to minus
0: Unipolar	4 to 20 mA	Limit below 0 point with 0
1: Unipolar	0 to 20 mA	
10: Bipolar	4 to 20 mA	Enable below 0 point as minus value.
11: Bipolar	0 to 20 mA	

■ Polarity selection for terminal [C1] (V2 function) (C45)

C45 data	Terminal input specification
0	0 to +10V When bias values are set to minus, below 0 point as minus value is enabled.
1	0 to +10V When bias values are set to minus, below 0 point is limited with 0.

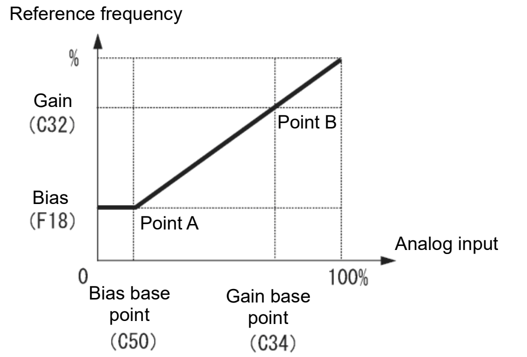
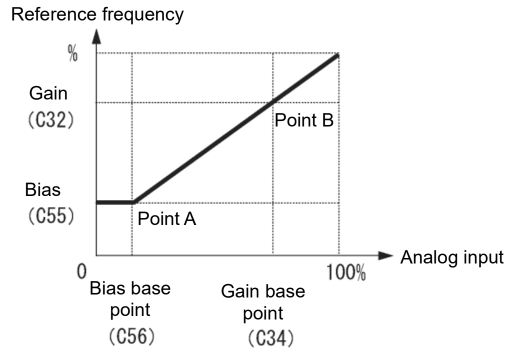
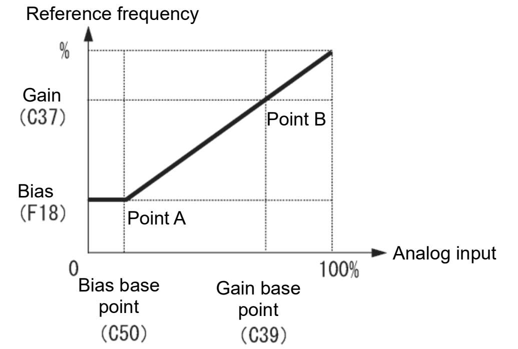
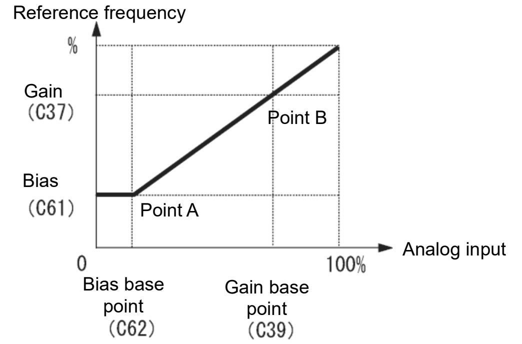
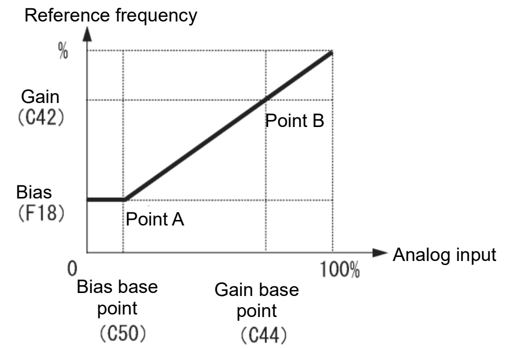
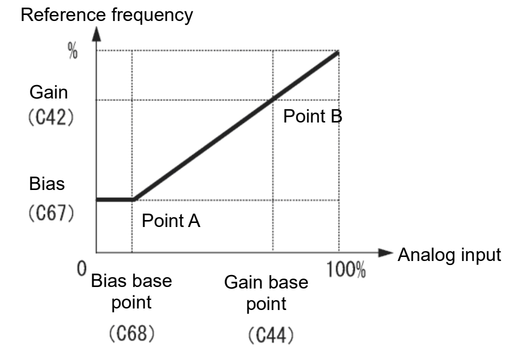
In order to use terminal [C1] with the C1 function, V2 function, and PTC function, the following settings are necessary.

[C1] terminal	SW3	SW4	C40	H26
When using C1 function (4 to 20 mA)	C1 side	AI side	0 (unipolar) 10 (bipolar)	0
When using C1 function (0 to 20 mA)	C1 side	AI side	1 (unipolar) 11 (bipolar)	0
When using V2 function (0 to +10 V)	V2 side	AI side	Either	0
When PTC function used	C1 side	PTC side	Either	1 or 2

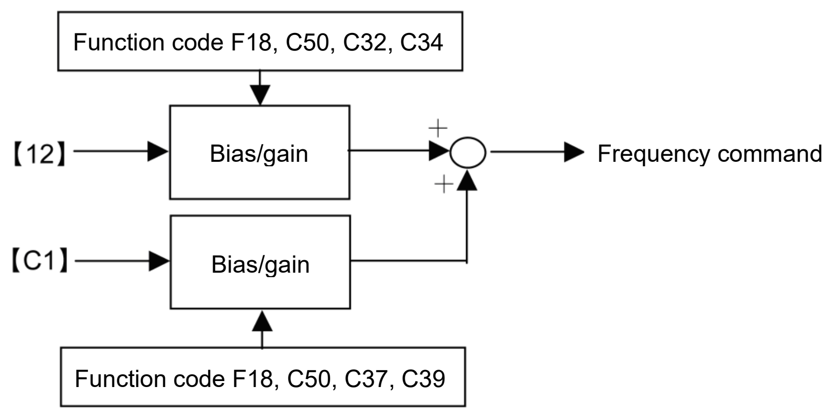
For details on SW3 and SW4, refer to Chapter 2 “2.2.7 Switching switches.”

Please note that the inverter may make unexpected frequency settings if the above switching settings are not made correctly.

■ **Gain, bias**

Terminal	<Frequency setting 1: F01>	<Frequency setting 2: C30>
[12]		
[C1] (C1 function)		
[C1] (V2 function)		

Note For [12] + [C1] (C1 function) (setting by the result of addition), bias and gain are reflected to [12] and [C1] (C1 function) individually, and added by frequency command value of the result.



If unipolar (terminal [12] (C35 = 1), terminal [C1] (V2 function) (C45 = 1), terminal [C1] (C1 function) (C40 = 0, 1))

For reference frequency and analog input of Frequency setting 1, it is possible to set arbitrary relationship by A point (determined by bias (F18) and bias reference point (C50)) and point B (determined by the gain corresponding to each analog input and the gain reference point (C32 and C34, C37 and C39, C42 and C44)).

For reference frequency and analog input of Frequency setting 2 (C30), it is possible to set arbitrary relationship by point A (determined by bias and bias reference point (C55 and C56, C61 and C62, C67 and C68) and point B (determined by the gain corresponding to each analog input and the gain reference point (C32 and C34, C37 and C39, C42 and C44).

Both data of bias and gain are set with 100% as the maximum output frequency. The data of bias reference point and gain reference point are set up with full scale of analog input (10 V or 20 mA) as 100%.

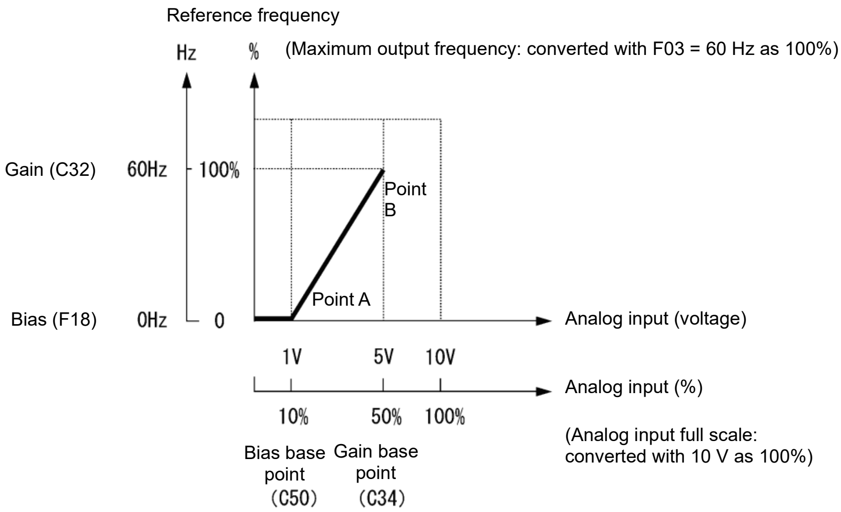
Note <Frequency setting 1: F01>

- Analog input at or below bias reference point (C50) is restricted by bias value (F18).
- When the value set in bias reference point (C50) ≥ each gain reference point (C34, C39, C44), it is judged as incorrect setting and reference point becomes 0 Hz.

<Frequency setting 2: C30>

- Analog input at or below bias reference point (C56, C62, C68) is restricted by bias value (C55, C61, and C67).
- When the value set in bias reference point (C56, C62, C68) ≥ each gain reference point (C34, C39, C44), it is judged as incorrect setting and reference point becomes 0 Hz.

Example) When setting reference frequency to 0 to 60 Hz by analog input (terminal [12]) 1 to 5 V
(When maximum output frequency is F03 = 60 Hz)



(Point A)

In order to set reference frequency to 0 Hz when analog input is 1 V, set bias (F18) to 0%. At this point, 1 V has to become the bias reference point and 1 V is equivalent to 10% against full scale 10 V of terminal [12], therefore, set the bias reference point (C50) to 10%.

(Point B)

In order to set reference frequency so that the frequency becomes the highest when analog input is 5 V, set the gain (C32) to 100%. At this point, 5 V has to become the gain reference point and 5 V is equivalent to 50% against full scale 10 V of terminal [12], therefore, set the gain reference point (C34) to 50%.

Note The setting method without changing reference point and by using gain and bias individually is the same as for Fuji's 11-series inverter.

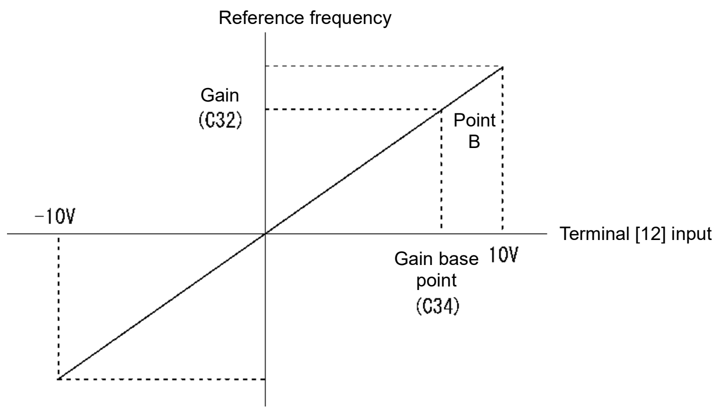
FUNCTION CODES
Chap 5

FUNCTION
F Codes
E Codes
C Codes
P Codes
H Codes
A Codes
b Codes
r Codes
J Codes
d Codes
U Codes
y Codes
K Codes

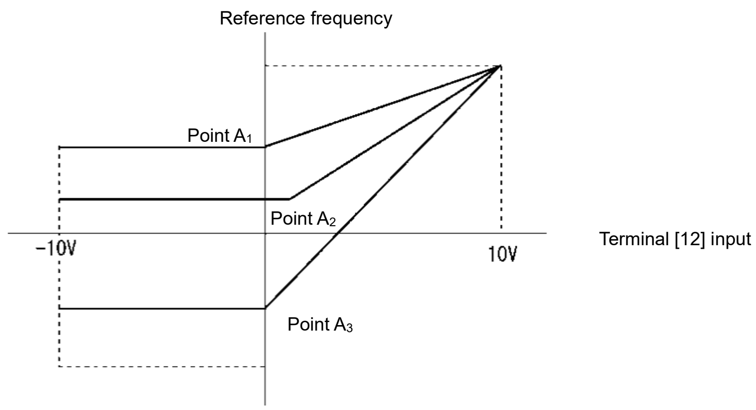
For bipolar (Terminal [12] (C35 = 0)

For terminal [12], by setting function codes C35 to “0,” it is possible to use bipolar input (-10 to +10 V).

When both bias (F18) and bias reference point (C50) are set to “0,” command becomes forward and reverse symmetric as shown in the diagram below.



Note • When bias (F18) and bias reference point (C50) are set to arbitrary value (A1 point, A2 point, and A3 point, etc.), as shown in the diagram below, it is determined by the bias value (F18).



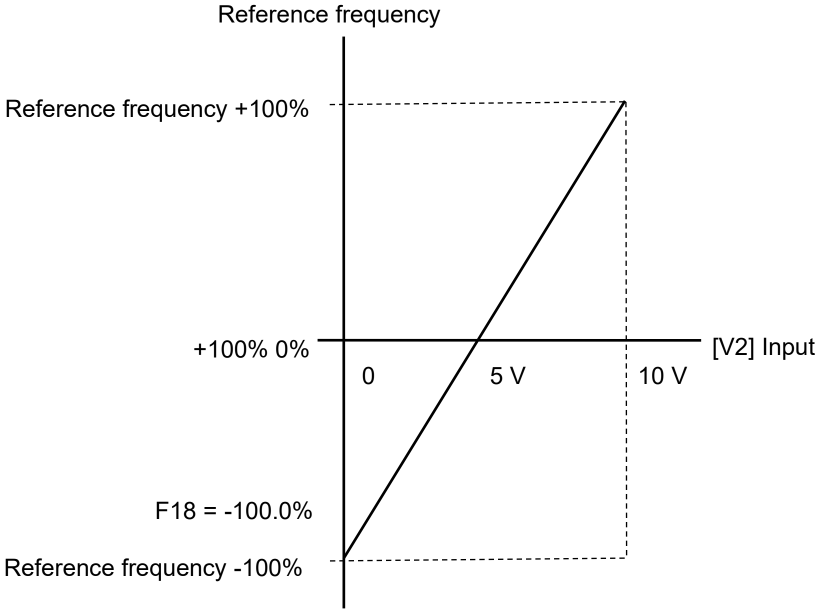
Note

- To input bipolar (0 to ±10 VDC) analog voltage by analog input, set function codes C35 to “0”. When the C35 data is “1”, only 0 to +10 VDC effective and negative polar input 0 to -10 VDC regarded as 0 (Zero) V.
- When setting reference frequency by display other than frequency (Hz), please change the speed monitor unit in E48.

When operating unipolar analog input as bipolar
(Terminal [12] (C35 = 0), Terminal [C1] (V2 function) (C45 = 0), Terminal [C1] (C1 function) (C40 = 10, 11))

By setting the bias value to a minus value, it is possible to obtain a negative reference frequency.

Example of frequency setting with terminal [C1] (V2 function) when -100% is set to the bias value is shown in the diagram below.



[3] Frequency setting by digital input signal “UP”/“DOWN” (F01=7)

As frequency setting, UP/DOWN control is selected, and when the terminal command UP or DOWN is turned on with Run command ON, the output frequency increases or decreases accordingly, within the range from 0 Hz to the maximum output frequency.

To perform frequency setting by UP/DOWN control, it is necessary to set the data of function code F01 to “7” and assign “UP command [UP], down command [DOWN]” to the digital input terminals. (Function code E01 to E05 data = 17, 18)

Input signal “UP”	Input signal "DOWN"	Tuning
Data = 17	Data = 18	
OFF	OFF	The output frequency will be held
ON	OFF	Increase output frequency by currently selected acceleration time
OFF	ON	Decrease output frequency by currently selected deceleration time
ON	ON	The output frequency will be held

■ UP/DOWN control initial value selection

In addition to the reference frequency initial value when starting control, select the following operations.

<table>
<tr><th>H61 data</th><th>Initial value of frequency setting when starting UP/DOWN control</th><th>UP/DOWN slope</th><th>UP/DOWN operation while the inverter is stopped</th></tr>
<tr><td>0</td><td>Mode to fix to "0" [Compatible with previous models]
When resuming operation (including when power turned ON), the initial value for the setting frequency with UP/DOWN control is cleared to "0."
Increase the speed with the UP command.</td><td rowspan="2">UP/DOWN based on selected acceleration/deceleration time</td><td>Not possible
(fixed at 0)</td></tr>
<tr><td>1</td><td>This is the mode to set reference frequency at the previous UP/DOWN control as the initial value. [Compatible with previous models]
The inverter internally holds the output frequency set by UP/DOWN control and starts to control from the previous operation frequency at the next restart (including powering ON).
The value in the memory is cleared by turning ON digital input UP/DOWN frequency clear command "STZ."
(Function code E01 to E05 data = 58)</td><td>Not possible
(previous value held)</td></tr>
<tr><td>2</td><td>Mode used to fix to "0"
When resuming operation (including when power turned ON), the initial value for the setting frequency with UP/DOWN control is cleared to "0."
Increase the speed with the UP command.</td><td rowspan="2">UP/DOWN based on the following slope that is not dependent on acceleration/ deceleration time

By turning ON UP or DOWN, the slope changes by 0.1%, and when continuously ON, the UP/DOWN operation is performed at change rate of 0.1%/0.1 s or 1%/0.1 s.
100% indicates the maximum output frequency.
This operation is the same as UP/DOWN control for PID commands.
(Function code J02 data = 3)</td><td>Not possible
(fixed at 0)</td></tr>
<tr><td>3</td><td>Mode used to set reference frequency operated with previous UP/DOWN command to initial value
The reference frequency can be increased or decreased with the UP/DOWN command, regardless of the inverter operating status, and control is started from the reference frequency at that point when operation is resumed (incl. when power turned ON).
The value in the memory is cleared by turning ON digital input UP/DOWN frequency clear command "STZ."
(Function code E01 to E05 data = 58)</td><td>Allowed</td></tr>
</table>

＜Initial value of UP/DOWN control when switching the setting method of frequency setting＞

The initial value when setting method of frequency setting is set to UP/DOWN control is shown in the following table.

Setting method prior to switching	Switching signal	Initial value of UP/DOWN control	
		H61 = 0,2	H61 = 1,3
Setting other than UP/DOWN (F01, C30)	Frequency setting 2/ Frequency setting 1	Reference frequency by setting method prior to switching	
PID control	PID Cancel	Reference frequency by PID control (PID output)	
Multistep frequency	Multistep frequency selection	Reference frequency by setting method prior to switching	Reference frequency by previous UP/DOWN control
Communication	Link operation selection		

＜UP/DOWN control extended function selection (H62)＞

If UP/DOWN control is not selected for frequency setting 1 or 2 (F01 ≠ 7 and C30 ≠ 7), and H61 = 3, by setting H62, the UP/DOWN control value can be assigned to the auxiliary frequency setting and torque command, etc., in the same way as that for the analog input terminal extension function selection (E61).

For details on operation, refer to the description of function code E61.
(However, setting value 5 cannot be selected.)

[4] Frequency setting using digital I/O (option DI interface card) (F01 = 11)

The frequency setting with binary (8, 12 bits) or BCD code via option DI/O interface card (OPC-DI) is also available to be selected. For details, refer to the Digital Input Output Interface Card Instruction Manual.

[5] Frequency setting using pulse string input (F01 = 12)

■ **Selecting the pulse string input format (d59)**

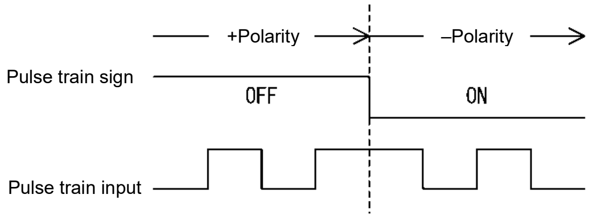
By inputting serial pulses to PG interface card (OPC-CP-PG, OPC-CP-PG3) or to inverter control circuit terminal [X5], a frequency proportional to the pulse frequency can be set. Specify the pulse string input method with d59. The pulse string sign/pulse string input, the forward rotation pulse/reverse rotation pulse, and the A and B phases with 90-degree phase difference (B phase lead, A phase lead) can all be input. If the inverter is equipped with a dual system PG interface card or with a PG interface card for PMSMs with sensor, the pulse string input function is disabled with terminal [X5].

With PG interface cards equipped with dual system pulse input, the pulse string input terminal can be switched between PG interface card terminal [YA] and [YB], allowing the frequency to be set with the “PG input switching “PG-SEL”” signal assigned to the digital input terminal.

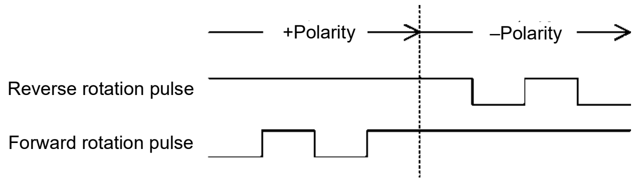
For details on “PG-SEL,” refer to function codes E01 to E05 (data = 83).

The table below lists pulse string formats and their operations.

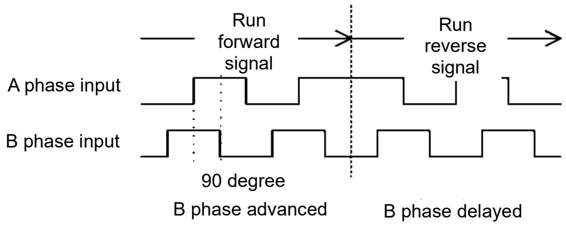
Selecting the pulse string input format d59 data	Operation overview	PG interface card terminals	Terminal [X5]
0: Pulse string sign/ Pulse string input	The speed command is given to the inverter unit based on the pulse string input frequency, and the speed command polarity can be set with a pulse string sign.	[XA]: - polarity when ON + polarity when OFF [XB]: Pulse string	Input the pulse string by assigning “PIN” (E05 = 48) to terminal [X5]. The polarity will be positive when OFF, and negative when ON by assigning “SIGN” (E01 to 04 = 49) to other than terminal [X5]. The polarity will be positive if “SIGN” is not assigned.
1: Forward and reverse pulse	Frequency/speed command according to the pulse string rate is given to the inverter. The forward rotation pulse gives a frequency/speed command with positive polarity, and a reverse rotation pulse, with negative polarity.	[XA]: Reverse rotation pulse [XB]: Forward rotation pulse	-
2: A, B phase 90° phase difference (B phase lead forward rotation)	Pulse strings generated by A and B phases with 90-degree phase difference give a frequency/speed command to the inverter based on their pulse rate and the phase difference (B phase advanced).	[XA]: A phase pulse [XB]: B phase pulse	-
3: A, B phase 90° phase difference (A phase lead forward rotation)			



Data 0: Pulse train sign/pulse train input



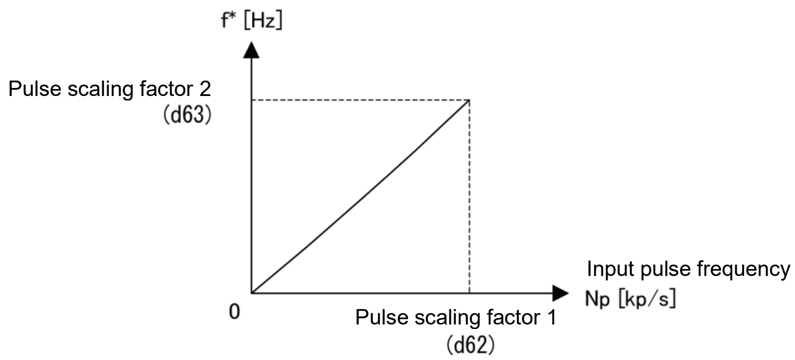
Data 1: Forward pulse/reverse pulse



Data 2: A, B phase 90° phase difference (B phase lead)

■ Pulse scaling factor 1 (d62), pulse scaling factor 2 (d63)

For pulse string input, set the relationship between input pulse frequency and frequency setting value by function code d62 (Command (pulse string input) pulse scaling factor 1) and d63 (Command (pulse string input) pulse scaling factor 2).



Relationship between input pulse frequency and frequency setting value

As shown in the above diagram, set input pulse frequency [kp/s] with function code d62 (Command (pulse string input) pulse scaling factor 1) and set frequency setting value [Hz] (when the input pulse frequency becomes the value set to function code d62) with function code d63 (Command (pulse string input) pulse scaling factor 2). At this time, the relationship formula of input pulse frequency to be entered and frequency setting value f* (or speed command value) is as follows:

$$f^* \text{ [Hz]} = \text{Np [kp/s]} \times \frac{\text{Pulse scaling factor 2 (d63)}}{\text{Pulse scaling factor 1 (d62)}}$$

f^* [Hz]: Frequency setting value

Np [kp/s]: Input pulse frequency to be input

In the case of an A- or B-phase 90° phase difference, the frequency is not a value multiplied by 4.

Depending on the pulse string sign, polarity of the command is determined. Rotation direction of the motor is determined by the polarity of pulse string input and “FWD” or “REV” command. Relationship between pulse string input polarity and rotation direction is shown in the following table.

Relationship between pulse string input polarity and rotation direction

Polarity according to the pulse string input	Run command	Rotational direction
+	“FWD” (Forward rotation command)	Forward
+	“REV” (Reverse rotation command)	Reverse rotation
-	“FWD” (Forward rotation command)	Reverse rotation
-	“REV” (Reverse rotation command)	Forward

■ **Filter time constant (d61)**

Set filter time constant for pulse string input. The larger the time constant, the slower the response. Specify the proper filter time constant taking into account the response speed of the machine (load). If the pulse is lower and frequency command fluctuates, set larger time constant.

■ **Switching frequency setting**

Switch Frequency setting 1 (F01) and Frequency setting 2 (C30) by the signal “Frequency setting 2/Frequency setting 1” “Hz2/ Hz1,” which was assigned to the external digital input terminal.

(For details on “Hz2/Hz1,” refer to Function code E01 to E05 (Data = 11).

Input signal “Hz2/ Hz1”	Frequency setting method to be selected
OFF	Frequency setting 1 (F01)
ON	Frequency setting 2 (C30)

F02 Operation method

Select the operation command setting method. Indicate instruction method of run/stop and rotation direction (forward/reverse rotation) for each setting method.

F02 data	Operation command setting method	
	Run/stop	Rotation direction command
0: Keypad operation (Rotation direction input: Terminal block)	RUN/STOP keys	"FWD," "REV"
1: External digital input signal	"FWD," "REV," "DIR," "HLD"	
2: Keypad operation (forward rotation)	RUN/STOP keys	Rotation direction command is unnecessary (Forward rotation operation only, reverse rotation operation disabled)
3: Keypad operation (reverse rotation)	RUN/STOP keys	Rotation direction command is unnecessary (Reverse rotation operation only, forward rotation operation disabled)

Digital input signals "FWD," "REV" need to be assigned to terminals [FWD], [REV].
(📖 Function code E98, E99 data = 98, 99)

Note
- F02 cannot be changed when "FWD" or "REV" is ON.
- If F02 = 1 and when assignment of terminal [FWD] or [REV] is changed from other function to "FWD" function or "REV" function, turn the terminal [FWD] and [REV] off in advance (motor may rotate due to change in the setting).

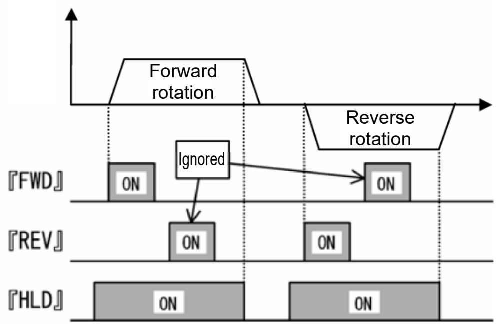
■ Forward rotation/reverse rotation selection "DIR"

Only when F02 = 1 external signal, it is possible to change the run command direction with the "forward rotation/reverse rotation "DIR"" signal assigned to the digital input terminal.

Input signal "DIR"	"FWD"	"REV"	Run command direction
OFF	ON	OFF	Forward
ON	ON	OFF	Reverse rotation
OFF	OFF	ON	Reverse rotation
ON	OFF	ON	Forward
Either	ON	ON	Stop command

■ Self-hold selection "HLD"

Self-hold can be applied to "FWD" and "REV" with the "Self-hold selection "HLD"" signal assigned to the digital input terminal. When "HLD" is ON, the inverter self-holds the "FWD" or "REV" signal, and when OFF, the hold state is released.

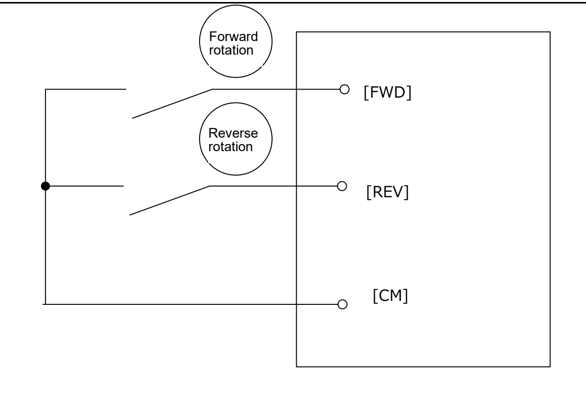


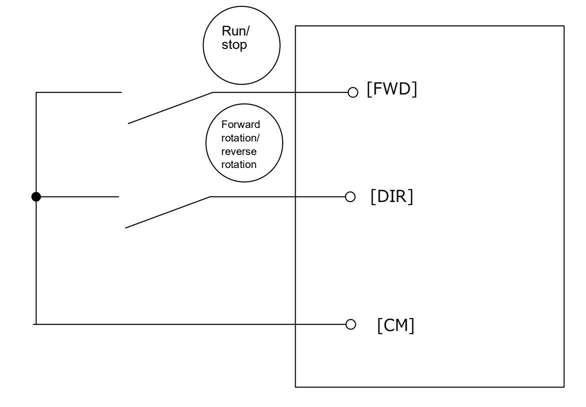
Chap 5 FUNCTION CODES

FUNCTION
F Codes
E Codes
C Codes
P Codes
H Codes
A Codes
b Codes
r Codes
J Codes
d Codes
U Codes
y Codes
K Codes

■ 2-wire operation

Two types of 2-wire operation can be configured regardless of whether “DIR” is used.

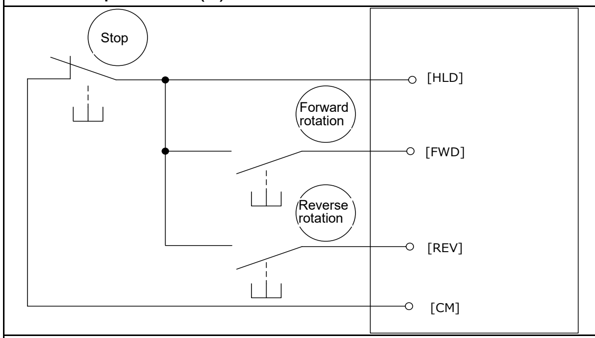
<table>
<tr><td>2-wire operation (1)</td><td>2-wire operation (2)</td></tr>
<tr><td>


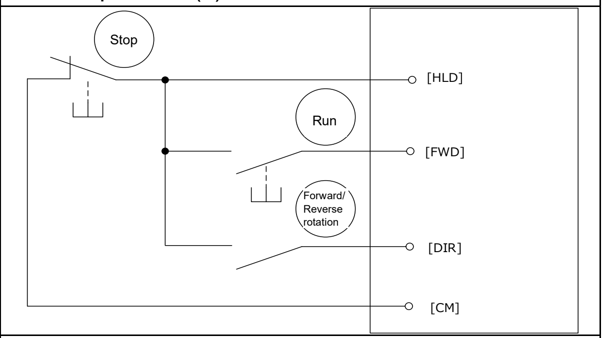
</td><td>


</td></tr>
<tr><td>Forward rotation/stop: [FWD]
Reverse rotation/stop: [REV]</td><td>Run/stop: [FWD]
Forward rotation/reverse rotation: [DIR]</td></tr>
</table>

■ 3-wire operation

Two types of 3-wire operation can be configured regardless of whether “HLD” or “DIR” are used.

<table>
<tr><td>3-wire operation (1)</td><td>3-wire operation (2)</td></tr>
<tr><td>


</td><td>


</td></tr>
<tr><td>Forward rotation: [FWD]
Reverse rotation: [REV]
Stop: [HLD]</td><td>Run: [FWD]
Forward rotation/reverse rotation: [DIR]
Stop: [HLD]</td></tr>
</table>

For details on “HLD,” refer to Function code E01 to E05 (data = 6).

In addition to these settings, run commands can be set using high priority setting methods (remote/local switching, communication, etc.) For details, refer to the block diagram in Chapter 8 “8.3.2 Operation Command Section.”

F03	Maximum output frequency 1

F03 specifies the maximum output frequency that the inverter outputs. When the device to be driven is set to its rated value or higher, the device may be damaged. Make sure to adjust to design specification values of the machinery.

- Data setting range: 5.0 to 599.0 (Hz)

Control method	Maximum setting range	Remarks
V/f control (incl. dynamic torque vector control, V/f control with sensor)	599.0 Hz	Speed sensor upper limit: 100 kHz
Vector control with sensor (induction motors, permanent magnet synchronous motors (PMSM))	599.0 Hz	Speed sensor upper limit: 100 kHz
Sensorless vector control (induction motors, permanent magnet synchronous motors (PMSM))	599.0 Hz	

The speed sensor pulse frequency is limited to 100 kHz or less, and therefore it is not possible to output frequencies higher than this.

⚠WARNING

Inverter high-speed operation settings can be specified easily. If settings are changed, use the product after sufficiently checking the motor and machine specification.

Failure to observe this could result in injury or damage.

Note When changing maximum output frequency (F03) in order to make the operation frequency a larger value, change the frequency limiter (upper limit) (F15) as well.

F04, F05 F06	Base frequency 1, rated base frequency voltage 1 Maximum output voltage 1 Related function code: H50, H51 Non-linear V/f 1 (Frequency, Voltage) H52, H53 Non-linear V/f 2 (Frequency, Voltage) H65, H66 Non-linear V/f 3 (Frequency, Voltage)

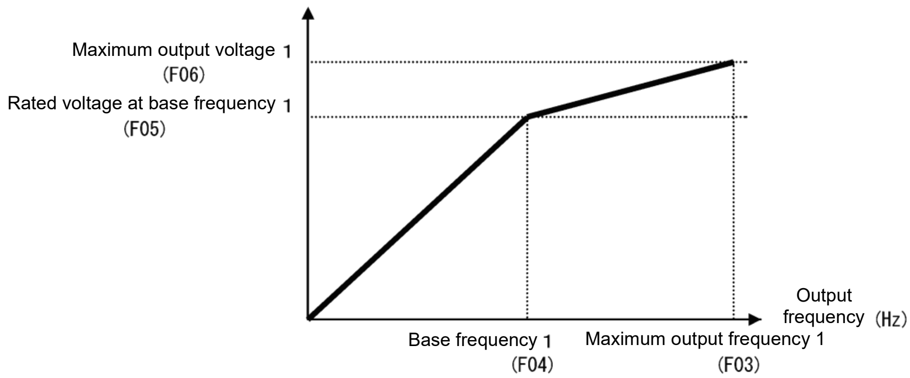
Set the base frequency and base frequency voltage that are essential to operation of the motor. By combining related function codes H50 to H53, H65, and H66, it is possible to set non-linear V/f pattern (weak or strong voltage by arbitrary point) and perform setting of V/f characteristics that is suitable for the load.

Impedance of the motor becomes larger with high frequency, and when output voltage becomes less, output torque may be reduced. In order to prevent this, increase the voltage at high frequency by setting function code F06 (maximum output voltage 1). However, it is not possible to output voltage at or higher than the input power voltage of the inverter.

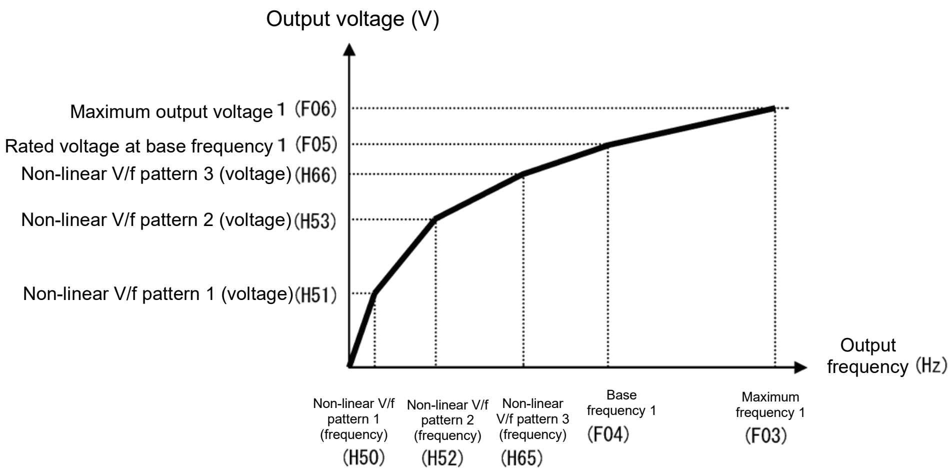
V/f point	Function codes		Remarks
	Frequency	Voltage	
Maximum output frequency	F03	F06	Enabled only when V/f control selected (F42 = 0 and F37 = 0, 1)
Base frequency	F04	F05	
Non-linear V/f 3	H65	H66	Enabled only when V/f control selected (F42 = 0 and F37 = 0, 1)
Non-linear V/f 2	H52	H53	
Non-linear V/f 1	H50	H51	

<Setting example>

■ **Normal V/f pattern setting**



■ **Non-linear V/f pattern setting (3 points)**



■ Base frequency (F04)

Set the data in accordance with rated frequency of the motor (given on the nameplate of the motor).

- Data setting range 5.0 to 599.0 (Hz)

■ Rated base frequency voltage (F05)

Set the data to “0” in accordance with rated voltage of the motor (given on the nameplate of the motor).

- Data setting range 0 : AVR disable
  80 to 240 (V) : AVR operation (at 200V series)
  160 to 500 (V) : AVR operation (at 400V series)
- When data is set to “0,” the base frequency voltage becomes equivalent to inverter input voltage. When input voltage fluctuates, output voltage fluctuates as well (no AVR operation).
- When data is set to arbitrary voltage other than “0,” automatically keeps the output voltage constant (AVR operation). When control function such as auto torque boost, auto energy-saving operation, and slip compensation is used, it is necessary to adjust to the rated voltage (given on the nameplate of the motor) of the motor.

Note The voltage that the inverter can output is lower than the input voltage of the inverter. Set the voltage appropriately based on the motor.

With vector control, current feedback control is performed. Current feedback control is used to control the current based on the difference between the motor induced voltage and the inverter output voltage. Consequently, if the inverter output voltage is not set to ensure that a higher voltage than the motor induced voltage is output, it will not be possible to perform control correctly. Generally speaking, the voltage difference is 20 V for the 200 V series, and 40 V for the 400 V series. The voltage that the inverter can output is equivalent to the input voltage of the inverter. Set the voltage appropriately based on the motor. If using a general-purpose motor to perform sensorless vector control, set the rated voltage for base frequency voltage 1 (F05). The above voltage difference is set with an induced voltage coefficient for vector control (P56). (Generally speaking, the initial value may be used.)

■ Non-linear V/f 1, 2, 3 (Frequency) (H50, H52, H65)

Set frequency at the arbitrary point of non-linear V/f pattern.

- Data setting range: 0.0 (Cancel), 0.1 to 599.00 (Hz)

Note When 0.0 is set, the setting becomes the pattern without using non-linear V/f pattern.

■ Non-linear V/f 1, 2, 3 (Voltage) (H51, H53, H66)

Set voltage at the arbitrary point of non-linear V/f pattern.

- Data setting range 0 to 240 (V) : AVR operation (at 200V series)
  0 to 500 (V) : AVR operation (at 400V series)

■ Maximum output voltage 1 (F06)

Set the voltage at maximum output frequency 1 (F03).

- Data setting range 80 to 240 (V) : AVR operation (at 200V series)
  160 to 500 (V) : AVR operation (at 400V series)

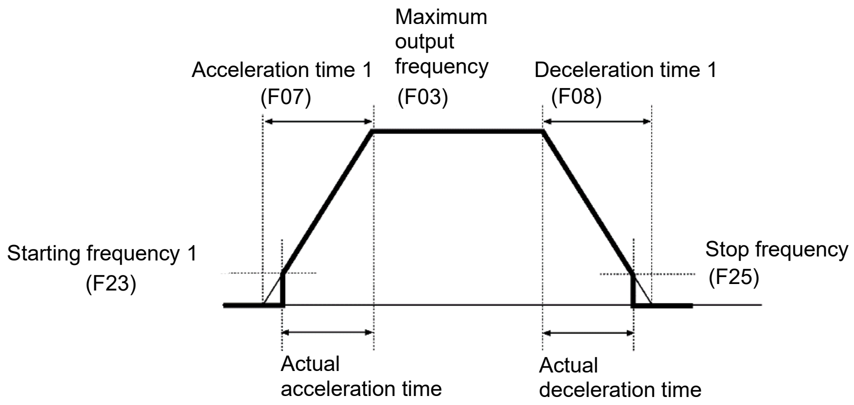
Note When rated voltage at base frequency (F05) is “0,” the data of non-linear V/f (H50 to H53, H65, and H66) and F06 becomes invalid (linear V/f for at or below base frequency, and constant voltage for at or higher than base frequency).

F07, F08	**Acceleration time 1, Deceleration time 1** **Related function code: E10, E12, E14 Acceleration time 2, 3, 4** **E11, E13, E15 Deceleration time 2, 3, 4** **H07 Curvilinear acceleration/deceleration** **H11 Deceleration mode** **H56 Deceleration time for forced stop** **H54 and H55 Acceleration/Deceleration time (Jogging operation)** **H57 to H60 1, 2 S-curve acceleration/deceleration range** **E61 to E63 Analog input (Extension function selection)** **d86 Acceleration/deceleration output filter**

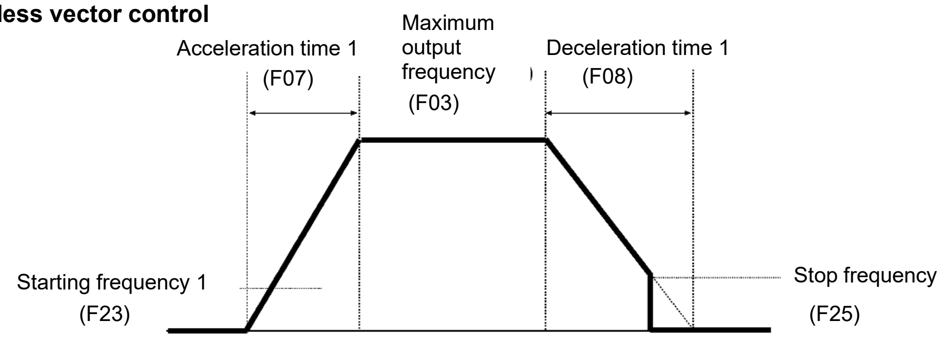
Acceleration time sets the time taken by the output frequency to reach the maximum output frequency from 0 Hz, and deceleration time sets the time taken by the output frequency to reach 0 Hz from the maximum frequency.

- Data setting range: 0.00 to 6000 (s)

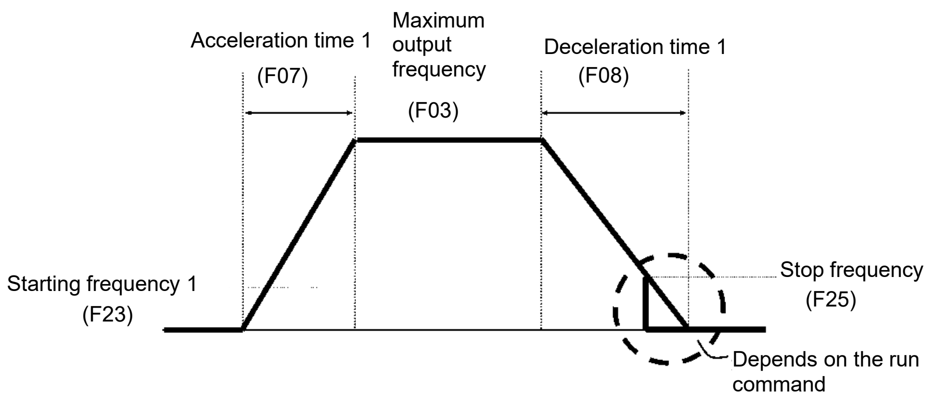
V/f control



Speed sensorless vector control



Vector control with speed sensor



■ Acceleration/deceleration time

Type of acceleration/deceleration time	Function codes: Acceleration time	Function codes: Deceleration time	Select ACC/DEC time (📖 Function codes E01 to E05): "RT2"	"RT1"	
ACC/DEC time 1	F07	F08	OFF	OFF	Changes are made with acceleration/deceleration selection "RT1" and "RT2" (data = 4, 5). When there is no assignment, acceleration/deceleration time 1 (F07, F08) is valid.
ACC/DEC time 2	E10	E11	OFF	ON	
ACC/DEC time 3	E12	E13	ON	OFF	
ACC/DEC time 4	E14	E15	ON	ON	
When performing jogging	H54	H55	When ready for jogging "JOG" is ON, switch to the mode with which jogging operation is possible (data = 10) (📖 function code C20).		
When performing forced stop	—	H56	forced stop "STOP" or "STOP-T" command OFF causes the motor to decelerate to a stop in accordance with the deceleration time for forced stop (H56). After the motor stops, the inverter enters the alarm state with the alarm er6 displayed (data = 30).		

Tip If function code H11 (Deceleration mode) is set to Coast to stop (= 1) when a run command is turned OFF, the motor coasts to a stop.

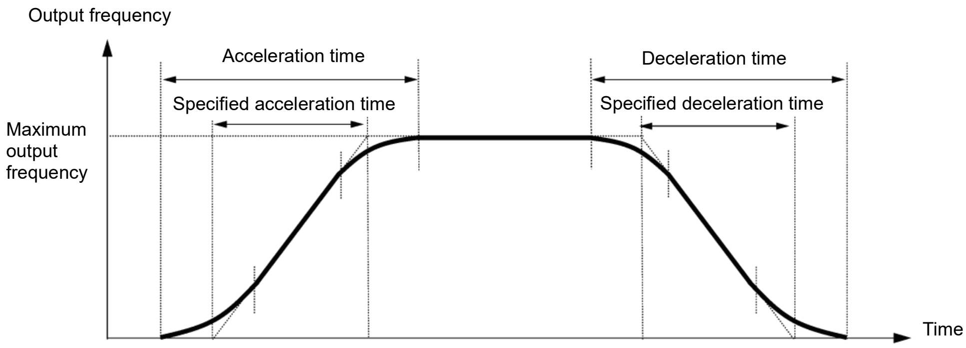
■ Curvilinear acceleration/deceleration (H07)

Select acceleration/deceleration pattern (change pattern of frequency) at acceleration/deceleration.

H07 Data	Curve acceleration/ deceleration	Operation		Function codes
0	Disable (Linear acceleration/deceleration)	Acceleration/deceleration with constant acceleration		—
1	S-curve acceleration/deceleration (Weak)	Smooth the speed change and reduce shock when starting acceleration and right before the speed becomes constant, as well as when starting deceleration and right before the deceleration stops.	Weak: Fix acceleration/deceleration change rate to 5% of the maximum output frequency within each S-curve range.	—
2	S-curve acceleration/deceleration (Arbitrary)		Arbitrary: It is possible to set acceleration/deceleration change rate arbitrarily within each S-curve range.	H57, H58 H59, H60
3	Curve acceleration/ deceleration	Linear acceleration/deceleration (constant torque) at or below base frequency and acceleration becomes gradually slower at or higher than the base frequency, and acceleration/deceleration with constant load rate (rated output). It is possible to accelerate/decelerate with the maximum capability.		—

S-curve acceleration/deceleration

For the purpose of decreasing the shock on the load machine, smooth the speed change at the start of acceleration and right before it becomes constant speed, and at the start of deceleration and right before the stop of deceleration. As for S-curve acceleration/deceleration values, fix with 5% for S-curve acceleration/deceleration (weak), and for S-curve acceleration/deceleration (arbitrary), it is possible to set individually for each 4 locations by function codes H57 to H60. The specified acceleration/deceleration time determines acceleration of linear part, and the actual acceleration/deceleration time becomes longer than the specified acceleration /deceleration time.



	At the start of acceleration	At the end of acceleration	At the start of deceleration	At the end of deceleration
S-curve (weak)	5%	5%	5%	5%
S-curve (arbitrary) Setting range: 0 to 100%	H57 During acceleration No. 1 S-curve range (when starting)	H58 During acceleration No. 2 S-curve range (when finished)	H59 During deceleration No. 1 S-curve range (when starting)	H60 During deceleration No. 2 S-curve range (when finished)

Acceleration/deceleration time

<S-curve acceleration/deceleration (weak): When frequency change is more than 10% of maximum output frequency>

$$\text{Acceleration or deceleration time (s)} = \left(2 \times \frac{5}{100} + \frac{90}{100} + 2 \times \frac{5}{100}\right) \times \text{reference acceleration or deceleration time}$$

$$= 1.1 \times \text{reference acceleration or deceleration time}$$

<S-curve acceleration/deceleration (optional: 10% at start, 20% at end): When frequency change is more than 30% of maximum output frequency>

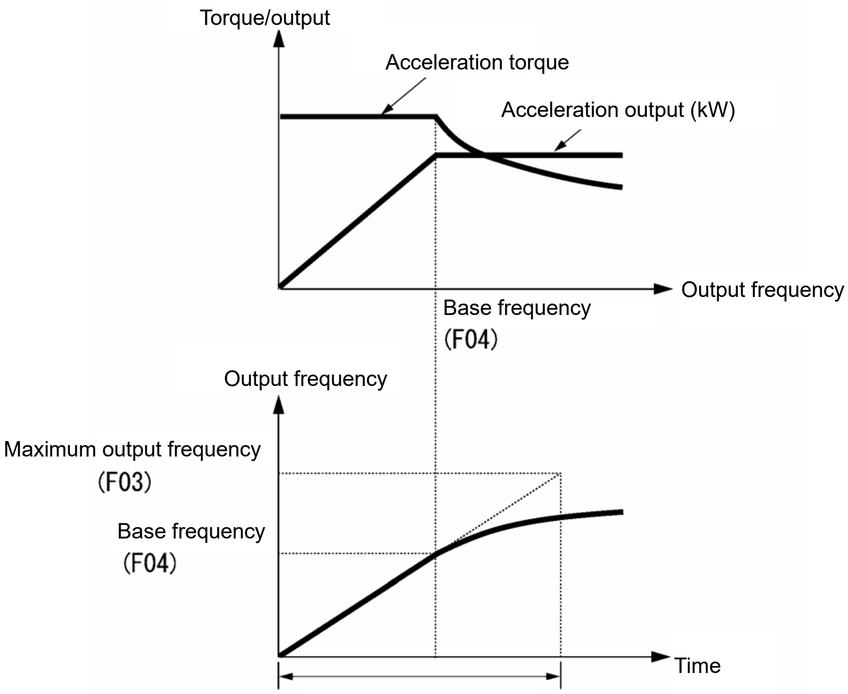
$$\text{Acceleration or deceleration time (s)} = \left(2 \times \frac{10}{100} + \frac{70}{100} + 2 \times \frac{20}{100}\right) \times \text{reference acceleration ordeceleration time}$$

$$= 1.3 \times \text{reference acceleration or deceleration time}$$

Curve acceleration/deceleration

This is a pattern to perform linear acceleration/deceleration (rated torque) at or below base frequency while acceleration becomes gradually slower at or higher than the base frequency, and acceleration/deceleration occurs with constant load rate (rated output).

It is possible to accelerate/decelerate with the maximum capability of the motor to be driven by the inverter.



The diagram on the left shows pattern at acceleration.
This is the same as at deceleration.

Note

- When S-curve acceleration/deceleration and curve acceleration/deceleration is selected by curve acceleration/deceleration H07, the actual acceleration/deceleration time becomes longer than the set value.
- If acceleration/deceleration time is set shorter than necessary, current limiting function, torque limit or anti-regenerative function may operate and acceleration/deceleration time may become longer than the set value.

■ **Acceleration/deceleration output filter (d86) (dedicated setting for V/f control)**

Sets the primary delay filter time constant for outputting the output frequency ramp function when accelerating and decelerating. Specify this setting if mechanical problems arise due to overshoot or undershoot when reaching the target frequency or when stopping. By setting a large value, the rate of output frequency change stabilizes, but responsiveness deteriorates.

This setting is effective only under V/f control (F42 = 0 to 2). If performing other than V/f control (F42 = 0 to 2), use a speed control speed command filter (d01, A43, b43, r43).

• Data setting range: 0.000 (filter disabled): 0.001 to 5.000 (s)

FUNCTION CODES
Chap 5
FUNCTION
F Codes
E Codes
C Codes
P Codes
H Codes
A Codes
b Codes
r Codes
J Codes
d Codes
U Codes
y Codes
K Codes

■ **Acceleration/deceleration time ratio setting with analog input (E61 to E63)**

By setting “12: Acceleration/deceleration time ratio” for analog input terminal [12], [C1] (C1 function) (V2 function), the applicable analog input (0 to 100%) is multiplied by the selected acceleration/deceleration time in real time to set the acceleration/deceleration time ratio. This is also valid for S-curve acceleration/deceleration and curve acceleration/deceleration. This setting is reflected immediately even during acceleration and deceleration. The data range is limited to positive polarity, and the negative side is recognized as 0. This setting is not reflected when performing jogging operation or when performing a forced stop.

F09	**Torque boost 1** **(Refer to F37)**

For details of torque boost 1 setting, refer to the section of function code F37.

F10 to F12	**Electronic thermal 1 (Motor protection) (Select motor characteristics, operation level, thermal time constant)**

Sets the motor temperature characteristics (characteristic selection (F10), thermal time constant (F12)) and the operation level (F11) for motor overload detection (electronic thermal overload relay function based on inverter output current).

If a motor overload is detected, the inverter is shut off to protect the motor, and motor overload alarm OL1 occurs.

Note If the electronic thermal overload relay function is set incorrectly, the motor will not be protected, and may burn out.

Note Motor temperature characteristics are used for motor overload early warning “OL” as well. Even if only overload early warning is used, it is necessary to set temperature characteristics of the motor (F10, F12) (Function code E34)

For disabling motor overload alarm, set F11 = 0.00 (Disable).

Note For PTC thermistor built-in motor, by connecting PTC thermistor to terminal [C1], it is possible to protect the motor. By doing so, set F11 = 0.00 A (Disable) to use. For details, refer to H26.

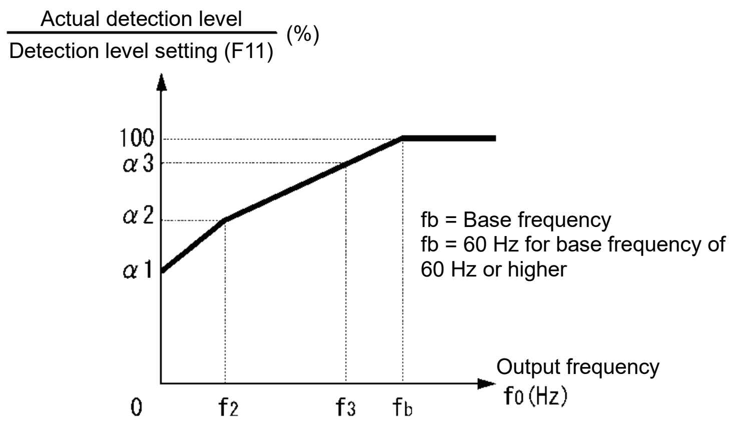
■ Select motor characteristics (F10)

F10 selects characteristics of cooling system of the motor.

F10 data	Function
1	Self-cooling fan of general-purpose motor (Self-cooling) (When operating with low frequency, cooling performance decreases.)
2	Inverter-driven motor, High-speed motor with separately powered cooling fan (Keep constant cooling capability irrespective to output frequency)

The electronic thermal operation characteristics diagram when F10 = 1 is set is shown below. The characteristics coefficient α1 to α3 and the switch coefficient f2, f3 differ depending on the characteristics of the motor.

Each coefficient that is set by motor characteristics that is selected by motor capacitance and motor selection (P99) is shown in the tables.



Characteristics diagram of motor cooling system

When P99 = 0, 4, or 5 (motor characteristics 0, other, motor characteristics 5)

<table>
<tr><th rowspan="2">Motor capacity</th><th rowspan="2">Thermal time constant τ</th><th rowspan="2">Thermal time constant setting Standard current value Imax</th><th colspan="2">Characteristics coefficient switch frequency</th><th colspan="3">Characteristics coefficient</th></tr>
<tr><th>f2</th><th>f3</th><th>α1</th><th>α2</th><th>α3</th></tr>
<tr><td>0.1 to 0.75 (kW)</td><td rowspan="5">5 min</td><td rowspan="8">Continuous allowance current value x 150%</td><td rowspan="5">5 Hz</td><td rowspan="2">7 Hz</td><td>75%</td><td>85%</td><td>100%</td></tr>
<tr><td>1.5 to 3.7 kW</td><td>85%</td><td>85%</td><td>100%</td></tr>
<tr><td>5.5 to 11 kW</td><td>6 Hz</td><td>90%</td><td>95%</td><td>100%</td></tr>
<tr><td>15 kW</td><td>7 Hz</td><td>85%</td><td>85%</td><td>100%</td></tr>
<tr><td>18.5, 22 kW</td><td>5 Hz</td><td>92%</td><td>100%</td><td>100%</td></tr>
<tr><td>30 to 45 kW</td><td rowspan="3">10 min</td><td rowspan="3">Base frequency x 33%</td><td rowspan="3">Base frequency x 83%</td><td>54%</td><td>85%</td><td>95%</td></tr>
<tr><td>55 to 90 kW</td><td>51%</td><td>95%</td><td>95%</td></tr>
<tr><td>110 kW or more</td><td>53%</td><td>85%</td><td>90%</td></tr>
</table>

When P99 = 1 or 3 (motor characteristic 1, 3)

Motor capacity	Thermal time constant τ	Thermal time constant setting Standard current value Imax	Characteristics coefficient switch frequency		Characteristics coefficient		
			f_2	f_3	α1	α2	α3
0.1 to 22 kW	5 min	Continuous allowance current value x 150%	Base frequency x 33%	Base frequency x 33%	69%	90%	90%
30 to 45 kW	10 min			Base frequency x 83%	54%	85%	95%
55 to 90 kW					51%	95%	95%
110 kW or more					53%	85%	90%

When F10=2 is set, cooling effect by output frequency will not decrease, therefore overload detection level becomes constant value (F11) without decrease.

If P99 = 20, 21, 22, or 23 (PMSM)

Motor capacity	Thermal time constant τ	Thermal time constant setting Standard current value Imax	Characteristics coefficient switch frequency		Characteristics coefficient		
			f_2	f_3	α1	α2	α3
90 kW or lower	5 min	Continuous allowance current value x 150%	Base frequency F04 x 33%	Base frequency F04 x 83%	53%	85%	95%
110 kW or more	10 min				53%	85%	90%

■ **Operation level (F11)**

F11 sets operation level of electronic thermal.

Normally, set the motor continuous allowance current (in general, about 1.0 to 1.1 times of motor rated current) when operating at base frequency in ampere units.

For disabling electronic thermal as disable, set F11 = 0.00: Disable.

■ **Thermal time constant (F12)**

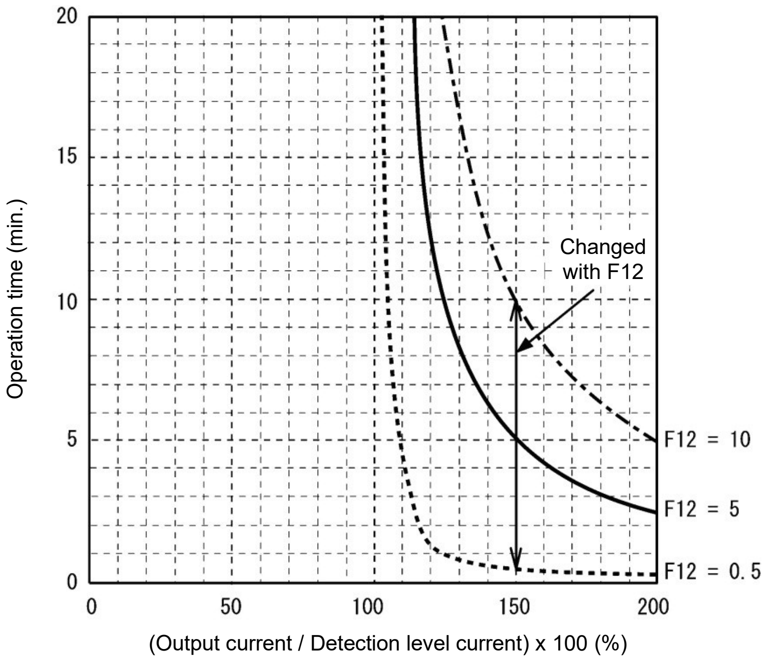
F12 sets thermal time constant of the motor. For overload detection level that is set by F11, set the electronic thermal operation time when 150% of current is flowing continuously. Thermal time constant of general-purpose motor of Fuji Electric and other general motors is 5 minutes for 22 kW or lower, and 10 minutes for 30kW or higher.

• Data setting range: 0.5 to 75.0 (min)

(Example) When the data of function code F12 is set to "5" (5 minutes).

As shown in the figure below, when 150% of current of operation level that was set flows for 5 minutes, motor overload (alarm OL1) protection function will operate. In addition, with 120%, it operates after 12.5 minutes.

The time when alarm actually occurs is shorter than the set data because the time until the current reaches 150% level after exceeding the continuous allowance current (100%) is considered.



Example of current-operation time characteristics

F14	**Momentary power failure restart (Operation selection)** **Related function code:** **H13 Momentary power failure restart (Waiting time)** **H14 Momentary power failure restart (Frequency fall rate)** **H15 Momentary power failure restart (Continued operation level)** **H16 Momentary power failure restart (Allowable momentary power failure time)** **H92 Continued operation (P)** **H93 Continued operation (I)**

Sets the operation (trip operation or restart operation method, etc. following power restoration) when a momentary power failure occurs.

■ **Momentary power failure restart (Operation selection) (F14)**

V/f control (F42 = 0, 1, 2), sensorless vector control (motor) (F42 = 5)

<table>
<tr><th rowspan="2">F14 data</th><th colspan="2">Operation details</th></tr>
<tr><th>Without auto search</th><th>With auto search</th></tr>
<tr><td>0: Trip immediately</td><td colspan="2">When momentary power failure occurs while operating the inverter, and at the time when undervoltage is detected by the DC link bus voltage of the inverter, undervoltage alarm IV is outputted, the inverter output shuts down, and the motor coasts to a stop.</td></tr>
<tr><td>1: Trip after a recovery from power failure</td><td colspan="2">When momentary power failure occurs while operating the inverter, and at the time when undervoltage is detected by the DC link bus voltage of the inverter, the inverter output shuts down and the motor coasts to stop, but the undervoltage alarm will not be output.
When auto-started from momentary power failure, undervoltage alarm IV is output.</td></tr>
<tr><td>2: Trip after momentary deceleration is stopped</td><td colspan="2">As soon as the DC link bus voltage drops below the continuous running level due to a momentary power failure, decelerate-to-stop control is invoked.
Decelerate-to-stop control regenerates kinetic energy from the load's moment of inertia, slowing down the motor and continuing the deceleration operation.
After decelerate-to-stop operation, an undervoltage alarm IV is issued.</td></tr>
<tr><td rowspan="3">3: Continue to run (for heavy inertia load or general load)</td><td colspan="2">As soon as the DC link bus voltage drops below the continuous running level due to a momentary power failure, decelerate-to-stop control is invoked.
Decelerate-to-stop control regenerates kinetic energy from the load's moment of inertia, slowing down the motor, and operation is continued to wait for auto-restarting.
If there is not enough energy for regeneration and when undervoltage is detected, the inverter output shuts down and the motor coasts to a stop.</td></tr>
<tr><td>If run command is entered at auto-restarting, restart from the frequency of when undervoltage is detected.</td><td>If run command is entered at auto-restarting, auto search is performed, motor speed is estimated, and restart from the frequency.</td></tr>
<tr><td colspan="2">This setting is most suited to applications such as large fans with large load moment of inertia.</td></tr>
<tr><td rowspan="3">4: Restart from frequency at power failure (for general loads)</td><td colspan="2">When momentary power failure occurs while operating the inverter, and at the time when undervoltage is detected by the DC link bus voltage of the inverter, the inverter output shuts down, and the motor coasts to a stop.</td></tr>
<tr><td>If run command is entered at auto-restarting, restart from the frequency of when undervoltage is detected.</td><td>If run command is entered at auto-restarting, auto search is performed, motor speed is estimated, and restart from the frequency.</td></tr>
<tr><td colspan="2">This setting is most suitable for cases where the load moment of inertia is large, and the motor speed drop is minimal even when the motor coasts to a stop following a momentary power failure (fans, etc.)</td></tr>
</table>

<table>
<tr><td rowspan="3">5: Restart from starting frequency</td><td colspan="2">When momentary power failure occurs while operating the inverter, and at the time when undervoltage is detected by the DC link bus voltage of the inverter, the inverter output shuts down, and the motor coasts to a stop.</td></tr>
<tr><td>If run command is entered at auto-restarting, restart from the starting frequency that was set by function code F23.</td><td>If run command is entered at auto-restarting, auto search is performed, motor speed is estimated, and restart from the frequency.</td></tr>
<tr><td colspan="2">This setting is most suitable for the case (pump etc.) when load inertia moment is small, when the load is heavy, and motor speed decreases up to 0 in a short time after the motor coasts to a stop due to momentary power failure.</td></tr>
<tr><td colspan="3">With auto search: Auto search is selected by starting mode selection “STM” ON or H09 (d67) = 1 or 2.
For details of starting mode selection “STM” ON auto search, refer to function code H09 and d67 (Starting characteristics).</td></tr>
</table>

⚠WARNING

When momentary power failure restart operation (F14 = 3 to 5) is selected, operation will resume automatically at auto-restarting. Design machines in such a way as to ensure operator safety even when operation is resumed.

Failure to observe this could result in an accident.

Sensorless vector control (PMSM) (F42 = 15)

F14 data	Operation details
0: Trip immediately	When momentary power failure occurs while operating the inverter, and at the time when undervoltage is detected by the DC link bus voltage of the inverter, undervoltage alarm LU is outputted, the inverter output shuts down, and the motor coasts to a stop.
1: Trip after a recovery from power failure	When momentary power failure occurs while operating the inverter, and at the time when undervoltage is detected by the DC link bus voltage of the inverter, the inverter output shuts down and the motor coasts to stop, but the undervoltage alarm will not be output. When auto-started from momentary power failure, undervoltage alarm LU is output.
2: Trip after momentary deceleration is stopped	As soon as the DC link bus voltage drops below the continuous running level due to a momentary power failure, decelerate-to-stop control is invoked. Decelerate-to-stop control regenerates kinetic energy from the load's moment of inertia, slowing down the motor and continuing the deceleration operation. After decelerate-to-stop operation, an undervoltage alarm LU is issued.
3: Continue to run (for heavy inertia load or general load)	As soon as the DC link bus voltage drops below the continuous running level due to a momentary power failure, decelerate-to-stop control is invoked. Decelerate-to-stop control regenerates kinetic energy from the load's moment of inertia, slowing down the motor, and operation is continued while waiting for auto-restarting. If there is not enough energy for regeneration and when undervoltage is detected, the inverter output shuts down and the motor coasts to a stop. If run command is entered at auto-restarting, auto search is performed, motor speed is estimated, and the inverter restarts from that frequency. This setting is most suited to applications such as large fans with large load moment of inertia.
4: Restart from frequency at power failure (for general loads) 5: Restart from starting frequency	The operation is the same for either F14 = 4 or 5. When momentary power failure occurs while operating the inverter, and at the time when undervoltage is detected by the DC link bus voltage of the inverter, the inverter output shuts down, and the motor coasts to a stop. If run command is entered at auto-restarting, auto search is performed, motor speed is estimated, and restart from the frequency.

V/f control with sensor (F42 = 3), Dynamic torque vector control with sensor (F42 = 4)
Vector control with sensor (F42 = 6, 16)

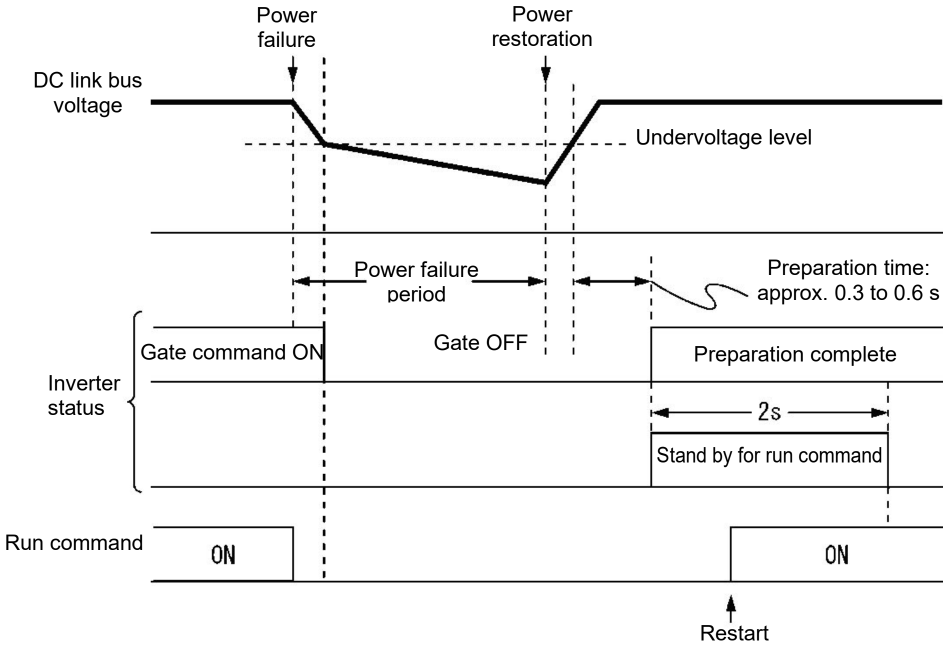
F14 data	Operation details
0: Trip immediately	When momentary power failure occurs while operating the inverter, and at the time when undervoltage is detected by the DC link bus voltage of the inverter, undervoltage alarm LU is outputted, the inverter output shuts down, and the motor coasts to a stop.
1: Trip after a recovery from power failure	When momentary power failure occurs while operating the inverter, and at the time when undervoltage is detected by the DC link bus voltage of the inverter, the inverter output shuts down and the motor coasts to stop, but the undervoltage alarm will not be output. When auto-started from momentary power failure, undervoltage alarm LU is output.
2: Trip after momentary deceleration is stopped	As soon as the DC link bus voltage drops below the continuous running level due to a momentary power failure, decelerate-to-stop control is invoked. Decelerate-to-stop control regenerates kinetic energy from the load's moment of inertia, slowing down the motor and continuing the deceleration operation. After decelerate-to-stop operation, an undervoltage alarm LU is issued.
3: Continue to run	As soon as the DC link bus voltage drops below the continuous running level due to a momentary power failure, decelerate-to-stop control is invoked. Decelerate-to-stop control regenerates kinetic energy from the load's moment of inertia, slowing down the motor, and operation is continued while waiting for auto-restarting. If there is not enough energy for regeneration and when undervoltage is detected, the inverter output shuts down and the motor coasts to a stop. If run command is entered at recovery from power failure, the motor restarts from the motor speed detected with the sensor.
4: Restart from frequency at power failure 5: Restart from starting frequency	The operation is the same for either F14 = 4 or 5. When momentary power failure occurs while operating the inverter, and at the time when undervoltage is detected by the DC link bus voltage of the inverter, the inverter output shuts down, and the motor coasts to a stop. If run command is entered at recovery from power failure, restart from the motor speed detected with the speed sensor.

■ Momentary power failure restart (Basic operation: Without auto search setting)

When inverter detected that DC link bus voltage becomes at or drops below undervoltage level while operating, it is judged as a momentary power failure. When load is light and momentary power failure is very short, momentary power failure may not be detected and motor operation might be continued because DC link bus voltage does not drop so much.

When inverter judges the state as momentary power failure, it returns to momentary power failure restart mode and prepares for restart. After power is auto-restarted, the inverter is in an inverter ready to run state after elapse of initial charging time. At momentary power failure, power of external circuit (relay circuit etc.), which controls the inverter, decreases as well, and run command may be turned off. Therefore, when the inverter is in an inverter ready to run state, wait 2 seconds for input of run command. When input of run command is confirmed within 2 seconds, initiate restarting according to F14 (mode selection). When there is no input of run command at run command input waiting state, momentary power failure restart mode will be released and start from normal starting frequency. Therefore, input run command within 2 seconds after auto-restarting or hold run command by off-delay timer or mechanical latch relay.

In case of F02 = 0 (run command from keypad and rotation direction command determined by terminal), it operates in the same way as above. For rotation direction fixed mode (F02 = 2, 3), run command is held within the inverter, therefore, it restarts immediately at inverter ready to run state.



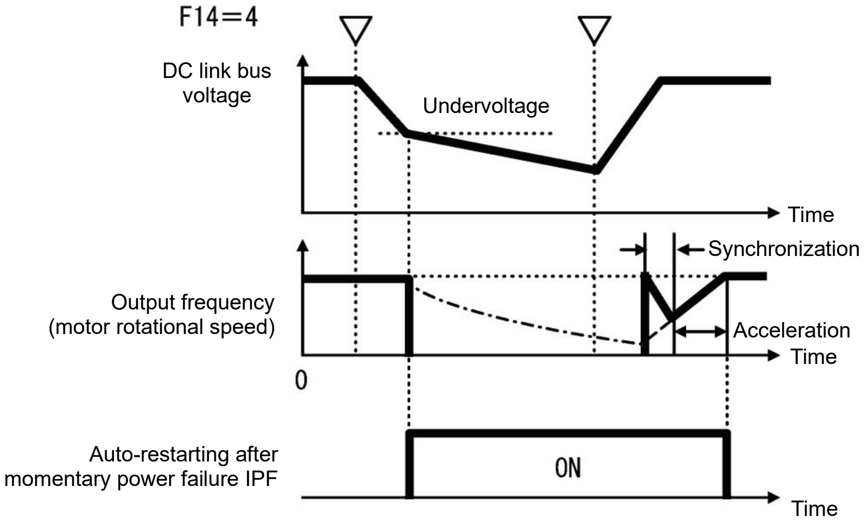
Note

- At auto-restarting, inverters waits 2 seconds for input of run command; however, if allowable momentary power failure time (H16) is elapsed after the state is judged as power failure, the state of run command input waiting for 2 seconds will be canceled and normal starting operation is performed.
- When coast-to-a-stop command "BX" is entered during power failure, momentary power failure restart waiting state is released and returned to normal run mode, and when run command is inputted, the inverter starts from normal starting frequency.
- Detection of momentary power failure within the inverter is performed by detecting DC link bus voltage drop of the inverter. With the structure in which a magnetic contactor is equipped on the output side of the inverter, there will be no operation power of the magnetic contactor at momentary power failure and the magnetic contactor is in an open state. When the magnetic contactor becomes open, connection of inverter and motor is released and load of the inverter is shutdown. Therefore, it becomes difficult to decrease DC link bus voltage of the inverter and it may not be judged as a momentary power failure. If this is the case, momentary power failure restart will not be performed normally. As a countermeasure against this case, by connecting auxiliary contact signal of the magnetic contactor to the interlock signal "IL" it is possible to detect momentary power failure without fail.

  Function code E01 to E05, data = 22

Terminal command "IL"	Meaning
OFF	No momentary power failure has occurred.
ON	A momentary power failure has occurred. (Momentary power failure restart enabled)

When motor speed decreases during momentary power failure, and when restarting from frequency of before momentary power failure after power is recovered (auto-restarting), current limiter becomes active and output frequency of the inverter decreases automatically. When output frequency and motor rotation speed synchronize, the speed is accelerated up to the original output frequency. Refer to the figure below. However, it is necessary to enable instantaneous overcurrent limiting (H12 = 1) to bring in synchronization of the motor.



• Auto-restarting after momentary power failure "IPF"

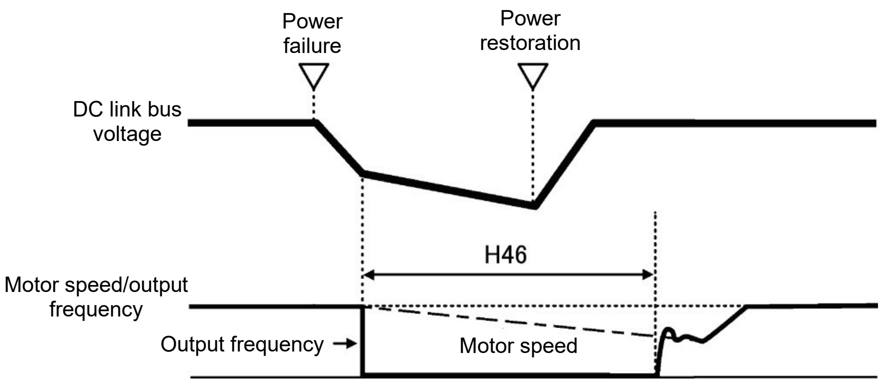
During momentary power failure auto-restarting "IPF" signal is turned on until returning to original frequency after auto-restarting after momentary power failure occurred. When "IPF": is turned ON, motor speed decreases, therefore, take necessary measures. (📖 Function code E20, E21 and E27, data = 6)

■ **Momentary power failure restart (Basic operation: With auto search setting)**

Auto search may fail if there is any motor residual voltage.

If so, it is necessary to secure the time until residual voltage runs out.

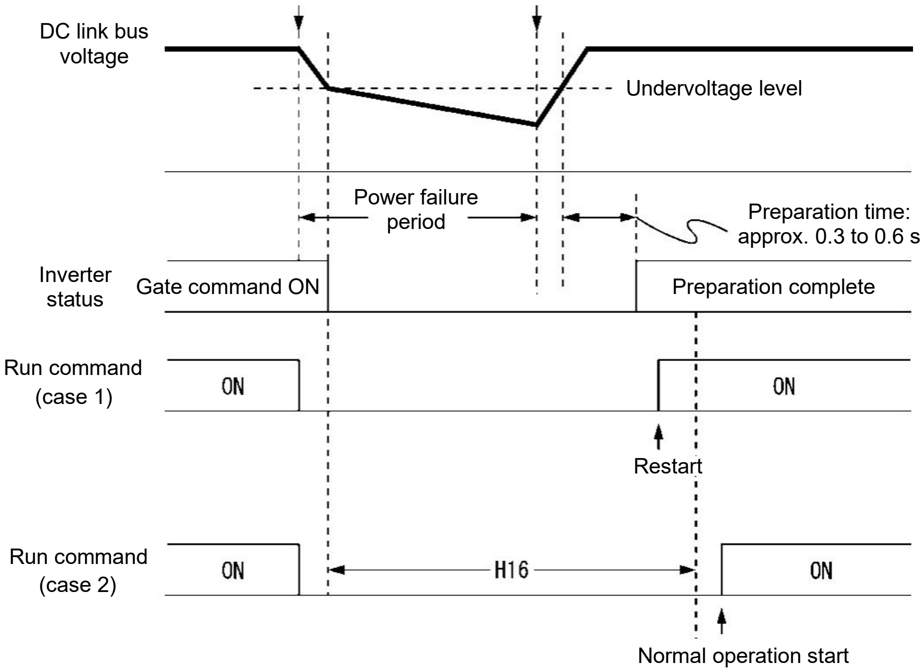
Restart mode after momentary power failure secures the necessary time with function code H46 starting mode (auto search delay time 2). Even if starting conditions are satisfied, the inverter does not start unless auto-search delay time elapses after inverter goes into OFF state. The inverter starts after elapse of auto search delay time. (📖 Function codes H09, d67)



Note
- When operating auto search, it is necessary to perform auto-tuning in advance.
- When the estimated speed exceeds the maximum output frequency or the upper limit frequency, the inverter disables auto search and starts running the motor with the maximum output frequency or the upper limit frequency, whichever is lower.
- During auto search, if an overcurrent or overvoltage trip occurs, the inverter will restart the auto search.
- Use 60 Hz or below for auto search
- Note that auto search may not fully provide the performance depending on load conditions, motor parameters, wiring length, and other external factors.
- When output circuit filter OFL-□□□-2, -4 is equipped on the output side of the inverter, auto search must be disabled. Use OFL-□□□-□A type.
- Do not set d67 to 0 if using a PMSM.

■ **Momentary power failure restart (Allowable momentary power failure time) (H16)**

Sets the maximum time from when momentary power failure (undervoltage level) occurs until restart (setting range: 0.0 to 30.0 s). Set coast to stop time which is allowable for machine and equipment. Momentary power failure restart operation should be performed within the specified time, however, if the set time is exceeded, the inverter judges the state as a power shut down, and then operates as powering on again without performing momentary power failure restart operation.



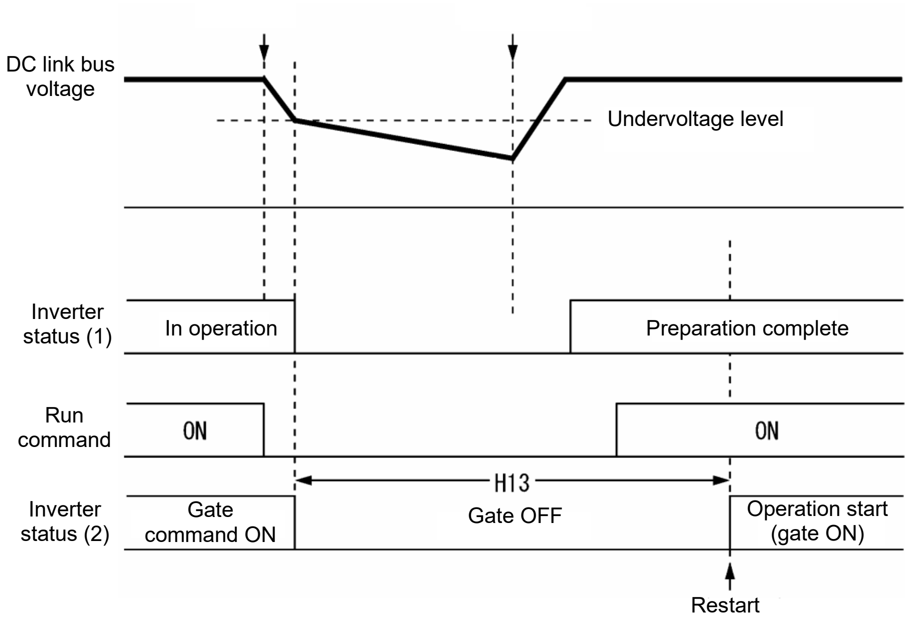
When the momentary power failure allowance time (H16) is set to "999," Momentary power failure restart is performed until the control circuit power is lost.

Chap 5 FUNCTION CODES
FUNCTION
F Codes
E Codes
C Codes
P Codes
H Codes
A Codes
b Codes
r Codes
J Codes
d Codes
U Codes
y Codes
K Codes

■ **Momentary power failure restart (Waiting time) (H13)**

Set the time until restart is performed after momentary power failure occurred. (At auto search setting, use H46 (auto search holding time 2)).

Restarting at the state when residual voltage of the motor is high, inrush current becomes greater or temporarily becomes at regeneration state, and overcurrent alarm may occur. For safety reasons, in order to restart after residual voltage is reduced to some extent, adjust H13. Even if auto-restarted, restart cannot be performed until the holding time (H13) elapses.



Factory default: At the factory default state, setting is performed so that it is appropriate to the standard motor (refer to Table 5.2-1 Factory default setting values by capacity). Basically, there is no need to modify the default setting. However, when problems occur due to the long holding time or decrease in flow rate of pump becomes significant, change to about half of the standard value and make sure that alarm etc. will not occur.

■ **Momentary power failure restart (H14) (Frequency fall rate)**

In momentary power failure restart operation, when inverter output frequency and motor rotation speed do not synchronize, overcurrent occurs and current limiter will operate. When current limit is detected, decrease of the output frequency and synchronization with the motor rotation speed are performed automatically. H14 sets the slope of lowering output frequency (frequency lowering rate in Hz/s).

H14 data	Output frequency lowering operation
0.00	Decrease by the selected deceleration time.
0.01 to 100.00 (Hz/s)	Decrease by the lowering rate that is set by H14.
999	Depending on the PI regulator of current limiting processing (PI constant is fixed value within the inverter), the rate will decrease.

Note When frequency lowering rate is increased, regeneration operation is performed at the moment when output frequency of the inverter and rotation speed of motor synchronize, and overvoltage trip may occur. When frequency lowering rate is reduced, the time until output frequency of the inverter and motor rotation speed synchronize (current limiting operation) becomes longer, and protection operation of inverter overload may be activated.

■ Momentary power failure restart (Continued operation level) (H15) Continued operation (P, I) (H92, H93)

- Trip after momentary deceleration is stopped

When trip after deceleration stopped is selected (F14 = 2), at momentary power failure restart operation (Mode selection), momentary power failure occurs while operating the inverter, and deceleration stop control starts when DC link bus voltage of the inverter becomes at or drops below the continuous running level.

Adjust voltage level of DC link bus to start deceleration stop control by H15.

Under decelerate-to-a-stop control, the inverter decelerates its output frequency keeping the DC link bus voltage constant using a PI regulator.

P (proportional) and I (integral) components of the PI regulator are specified by H92 and H93, respectively.

For normal inverter operation, it is not necessary to modify data of H15, H92 or H93.

- Continued operation

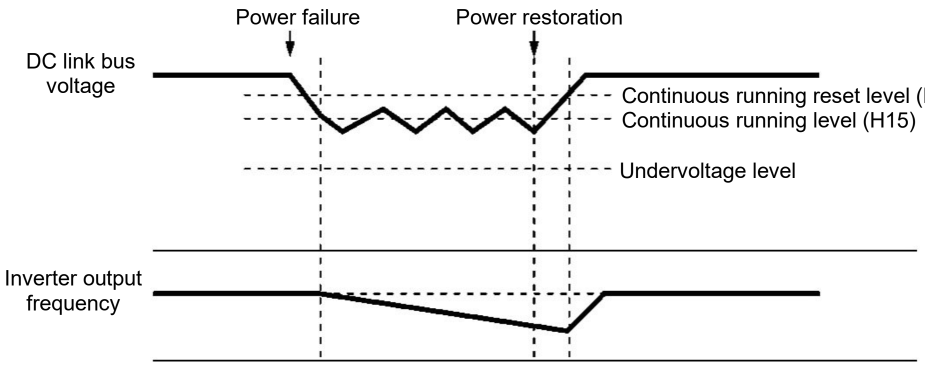
When momentary power failure restart operation (Continued operation) is selected (F14 = 3) at momentary power failure restart (operation selection), momentary power failure occurs while operating the inverter and continued operation control starts when DC link bus voltage of the inverter becomes at or drops below the continued operation level.

Adjust continued operation level to start continued operation control by H15.

Under the continued operation control, the inverter continues operation, keeping the DC link bus voltage constant using the PI regulator.

P (proportional) and I (integral) components of the PI regulator are specified by H92 and H93, respectively.

For normal inverter operation, it is not necessary to modify data of H15, H92 or H93.



Power supply voltage	α
200 V	5 V
400 V	10 V

Note: Even if “Deceleration stop control” or “Continued operation” are selected, the inverter may not be able to perform the function when the inertia of the load is small or the load is heavy, due to undervoltage caused by the control delay. In such a case, when “Deceleration stop control” is selected, the inverter allows the motor to coast to a stop; when “Continued operation” is selected, the inverter saves the output frequency being applied when the undervoltage alarm occurs and perform momentary power failure restart operation.

When the input power voltage for the inverter is high, setting the continued operation level high makes the control more stable even if the inertia of the load is relatively small. Raising the continued operation level too high, however, might cause the continued operation control activated even during normal operation.

When the input power voltage for the inverter is extremely low, continued operation control might be activated even during normal operation, at the beginning of acceleration or at an abrupt change in load. To avoid this, lower the continued operation level. Lowering it too low, however, might cause undervoltage that results from voltage drop due to the control delay.

Before you change the continued operation level, make sure that the continued operation control will be performed properly, by considering the fluctuations of the load and the input voltage.

F15, F16	Frequency limiter (Upper limit), Frequency limiter (Lower limit) Related function code: H63 Lower limit limiter (Operation selection)

■ Frequency limiter (Upper limit) (Lower limit) (F15, F16)

F15 and F16 specify the upper and lower limits of the output frequency or reference frequency, respectively.

Frequency limiter		Object to which the limit is applied
Frequency limiter (upper limit)	F15	Output frequency
Frequency limiter (lower limit)	F16	Reference frequency
Note When the limit is applied to the reference frequency, delayed responses of control may cause an overshoot or undershoot, and the frequency may temporarily go beyond the limit level.		

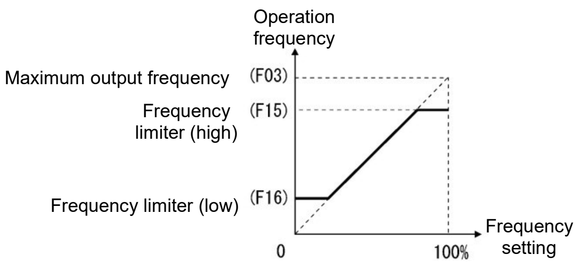
• Data setting range: 0.0 to 599.0 (Hz)

■ Lower Limit Limiter (Operation selection) (H63)

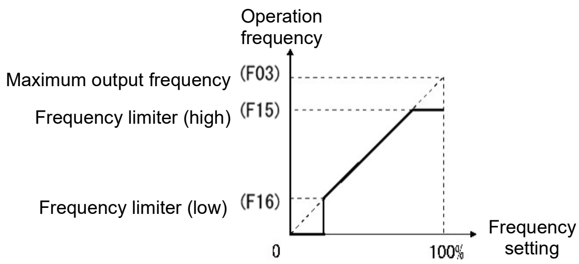
H63 specifies the operation to be carried out when the reference frequency drops below the low level specified by F16, as follows:

H63 data	Tuning
0	The output frequency will be held at the low level specified by F16.
1	Decelerate to stop

the figure below.



(For H63 = 0)



(For H63 = 1)

■ Upper/lower limit limiter with analog input (E61 to E63)

By setting analog input terminal [12], [C1] (C1 function), or [C1] (V2 function) to “13: Frequency limiter (upper limit)” or “14: Frequency limiter (lower limit)” in function code E61 to E63, the frequency obtained by multiplying the applicable analog input (0 to 100%) by the maximum output frequency in real time is used as the frequency limiter. The data range is limited to positive polarity, and the negative side is recognized as 0. The same operation is performed for both the F15 and F16 settings.

Note
- When changing the Frequency limiter (upper limit) (F15) in order to raise the operation frequency, be sure to change the maximum output frequency accordingly.
- Set each function code related to operation frequency so that the relationship among data becomes the following magnitude relationship.
  - F15>F16, F15>F23, F15>F25
  - F03>F16

  However, F23 is the starting frequency, and F25 is stop frequency

  If any wrong data is specified for these function codes, the inverter may not run the motor at the desired speed, or may not be able to start it normally.

F18	Bias (Frequency setting 1) (Refer to F01)

For details of bias (Frequency setting 1) setting, refer to the description of function code F01.

F20 to F22 **H95** **H195**	**DC braking 1 (Starting frequency, Operation level, Braking time)** **DC braking (Select motor characteristics)** **DC braking (Braking time at the startup)**

These function codes specify the DC braking that prevents motor 1 from running by inertia during decelerate-to-a-stop operation.

If the motor enters a decelerate-to-a-stop operation by turning OFF the run command or by decreasing the reference frequency below the stop frequency, the DC braking starts when output frequency reached the DC braking starting frequency. Set braking starting frequency (F20), braking level (F21), and braking time (F22) to start DC braking when deceleration is stopped.

Setting the braking time to “0.00” (F22 = 0) disables the DC braking.

By H195, it is possible to perform DC braking when starting up inverter. By doing so, it is efficient for preventing the load being lifted from falling when the brake is released, and prompts torque startup when starting up.

■ Starting frequency (F20)

F20 specifies the frequency at which the DC braking starts its operation during motor decelerate-to-a-stop state.

- Data setting range: 0.0 to 60.0 (Hz)

■ Operation level (F21)

F21 specifies the output current level to be applied when the DC braking is activated. The function code data should be set, assuming the rated output current of the inverter as 100%, in increments of 1%.

- Data setting range HHD (F80 = 0): 0 to 100%
  HND (F80 = 1): 0 to 80%
  HD (F80 = 3): 0 to 80%
  ND (F80 = 4): 0 to 60%
  HND (F80 = 4): 0 to 60% (FRN0012, 0020E3☐-2G / FRN0001 to 0012E3☐-7G only)

Note The inverter rated output current differs between the HHD/HND/HD/ND mode.

■ Braking time (F22)

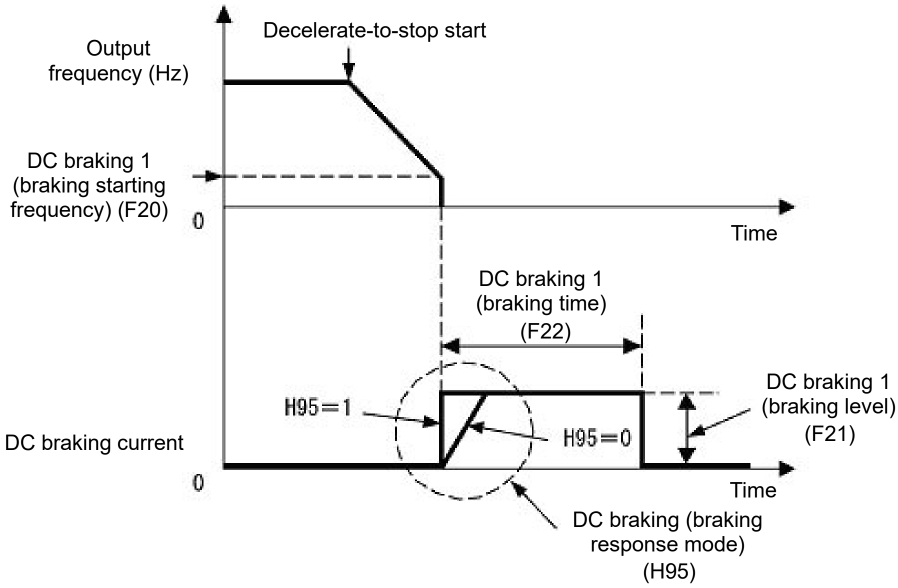
F22 specifies the braking period that activates DC braking.

- Data setting range: 0.00 (Disable), 0.01 to 30.00 (s)

■ **Select motor characteristics (H95)**

H95 specifies the DC braking characteristics.

H95 data	Characteristics	Note
0	Slow response. Slows the rising edge of the current, thereby preventing reverse rotation at the start of DC braking.	Insufficient braking torque may result at the start of DC braking.
1	Quick response. Quickens the rising edge of the current, thereby accelerating the build-up of the braking torque.	Reverse rotation may result depending on the moment of inertia of the mechanical load and the coupling mechanism.



Tip It is also possible to input DC braking command “DCBRK” by using an external digital input signal as the terminal command. As long as the “DCBRK” is ON, the inverter performs DC braking, regardless of the braking time specified by F22. (📖For details on “DCBRK,” refer to function codes E01 to E05 (data =13))

Turning the “DCBRK” ON even when the inverter is in a stopped state activates the DC braking. This feature allows the motor to be excited before starting, resulting in smoother acceleration (quicker build-up of acceleration torque) (under V/f control).

Note In general, specify data of function code F20 at a value close to the rated slip frequency of motor. If an extremely high value is set, control may become unstable and an overvoltage alarm may result in some cases.

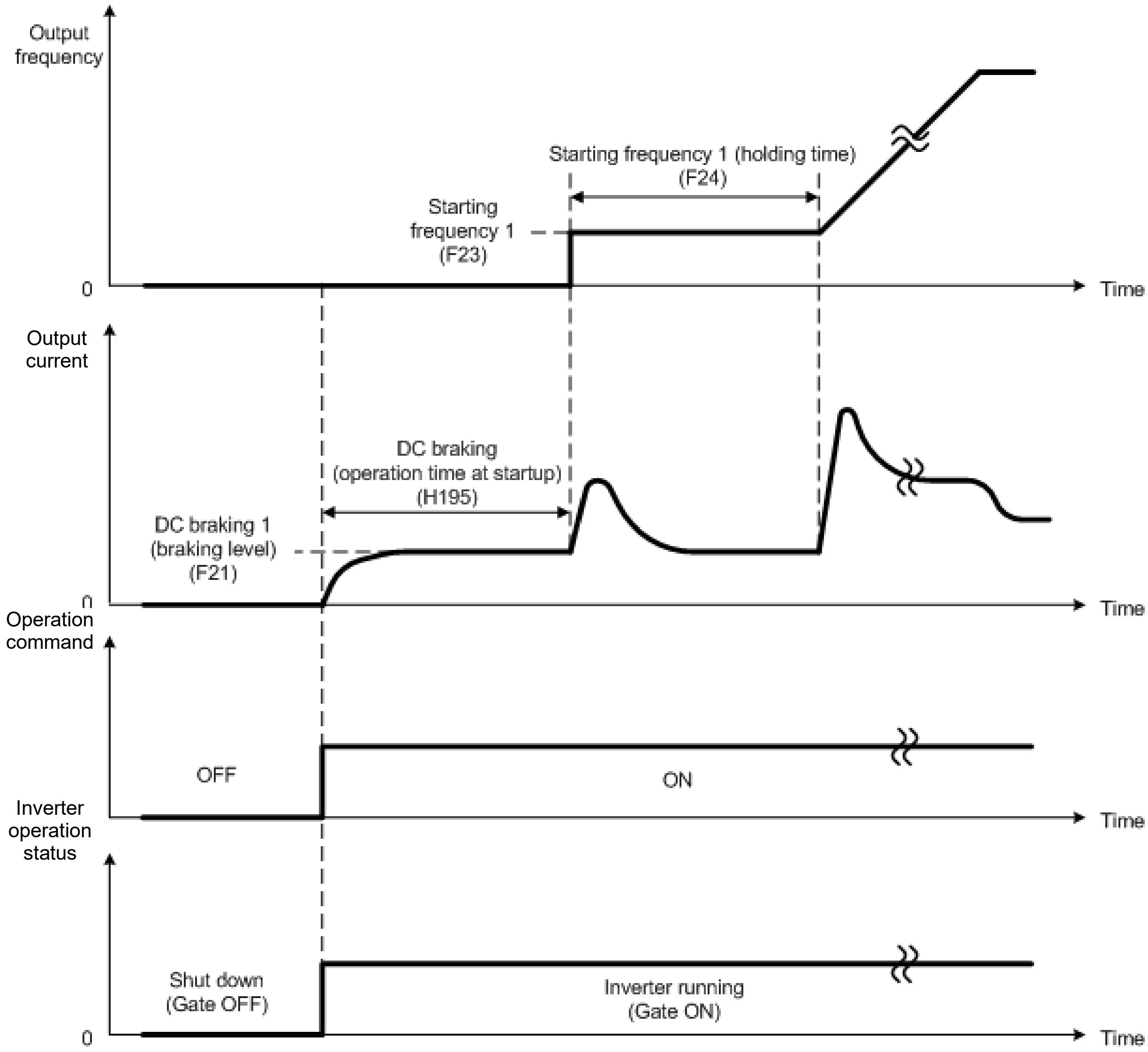
⚠CAUTION
The DC braking function of the inverter does not provide any holding mechanism. **Failure to observe this could result in injury.**

■ Braking time at the startup (H195)

When starting up inverter by run command, it is possible to start by operating DC braking.

This is particularly useful in applications such as hoists and elevators where the inverter runs at low speed braking mode after starting up, preventing loads from falling.

- Data setting range: 0.00: No DC braking at the start up 0.01 to 30.00 (s)

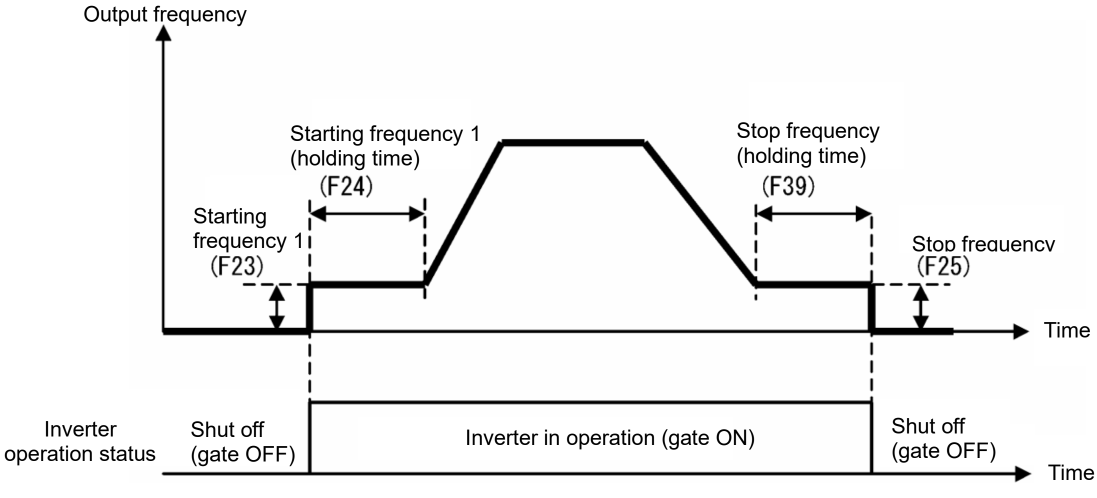


F23 to F25	Starting frequency 1, Starting frequency 1 (Holding time) and Stop frequency Related function code: F38 and F39 (Stop frequency (Detection method) and Stop frequency (Holding time)) d24 (Zero speed control)

Under V/f control

At the startup of an inverter, the initial output frequency is equal to the starting frequency. The inverter stops its output when the output frequency reaches the stop frequency. Set the starting frequency to a level at which the motor can generate enough torque for startup. Generally speaking, set the rated slip frequency of the motor as the starting frequency.

Specifying the holding time for the starting frequency compensates for the delay time for the establishment of a magnetic flux in the motor; specifying that for the stop frequency stabilizes the motor speed at the stop of the inverter.



■ Starting frequency 1 (F23)

F23 specifies the starting frequency at the startup of an inverter.

- Data setting range: 0.0 to 60.0 (Hz)
  Under V/f control, even if the start frequency is set at 0.0 Hz, the inverter starts its output at 0.1 Hz.

■ Starting frequency 1 (Holding time) (F24)

F24 specifies the holding time for the starting frequency 1.

- Data setting range: 0.00 to 10.00 (s)

■ Stop frequency (F25)

F25 specifies the stop frequency at the stop of the inverter.

- Data setting range: 0.0 to 60.0 (Hz)
  Under V/f control, even if the stop frequency is set at 0.0 Hz, the inverter stops its output at 0.1 Hz.

■ Stop frequency (Holding time) (F39)

F39 specifies the holding time for the stop frequency.

- Data setting range: 0.00 to 10.00 (s)

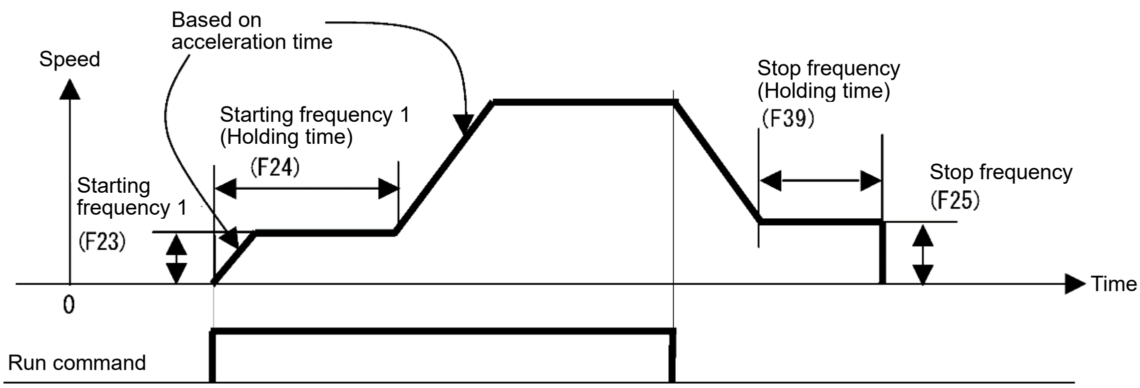
Note: If the starting frequency is lower than the stop frequency, the inverter does not output any power as long as the reference frequency does not exceed the stop frequency.

Sensorless vector control/Vector control with sensor

At the startup, the inverter first starts at the "0" speed and accelerates to the starting frequency according to the specified acceleration time. After holding the starting frequency for the specified period, the inverter again accelerates to the reference speed according to the specified acceleration time. The inverter stops its output when the reference speed or actual speed (specified by F38 under vector control with speed sensor only) reaches the stop frequency specified by F25.

Specifying the holding time for the starting frequency compensates for the delay time for the establishment of a magnetic flux in the motor; specifying that for the stop frequency stabilizes the motor speed at the stop of the inverter.

If using a configuration for which it is necessary to pull in the magnetic pole position under vector control with sensor (PMSMs), an operation different from this operation is performed. It is not possible to ensure sufficient torque when the motor starts at this time. Refer to the description for function code P30.



■ **Starting frequency 1 (F23)**

F23 specifies the starting frequency at the startup of an inverter.

- Data setting range: 0.0 to 60.0 (Hz)

■ **Starting frequency 1 (Holding time) (F24)**

F24 specifies the holding time for the starting frequency 1.

- Data setting range: 0.00 to 10.00 (s)

■ **Stop frequency (F25)**

F25 specifies the stop frequency at the stop of the inverter.

- Data setting range: 0.0 to 60.0 (Hz)

■ **Stop frequency (Holding time) (F39)**

F39 specifies the holding time for the stop frequency.

- Data setting range: 0.00 to 10.00 (s)

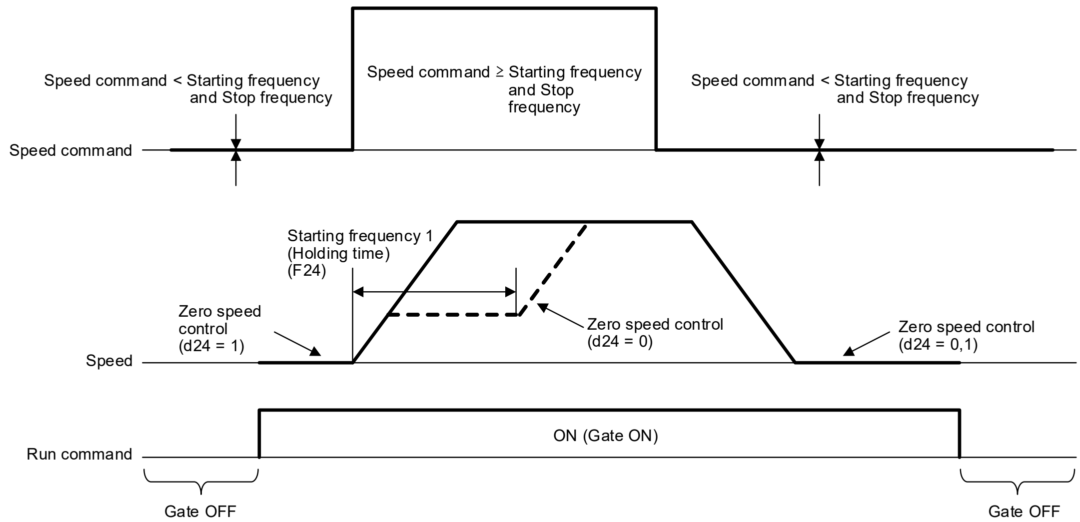
■ Zero speed control (d24) (Under vector control with sensor and sensorless vector control (induction motors only))

To perform zero speed control, it is necessary to set the speed command (frequency command) below the starting and stop frequencies. If the starting and stop frequencies are 0.0 Hz, however, zero speed control is enabled only when the speed command is 0.00 Hz. d24 specifies the operation for zero speed control when inverter starts and stops.

d24 data	Zero speed control when starting	Zero speed control at stop	Description
0	Not possible	Allowed	When it is smaller than the stop frequency and start frequency the speed command, zero speed control does not work even ON the operation command. Zero speed control to work once you have started once it is set to higher than the starting frequency the speed command.
1	Allowed	Allowed	Setting the speed command at below the starting and stop frequencies and turning a run command ON enables zero speed control.
2	Not possible	Not possible	Zero speed control is not performed either when starting or stopping, regardless of the speed command.

The table below shows the conditions for enabling and disabling zero speed control when starting.

	Speed command	Run Command	Operation		
			d24=0	d24=1	d24=2
When starting	Starting frequency/ Stop frequency Less than	OFF	Stop (Gate OFF)		
		ON	Stop (Gate OFF)	Zero speed control	Disable command (Gate OFF)
At stop	Below the stop frequency	0N	Zero speed control	Zero speed control	Disable command (Gate OFF)
		OFF	Stop (Gate OFF)		



■ **Stop frequency (Detection method) (F38) (Under vector control with sensor only)**

F38 specifies whether to use the actual speed or reference one as a decision criterion to shut down the inverter output. Usually the inverter uses the detected speed. However, if the inverter undergoes a load exceeding its capability, e.g., an excessive load, it cannot stop because the motor cannot stop so that the detected speed may not reach the stop frequency level. If this happens, the inverter will be unable to stop. By specifying a setting that allows judgment to made based on the speed command value, the command value is reached even if the detection value is not, and therefore the inverter will come to a complete stop. If such a situation could arise, select the reference speed that can reach the stop frequency level even if the detected speed does not, in order to stop the inverter without fail achieving a fail-safe operation.

- Data setting range 0: Speed detect value 1: Speed command value

F26, F27	**Motor sound (Carrier frequency, Tone)** **Related function code: H98 Protection/maintenance functions (Operation selection)**

■ **Motor sound (Carrier frequency) (F26)**

Adjusts the carrier frequency. By changing carrier frequency, it is possible to reduce an audible noise generated by the motor or electromagnetic noise from the inverter itself, and to decrease a leakage current from the main output (secondary) wiring.

Setting frequency of carrier frequency differs depending on each model overload rating (ND/HD/HND/HHD).

Item	Characteristics
Carrier frequency	Small to Large
Motor sound noise emission	High ↔ Low
Motor temperature (harmonic components)	High ↔ Low
Ripples in output current waveform	Large ↔ Small
Leakage current	Low ↔ High
Electromagnetic noise emission	Low ↔ High
Inverter loss	Low ↔ High

Setting range of carrier frequency is as follows.

F80 data	Drive mode	F26: Setting range	Type of inverter
0	HHD	0.75 to 16 kHz	All models
1	HND	0.75 to 16 kHz	FRN0001 to 0010E3□-2G / FRN0030 to 0088E3□-2G FRN0002 to 0059E3□-4G
		0.75 to 10 kHz	FRN0115E3□-2G / FRN0072E3□-4G
3	HD	0.75 to 16 kHz	FRN0002 to 0059E3□-4G
		0.75 to 10 kHz	FRN0072E3□-4G
4	ND	0.75 to 10 kHz	FRN0002 to 0059E3□-4G
		0.75 to 6 kHz	FRN0072E3□-4G
4	HND	0.75 to 10 kHz	FRN0012, 0020E3□-2G FRN0001 to 0012E3□-7G

Note

- Specifying a carrier frequency that is too low will cause the output current waveform to have a large amount of ripple (large amount of harmonic components). As a result, the motor loss increases, causing the motor temperature to rise. Furthermore, the large amount of ripple tends to cause a current limiting alarm. When the carrier frequency is set to 1 kHz or lower, therefore, reduce the load so that the inverter output current comes to be 80% or less of the rated current.

  When a high carrier frequency is specified, the temperature of the inverter may rise due to the ambient temperature rise or an increase of the load. If it happens, the inverter automatically decreases the carrier frequency to prevent the inverter overload (OLU). With consideration for motor noise, the automatic reduction of carrier frequency can be disabled. Refer to the description of H98.

  It is recommended to set the carrier frequency at 5 kHz or above under vector control with sensor. <u>DO NOT set it at 1 kHz or below.</u>

- Running a PMSM at low carrier frequency may overheat the permanent magnet due to the output current harmonics, resulting in demagnetization. When decreasing the carrier frequency setting, be sure to check the allowable carrier frequency of the motor.

  When using a Fuji standard PMSM at rated load, set the carrier frequency to 2 kHz or higher.

■ **Motor sound (Tone) (F27)**

F27 changes the motor running sound tone (only for motors under V/f control). This setting is effective when the carrier frequency specified by function code F26 is 7 kHz or lower. Changing the tone level may reduce the high and harsh running noise from the motor.

Note If the tone level is set too high, the output current may become unstable, or mechanical vibration and noise may increase. Also, this function code may not be very effective for certain types of motor.

F27 data	Function
0	Disable (Level 0)
1	Enable (Level 1)
2	Enable (Level 2)
3	Enable (Level 3)

F29 to F31, F33 to F35 F58, F59 F32, F62 to F63	Terminal [FM1] (Mode selection, Output gain, Function selection, Pulse rate, Filter, Bias) Terminal [FM2] (Mode selection, Output gain, Function selection, Filter, Bias)

These function codes allow outputting monitor data such as output frequency and output current to terminals [FM1] and [FM2] as analog DC voltage, current, and pulse ([FM1] only). In addition, voltage and current output level on terminals [FM1] and [FM2] is adjustable.

Note When switching voltage, current, and pulse, it is necessary to switch both mode selection function code and switch on the PCB.

Terminal	Mode selection	Gain	Bias	Function	Pulse rate	Filter	Switch
[FM1]	F29	F30	F59	F31	F33	F58	SW5
[FM2]	F32	F34	F63	F35	-	F62	SW7

■ **Mode selection (F29, F32)**

Select the output form for terminal [FM1] and [FM2]. Also change switches SW4 and SW6 on the PCB.

For details of the switches on the control PCB, refer to Chapter 2 "2.2.7 Switching switches."

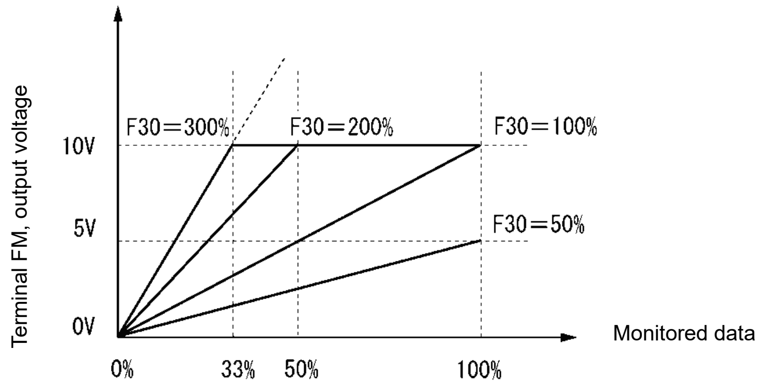
F29, F32 data	Terminal [FM1], [FM2] output form	Control PCB switch	
		[FM1]: SW5	[FM2]: SW7
0	Voltage output (0 to +10 VDC) (unipolar)	FMV	FMV2
1	Current output (4 to 20 mA DC)	FMI	FMI2
2	Current output (0 to 20 mA DC)		
3	Pulse output	FMP	-

Note The output current has the same electrical potential as analog input, and is not an isolated power supply. Therefore, if an electrical potential relationship between the inverter and peripheral equipment has been established, e.g., by connecting an analog input, the cascade connection (series connection to multiple inverters' current input) for current output cascade connections is not available.

Keep the optimum connection wire length.

■ Gain (F30, F60)

F30, and F60 allow you to adjust the output voltage and current within the range of 0 to 300%.

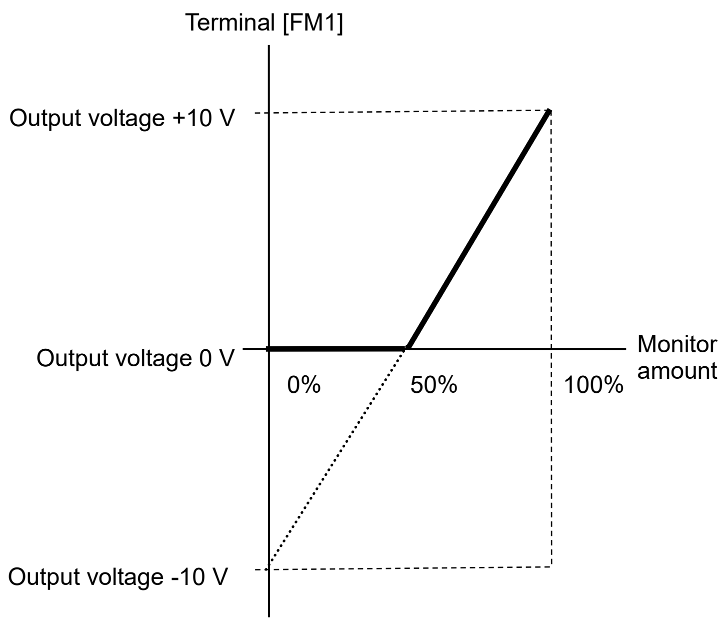


■ Bias (F59, F63)

F59 and F63 allow you to adjust the bias for the output voltage value and current value within the -100 to 0 to 100% range.
The bias is applied after multiplying the gain.

The figure below shows the effect of setting a gain of 200% and bias of -100% with unipolar voltage output of 0 to +10 V from terminal [FM1].

Note Inverters of the FRN-E3 series cannot output negative voltage.



■ **Function selection (F31, F61)**

F31 and F61 specify which data is monitored at output terminals [FM1] and [FM2]. An absolute value is output when unipolar.

F31, F61 Data	Subject of monitoring	Content	Definition of monitor amount 100%
0	Output frequency 1 (before slip compensation)	Output frequency of the inverter (Equivalent to the motor synchronous speed)	Maximum output frequency
1	Output frequency 2 (after slip compensation)	Output frequency of the inverter	Maximum output frequency
2	Output current	Output current (RMS) of the inverter	Twice the inverter rated current (Depending on F80 setting value)
3	Output voltage	Output voltage (RMS) of the inverter	200V series: 250 V 400V series: 500 V
4	Output torque	Motor shaft torque	Twice the rated motor load
5	Load rate	Motor load factor	Twice the rated motor load
6	Input power	Input power of the inverter	Twice the rated output power (Inverter rated output power depending on F80)
7	PID feedback value (PV)	Feedback value under PID control	100% of the feedback amount
8	PG feedback value (speed)	Speed detected with the PG interface, or estimated speed (under speed sensorless vector control)	Maximum speed (100% of the feedback amount)
9	DC link bus voltage	DC link bus voltage of the inverter	200V series: 500 V 400V series: 1000 V
10	Universal AO	Command via communications link (📖RS-485 Communications User's Manual)	20,000
13	Motor output	Motor output (kW)	Twice the rated motor output (P02/A16 setting value)
14	Analog output test	For analog meter calibration Full scale output	Always full scale (Equivalent to 100%) output
15	PID command (SV)	Command value under PID control	PID command 100%
16	PID output (MV)	Output level of the PID processor under PID control (Frequency command)	Maximum output frequency
17	Master-follower angle deviation	Position deviation when performing master-follower operation	Monitor amount 0% to 5% to 100% Representing a deviation of -180° to 0° to +180° respectively
18	Heat sink temperature	Heat sink detection temperature of inverter	200°C (392°F)
21	PG feedback value	Actual speed (When PG interface option card is mounted, the speed is always calculated and output regardless of the control method.)	Maximum speed as 100%
22	Torque current command	Torque current command under vector control with sensor, sensorless vector control	Twice the motor rated torque current

F31, F61 Data	Subject of monitoring	Content	Definition of monitor amount 100%
26	Reference frequency (before acceleration/deceleration calculation)	Setting frequency immediately before acceleration/deceleration arithmetic unit	Maximum output frequency 100%
111 to 124	Customizable logic Output signal 1 to 14	Enable only at analog output	100%

Note If F31 and F61 = 16 (PID output), J01 = 3 (Dancer control), and J62 = 2 or 3 (Ratio compensation enabled), the PID output is equivalent to the ratio against the primary reference frequency and may vary within 300% of the frequency. To indicate the value up to the full-scale of 300%, set F30 and F60 data to "33" (%).

■ **Filter (F58, F62)**

F58 and F62 set filter time constants for the analog DC voltage and current. The larger the time constant, the slower the response. Specify the proper filter time constant taking into account the response speed of the receiving side. If fluctuation occurs due to noise, increase the time constant.

• Data setting range: 0.00 to 5.00 (s)

F37	**Load Selection/Auto Torque Boost/Auto Energy-Saving Operation 1** **Related function code: F09 Torque boost 1** **H67 Auto energy-saving operation (Mode selection)**

F37 specifies V/f pattern, torque boost type, and auto energy-saving operation in accordance with the characteristics of the load.

F37 Data	V/f characteristics	Torque boost	Auto energy-saving operation	Applicable load
0	Quadratic-torque characteristics	Based on F09 Torque boost	Disable	Quadratic-torque load (generally the fan and pump load)
1	Linear V/f pattern			Constant torque load
2		Auto torque boost		Constant torque load (to be selected if a motor may be over-excited at no load)
3	Quadratic-torque characteristics	Based on F09 Torque boost	Tuning	Quadratic-torque load (generally the fan and pump load)
4	Linear V/f pattern			Constant torque load
5		Auto torque boost		Constant torque load (to be selected if a motor may be over-excited at no load)

Note: If a required “load torque + acceleration torque” is 50% or more of the rated torque, it is recommended to select the linear V/f pattern. Factory defaults are set to linear V/f pattern.

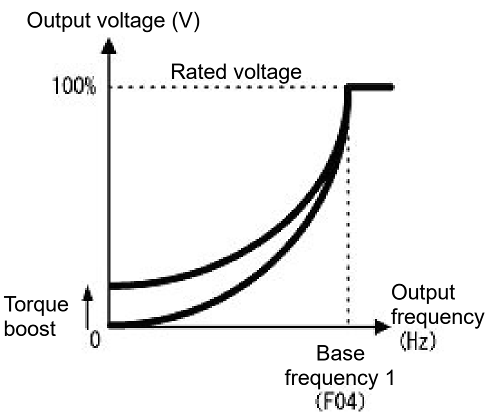
Tip
- When under vector control with sensor, function code F37 is used with the auto energy-saving operation enable/disable selection (V/f characteristics and torque boost will be disabled.)

F37 data	Tuning
0 to 2	Auto energy-saving operation OFF
3 to 5	Auto energy-saving operation ON

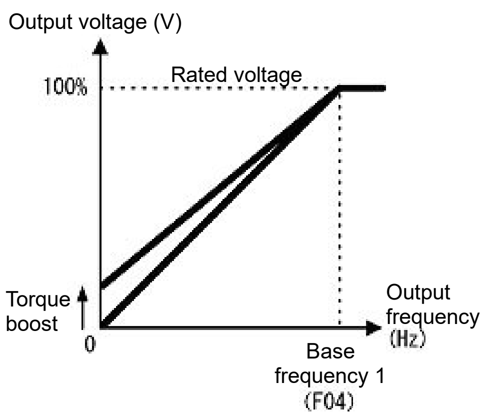
- Under sensorless vector control, both function code F37 and F09 are disabled. Auto energy-saving operation is also impossible.

■ V/f characteristics

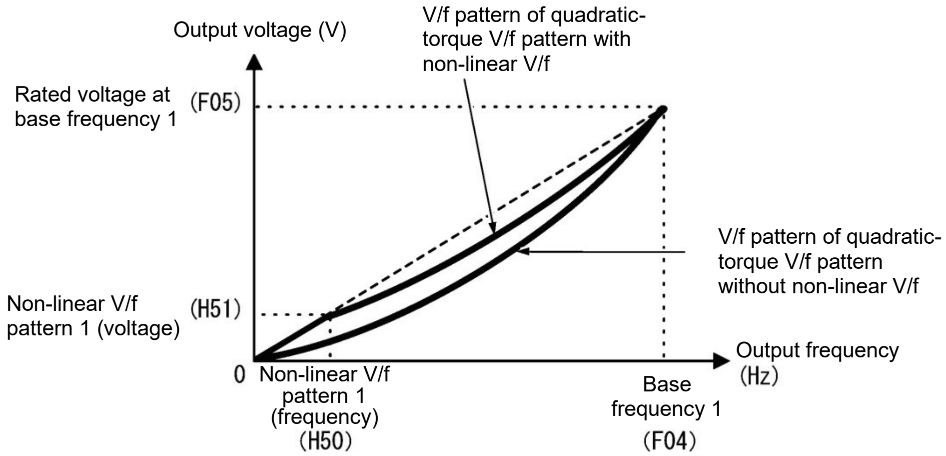
Fuji inverters offer a variety of V/f patterns and torque boosts, which include V/f patterns suitable for variable torque load such as general fans and pumps and for constant torque load (including special pumps requiring high starting torque). Two types of torque boosts are available: manual and automatic.



Quadratic-torque characteristics (F37 = 0)



Linear V/f pattern (F37 = 1)



■ **Torque boost**

- **Manual torque boost by F09 (Manual adjustment)**
- Data setting range: 0.0 to 20.0 (%), (100%/base frequency voltage)

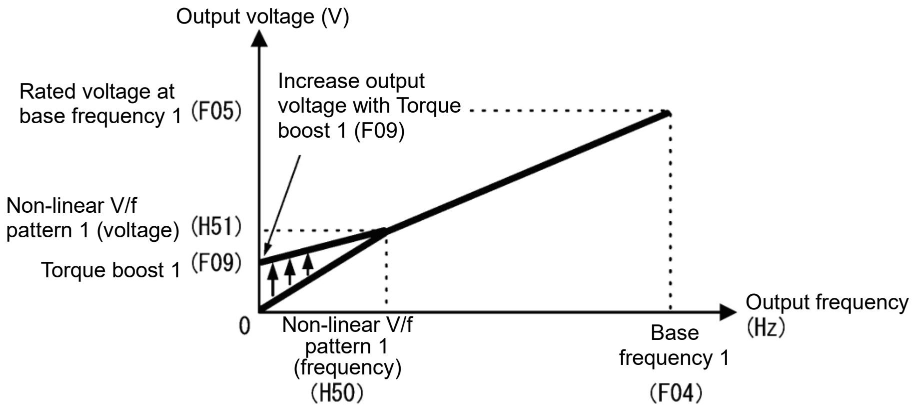
In torque boost using F09, constant voltage is added to the basic V/f pattern, regardless of the load. To secure a sufficient starting torque, manually adjust the output voltage to optimally match the motor and its load by using F09. Specify an appropriate level that guarantees smooth Startup and yet does not cause over-excitation at no or light load. Generally speaking, torque boost is unnecessary (0.0%) with motors of 30kW or higher.

Torque boost using F09 ensures high driving stability since the output voltage remains constant regardless of the load fluctuation.

Specify the function code F09 data in percentage to the base frequency voltage.

Note

- Precautions when driving an old model IE1 motor
  Except for models whose destination is America, with the 0.75 kW to 22 kW factory default value, a boost amount that ensures a starting torque of approximately 100% is set for high-efficiency premium motors (IE3), but with the IE1 motor, starting torque may be insufficient because the boost amount is low. If starting torque is insufficient during the test run, either adjust the torque manually, or check the appropriate torque boost value with the motor manufacturer, and set that value. If using a Fuji Electric motor (IE1), by selecting Fuji Electric motor 8-series by setting P99 to 0, and initializing the motor constants with H03, the torque boost is reset to an appropriate value.
- Specifying a high torque boost level will generate a high torque, but may cause overcurrent due to over-excitation at no load. If you continue to drive the motor, it may overheat. To avoid such a situation, adjust torque boost to an appropriate level.
- When the non-linear V/f pattern and the torque boost are used together, the torque boost takes effect below the frequency on the non-linear V/f pattern's point.



- **Auto torque boost**

This function automatically optimizes the output voltage to fit the motor with its load. Under light load, auto torque boost decreases the output voltage to prevent the motor from over-excitation. Under heavy load, it increases the output voltage to increase the output torque of the motor.

Note
- This function controls in accordance with motor characteristics. Therefore, set the base frequency 1 (F04), rated voltage at base frequency 1 (F05), and other pertinent motor parameters (P01 through P03 and P06 through P99) in line with the motor capacity and characteristics, or else perform auto-tuning (P04).
- When a special motor is driven or the load does not have sufficient rigidity, the maximum torque might decrease or the motor operation might become unstable. In such cases, do not use auto torque boost but choose manual torque boost using F09 (F37 = 0 or 1).

- Auto energy-saving operation (Mode selection) (H67)

Automatically controls the output voltage to the motor in order to minimize the total motor and inverter loss. (Depending on the motor and load characteristics, this may not be effective. Verify the benefits of using auto energy-saving operation for the actual application.)
Auto energy-saving control can be selected from that applied when performing constant speed operation only, and when performing constant speed operation and acceleration/deceleration.

H67 data	Auto energy-saving operation
0	When performing constant speed operation only (when accelerating and decelerating, torque boost or auto torque boost is applied with F09 based on the F37 setting)
1	When performing constant speed operation and acceleration/deceleration (Note: This should be restricted to acceleration/deceleration operation with a light load.)

If using auto-energy saving operation, the response when changing the speed from constant speed operation will be slow. If sudden acceleration/deceleration is necessary, use after canceling auto energy-saving operation beforehand.

Note
- Use auto energy-saving operation at base frequency of 60 Hz or lower. By setting the base frequency to 60 Hz or higher, energy-saving operation may be less effective, or offer no benefit. Auto energy-saving operation operates at a frequency less than the base frequency. Auto energy-saving operation will be disabled if the frequency is equal to or higher than the base frequency.
- This function controls in accordance with motor characteristics. Therefore, set the base frequency 1 (F04), rated voltage at base frequency 1 (F05), and other pertinent motor parameters (P01 through P03 and P06 through P99) in line with the motor capacity and characteristics, or else perform auto-tuning (P04).
- Under sensorless vector control, auto energy-saving operation is disabled.

F38, F39	Stop frequency (Detection method and Holding time)	Refer to F23.

For details about the setting of the stop frequency (detection mode and holding time), refer to the description in the function code F23 section.

F40, F41	**Torque limiter 1-1/Torque limiter 1-2** **Related function code:** **E16, E17 Torque limiter 2-1, 2-2** **H73 Torque limiter (Operating condition selection)** **H74 Torque limiter (Control target)** **H75 Torque limiter (Target quadrant)** **H76 Torque limiter (Braking) (Increasing frequency limiter)**

Under V/f control (F42 = 0, 1, 2, 3, 4)

If the inverter output torque exceeds the specified levels of the torque limiters, the inverter controls the output frequency and limits the output torque for preventing a stall.

Note In braking, the inverter increases the output frequency to limit the output torque. Depending on the conditions during operation, the output frequency could dangerously increase. H76 (Frequency rising limit for braking) is provided to limit the increasing frequency component.

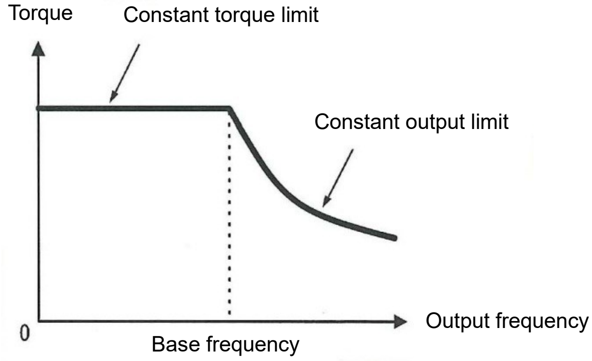
Related function codes

Function codes	Name	V/f control	Remarks
F40	Torque limiter 1-1	Y	
F41	Torque limiter 1-2	Y	
E16	Torque limiter 2-1	Y	
E17	Torque limiter 2-2	Y	
H73	Torque limiter (Operating condition selection)	Y	
H74	Torque limiter (Control target)	N	
H75	Torque limiter (Target quadrant)	N	
H76	Torque limiter (Braking) (Increasing frequency limiter)	Y	
E61 to E63	Terminal [12], [C1] (C1 function) (V2 function) Extension function selection	Y	7: Analog torque limiter A 8: Analog torque limiter B

■ Torque limit control mode

Under V/f control, torque limiting is performed by limiting torque current flowing across the motor.

The graph below shows the relationship between the torque and the output frequency at the constant torque current limit.



■ Torque limiter (F40, F41, E16, E17) Data setting range: -300 to 300(%). 999 (Disable)

These function codes specify the operation level at which the torque limiters become activated, as the percentage of the motor rated torque. Switching between motor 1 and 2 is possible using the control terminals (described later).

Function code	Name	Torque limit feature
F40	Torque limiter 1-1	Driving torque current limiter 1
F41	Torque limiter 1-2	Braking torque current limiter 1
E16	Torque limiter 2-1	Driving torque current limiter 2
E17	Torque limiter 2-2	Braking torque current limiter 2

Note The setting range is the plus/minus range, but a plus value should be set. Operation will be performed with an absolute value if a minus value is set.

Although the setting range of the torque is 300%, the torque limiter determined by the overload current of the unit internally limits the torque current output. Therefore, the torque current output is automatically limited at a value lower than 300%, the maximum setting value.

■ Analog torque limiter (E61 to E63)

The torque limit value can be specified by analog inputs (voltage or current) through terminals [12], [C1] (C1 function), and [C1] (V2 function). Assign as follows with function codes E61, E62, and E63.

E61, E62, E63 Data	Name	Function	Description
7	Analog torque limiter A	Driving torque current limiter	Input modes: 100% / 10 V or 20 mA
8	Analog torque limiter B	Braking torque current limiter	

If these terminals have been set up to have the same data, the operation priority is given in the following order: E61 > E62 > E63.

■ Torque limiter levels specified via communications link (S10, S11)

The torque limiter levels can be changed via the communications link. Communication dedicated codes S10, S11 interlock with the function codes F40, F41.

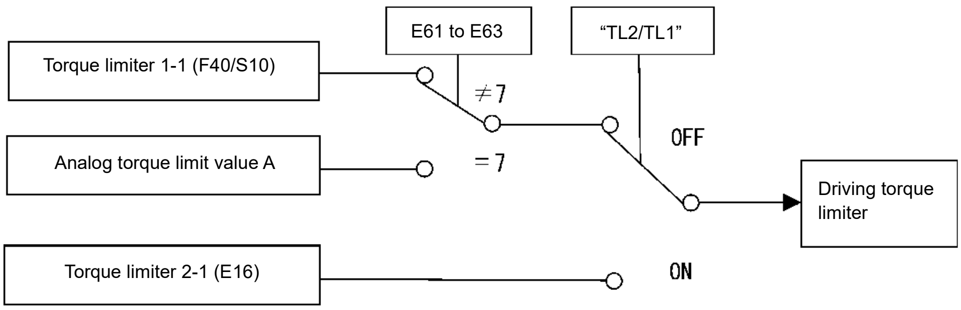
■ **Switching torque limiters**

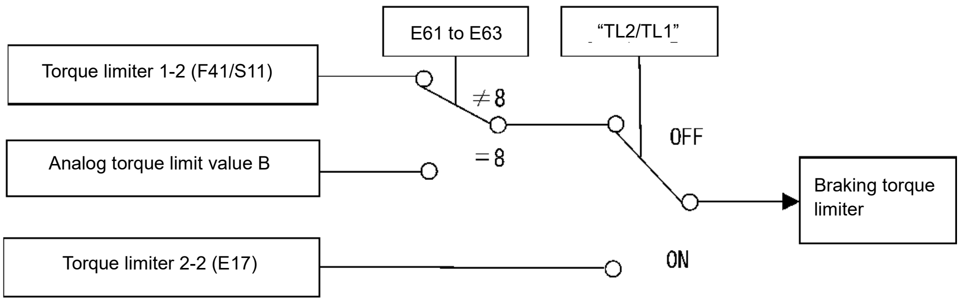
The torque limiters can be switched by the function code setting and the terminal command "TL2/TL1" (Select torque limiter level 2/1) assigned to any of the digital input terminals. To assign the Torque limiter 2/Torque limiter 1, "TL2/TL1" set Data = 14 in function codes from E01 to E05. If no "TL2/TL1" is assigned, torque limiter levels 1-1 and 1-2 (F40 and F41) take effect by default.

■ **Torque limiter (Braking) (Increasing frequency limiter) (H76) Data setting range: 0.0 to 599.0 (Hz)**

H76 specifies the rising limit of the frequency in limiting torque for braking. The factory default is 5.0 Hz. If the increasing frequency during braking reaches the limit value, the torque limiters no longer function, resulting in an overvoltage trip. Such a problem may be avoided by increasing the setting value of H76.

Note The torque limiter and current limiter are very similar in function. If both are activated concurrently, they may conflict with each other and cause hunting. Avoid concurrent activation of these limiters.





■ **Torque limiter (Operating condition selection) (H73)**

It is possible to set whether to enable or disable torque limiting while the motor is accelerating or decelerating, or while it is running at constant speed.

H73 data	During acceleration/deceleration	During constant speed running
0	Enable	Enable
1	Disable	Enable
2	Enable	Disable

Under sensorless vector control/vector control with sensor (induction motors, PMSMs) (F42 = 5, 6, 15, 16)

If the inverter's output torque exceeds the specified levels of the torque limiters, the inverter controls the speed regulator's output (torque command) in speed control or a torque command in torque control in order to limit the motor-generating torque.

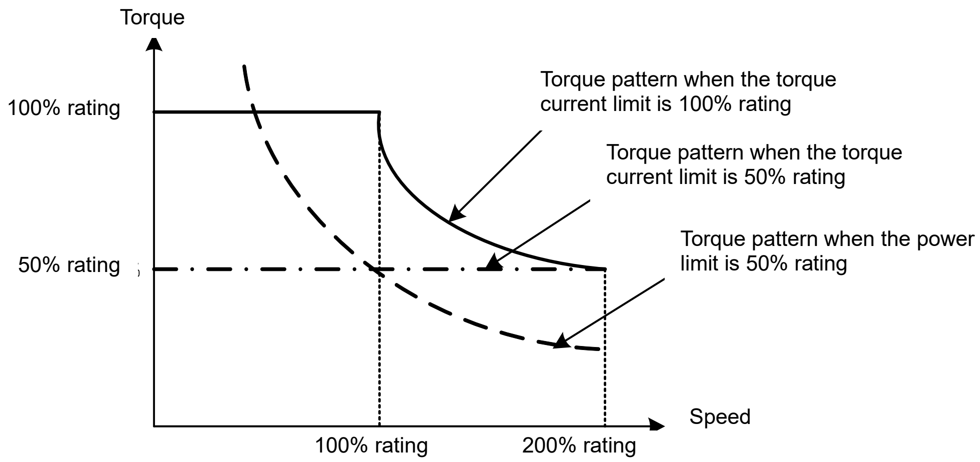
Related function codes

Function codes	Name	Vector control	Remarks
F40	Torque limiter 1-1	Y	
F41	Torque limiter 1-2	Y	
E16	Torque limiter 2-1	Y	
E17	Torque limiter 2-2	Y	
H73	Torque limiter (Operating condition selection)	Y	
H74	Torque limiter (Control target)	Y	
H75	Torque limiter (Target quadrant)	Y	
H76	Torque limiter (Braking) (Increasing frequency limiter)	Y	
E61 to E63	Terminal [12], [C1] (C1 function) (V2 function) (Extension function selection)	Y	7: Analog torque limiter A 8: Analog torque limiter B

■ **Torque limiter (Control target) (H74)**

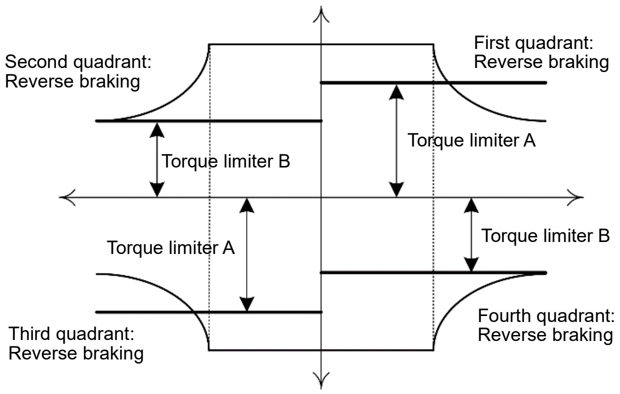
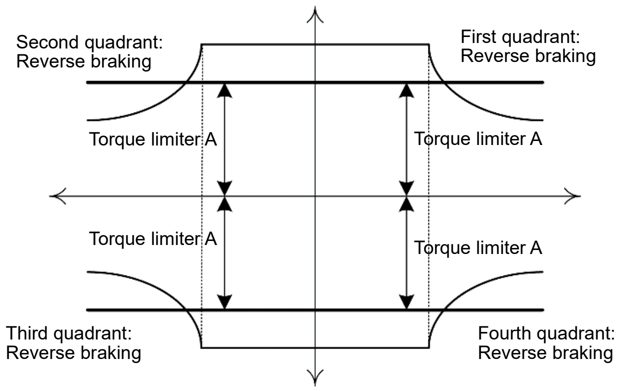
Under vector control, the inverter can limit motor-generating torque or output power, as well as a torque current (default).

H74 data	Control target
0	Keeps torque constant.
1	Keeps torque current constant.
2	Keeps power constant.



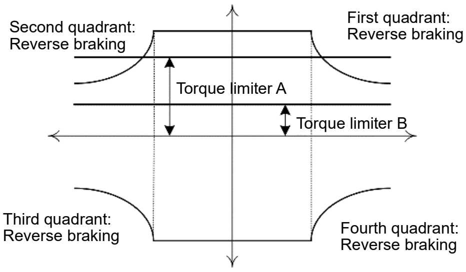
■ **Torque limiter (Target quadrant) (H75)**

The settings for each quadrant (forward rotation drive/braking, reverse rotation drive/braking) for which torque limiter A and B are enabled can be selected from “Drive/braking torque limiter,” “4 identical quadrants torque limiter,” and “Upper limit/lower limit torque limiter” shown below.

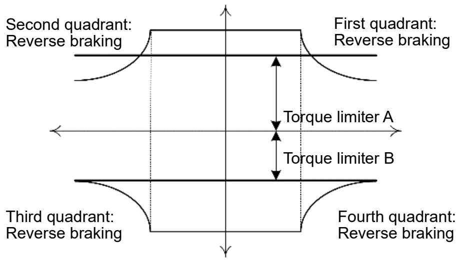
H75	Target quadrant
0: Drive/braking	Limiting is applied by separating torque limiting when driving (torque limiter A) and torque limiting when braking (torque limiter B) for both forward rotation and reverse rotation. 
1: 4 quadrants identical	Limiting is applied with the same limiting value (torque limiter A) for both forward/reverse rotation and driving/braking. 

H75	Applicable quadrant
2: Upper limit/ lower limit	Limiting is applied by separating limit values into the upper limit value (torque limiter A) and the lower limit value (torque limiter B). Limiting is applied in the following patterns depending on the polarity of torque limiter A and torque limiter B

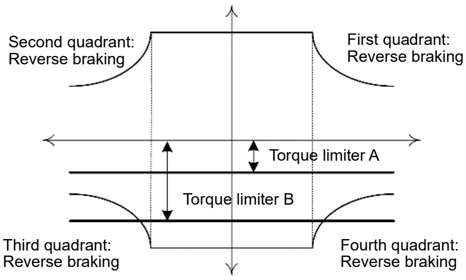
	Torque limit value A	Torque limit value B
Pattern 1	Plus	Plus
Pattern 2	Plus	Minus
Pattern 3	Minus	Minus



Pattern 1



Pattern 2



Pattern 3

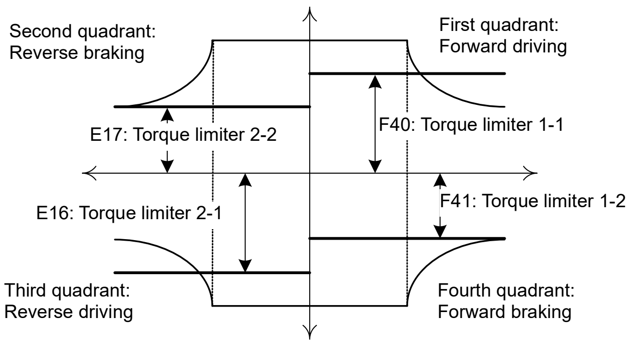
Note

- If torque limiter A < torque limiter B, limiting is fixed with torque limiter A.
- By setting an upper limit/lower limit for torque limiting, reciprocating vibrations may occur between the upper limit value and lower limit value depending on conditions such as a narrowing in the width of the upper limit/lower limit setting value, or a delay in the speed control system response, and therefore caution is advised.

3: 4 quadrants independent

With the following assignments, limiting values are applied for the 4 quadrants independently.

	Name	Terminal command assigned
F40	Torque limiter 1-1	Quadrant I (forward rotation drive)
F41	Torque limiter 1-2	Quadrant IV (forward rotation braking)
E16	Torque limiter 2-1	Quadrant III (reverse rotation drive)
E17	Torque limiter 2-2	Quadrant II (reverse rotation braking)



FUNCTION CODES
Chap 5

F42	Control method selection 1 Related function code: H68 Slip compensation 1 (Operating condition selection)

F42 specifies the motor drive control. For details on control methods, refer to Chapter 4 “4.6 Selecting a Desired Motor Drive Control” to “4.8 Configuring Function Codes for Drive Controls.”

<table>
<tr><th>F42 data</th><th>Inverter drive control</th><th>Basic control</th><th>Speed feedback</th><th>Speed control</th></tr>
<tr><td>0</td><td>V/f control: without slip compensation</td><td rowspan="5">V/f control</td><td rowspan="3">No</td><td>Frequency control</td></tr>
<tr><td>1</td><td>Dynamic torque vector control (with slip compensation, auto torque boost)</td><td rowspan="2">Frequency control with slip compensation</td></tr>
<tr><td>2</td><td>V/f control with slip compensation</td></tr>
<tr><td>3</td><td>V/f control with sensor</td><td rowspan="2">Yes</td><td rowspan="2">Frequency control with automatic speed regulator (ASR)</td></tr>
<tr><td>4</td><td>Dynamic torque vector control with sensor</td></tr>
<tr><td>5</td><td>Sensorless vector control</td><td rowspan="4">Vector control</td><td>Speed estimation</td><td rowspan="4">Speed control with automatic speed regulator (ASR)</td></tr>
<tr><td>6</td><td>Vector control with sensor</td><td>Yes</td></tr>
<tr><td>15</td><td>Vector Control without sensor (PMSMs)</td><td>Speed estimation</td></tr>
<tr><td>16</td><td>Vector control with sensor (PMSMs)</td><td>Yes</td></tr>
</table>

■ F42 = 0: V/f control without slip compensation

Under this control, the inverter controls a motor with the voltage and frequency according to the V/f pattern specified by function codes. This control disables all automatically controlled features such as the slip compensation, so no unpredictable output fluctuation results, enabling stable operation with constant output frequency.
If running multiple motors, select this control method.

■ F42 = 2: V/f control with slip compensation

Applying any load to an induction motor causes a rotational slip due to the motor characteristics, decreasing the motor rotation. The inverter’s slip compensation function first presumes the slip value of the motor based on the motor torque generated and raises the output frequency to compensate for the decrease in motor rotation. This prevents the motor from decreasing the rotation due to the slip.

That is, this function is effective for improving the motor speed control accuracy.

Function codes		Tuning
P12	Rated slip frequency	Specify the motor rated slip frequency.
P09	Slip compensation gain for driving	Adjust the slip compensation for driving. Slip compensation amount when driving = Rated slip x Slip compensation gain (when driving)
P11	Slip compensation gain for braking	Adjust the slip compensation amount when braking. Slip compensation amount when braking = Rated slip x Slip compensation gain (when braking)
P10	Slip compensation response time	Set the slip compensation response time. Basically, there is no need to modify the setting.

To improve the accuracy of slip compensation, perform auto-tuning.

H68 enables or disables the slip compensation function 1 according to the motor driving conditions.

H68 data	Motor driving conditions		Motor driving frequency zone	
	Accl/Decel	Constant speed	Base frequency or below	Above the base frequency
0	Enable	Enable	Enable	Enable
1	Disable	Enable	Enable	Enable
2	Enable	Enable	Enable	Disable
3	Disable	Enable	Enable	Disable

■ F42 = 1: Dynamic torque vector control

To get the maximal torque out of a motor, this control calculates the motor torque for the load applied and uses it to optimize the voltage and current vector output. Specify motor constants or perform auto tuning.

Selecting this control automatically enables the auto torque boost and slip compensation function. This control is effective for improving the system response to external disturbances such as load fluctuation, and the motor speed control accuracy.

Note that the inverter may not respond to a rapid load fluctuation.

■ F42 = 3: V/f control with sensor

Applying any load to an induction motor causes a rotational slip due to the motor characteristics, decreasing the motor rotation. Under V/f control with speed sensor, the inverter detects the motor rotation using the encoder mounted on the motor shaft and compensates for the decrease in slip frequency by the PI control to match the motor rotation with the commanded speed. This improves the motor speed control accuracy.

Note Speed detection is performed, but the motor starts based on the H09: Auto search mode setting. The motor starts from the speed detection value only if auto search is enabled with function code H09 set to 1 or 2. If H09 = 0, the speed detection value is ignored, and the motor starts from the starting frequency.

■ F42 = 4: Dynamic torque vector control with sensor

The difference from the "V/f control with sensor" stated above is that this method calculates the motor torque for the load applied and uses the calculated torque to optimize the output voltage and current vectors for getting the maximal torque out of a motor. This is effective for improving the system response to external disturbances such as load fluctuations, and the motor speed control accuracy.

Note Speed detection is performed, but the motor starts based on the H09: Auto search mode setting. The motor starts from the speed detection value only if auto search is enabled with function code H09 set to 1 or 2. If H09 = 0, the speed detection value is ignored, and the motor starts from the starting frequency.

■ F42=5: Sensorless vector control

This control estimates the motor speed based on the inverter's output voltage and current to use the estimated speed for speed control. In addition, it decomposes the motor drive current into the exciting and torque current components, and controls each of those components in vector. No PG (pulse generator) interface card is required. It is possible to obtain the desired response by adjusting the control constants (PI constants) using the speed regulator (PI controller).

With vector control, a difference (voltage margin) is required between the voltage that the inverter is capable of outputting and the motor induced voltage to a certain extent in order to control the motor current. Generally speaking, general-purpose motors are designed for use with commercial power supplies, but due to the need for this voltage margin, it is necessary to control the current by suppressing the motor terminal voltage. By doing so, it is not possible to deliver rated torque even when the original motor rated current is flowing. To ensure that the rated torque is delivered, it is necessary to increase the rated current (the same applies with vector control with sensor).

■ F42 = 6: Vector control with sensor

This control requires an optional PG (pulse generator) and an optional PG interface card to be mounted on a motor shaft and an inverter, respectively. The inverter detects the motor's rotational position and speed according to PG feedback signals and uses them for speed control. It also decomposes the motor drive current into the exciting and torque current components, and controls each of components as vectors.

It is possible to obtain the desired response by adjusting the control constants (PI constants) using the speed regulator (PI controller).

■ **F42 = 15: Sensorless vector control (PMSMs)**

This control estimates the motor speed based on the inverter's output voltage and current to use the estimated speed for speed control. In addition, it decomposes the motor drive current into the exciting and torque current components, and controls each of those components in vector. No PG (pulse generator) interface card is required. It is possible to obtain the desired response by adjusting the control constants (PI constants) using the speed regulator (PI controller).

■ **F42 = 16: Vector control with sensor (PMSMs)**

This control requires an optional PG (pulse generator) and an optional PG interface card to be mounted on a motor shaft and an inverter, respectively. The inverter detects the motor's rotational position and speed according to PG feedback signals and uses them for speed control. It also decomposes the motor drive current into the exciting and torque current components, and controls each of components as vectors.

It is possible to obtain the desired response by adjusting the control constants (PI constants) using the speed regulator (PI controller).

Note: Slip compensation, dynamic torque vector control, sensorless vector control, and vector control with sensor use motor constants. Consequently, the following conditions should be satisfied; otherwise, full control performance may not be obtained.

- A single motor should be controlled per inverter.
- Motor parameters P02, P03, P06 to P13 should be properly configured or auto-tuning should be performed.
- If the capacity of the motor being controlled is smaller than the inverter rated capacity, the current detection resolution will deteriorate, and control performance will drop. In such cases, a motor and inverter combination up to one rank lower is recommended.
- The wiring distance between inverter and motor should be 50 m (164 ft) or less for FRN0001 to 0020E3S/T/N-2G, FRN0002 to 0012E3S/T/N-4G, and FRN0001 to 0012E3S/T/N-7G, and 100 m (328 ft) or less for FRN0030 to 0115E3S/N-2G and FRN0022 to 0072E3S/N-4G. If it is longer, the inverter may not control the motor due to leakage current flowing through stray capacitance to the ground or between wires. Especially, small capacity inverters whose rated current is also small may be unable to control the motor correctly even when the wiring is less than 100 m (328 ft). In that case, make the wiring length as short as possible or use a wire with small stray capacitance (e.g., loosely-bundled cable) to minimize the stray capacitance.

■ Control parameters which are initialized when the control method F42 is changed

If the control selection (F42) is changed from induction motor control (other than F42 = 15, 16) to PMSM control (F42 = 15, 16), the function code values in the following table are automatically changed to the initial values.

Function codes	If changed by setting F42 to 15 or 16, or other than 15 or 16	If P02 changed	If motor constants are initialized by setting H03 to 2 with F42 = 0 to 6	If motor constants are initialized by setting H03 to 2 with F42 = 15 or 16
F03	Y	N	N	N
F04	Y	*1	*2	Y
F05	Y	*1	*2	Y
F06	Y	N	N	Y
F09	N	N	Y	Y
F10	N	N	N	Y
F11	Y	N	Y	Y
F12	Y	N	N	Y
F15	Y	N	N	N
F23	Y	N	N	N
F24	N	N	N	Y
F26	Y	N	N	N
F40 to F41	Y	N	N	N
E50	Y	N	N	N
P01	Y	N	Y	Y
P02	N	N	N	N
P03	Y	Y	Y	Y
P06 to P23	N	Y	Y	Y
P30	N	Y	Y	Y
P55 to P57	N	Y	Y	Y
P60 to P64	N	Y	Y	Y
P87	N	Y	Y	Y
P90	N	Y	Y	Y
P99	Y	N	N	N
H46	N	Y	Y	Y
d01 to d04	Y	N	N	N
d06	Y	N	N	N
d67	Y	N	N	N
d90	N	N	Y	Y

Y: Change N: No change

*1 If P99 = 1: Motor characteristics 1 (HP typical motor, typical model) and PMSM control (F42 = 15, 16): Y applies (function code values are changed); if neither is relevant: N applies (function code values are not changed).

*2 If P99 = 1: Motor characteristics 1 (HP typical motor, typical model): Y applies (function code values are changed); if neither is relevant: N applies (function code values are not changed).

Note If the control selection (F42) is set to induction motor sensorless vector control (F42 = 5), the function code d67 value is automatically changed.

F43, F44	**Current limiter (Operation selection, Operation level)** **Related function code: H12 Instantaneous overcurrent limit (Operation selection)**

This is a dedicated V/f control function. It does not work under sensorless vector control or vector control with sensor.

When the output current of the inverter exceeds the level specified by the current limiter (F44), the inverter automatically manages its output frequency to prevent a stall and limits the output current. The F44 setting is automatically set by the F80 setting (as shown in the table below). If an overload current of 160% or higher, or 130% or higher flows momentarily, and the frequency drop resulting from current limiting becomes a problem, consider increasing the limiting level.

Operation at constant speed only (F43 = 1), and operation when acceleration and at constant speed (F43 = 2) can be set for the operation selection. Choose F43 = 1 if you need to run the inverter at full capability during acceleration and to limit the load (current) during constant speed operation.

Current limiter value

F80 data	Drive mode	F44: limiter value	Type of inverter
0	HHD	180%	FRN0001 to 0069E3☐-2G / FRN0002 to 0044E3☐-4G FRN0001 to 0012E3△-7G / FRN0001 to 0011E3E-7G
		160%	FRN0088 to 0115E3☐-2G / FRN0059, 0072E3☐-4G
1	HND	130%	All models
4 *	HND*		
3	HD	160%	Only FRN****E3☐-4G
4	ND	130%	

* Only FRN0012, 0020E3☐-2G / FRN0001 to 0012E3☐-7G

■ Operation selection (F43)

F43 selects the motor running state in which the current limiter becomes active.

F43 data	Running states that enable the current limiter		
	During acceleration	Constant speed	During deceleration
0	Disable	Disable	Disable
1	Disable	Enable	Disable
2	Enable	Enable	Disable

■ Operation level (F44)

F44 specifies the operation level at which the output current limiter becomes activated, as a ratio of the inverter rating.

- Data setting range: 20 to 200 (%) of rated current of the inverter
  (Inverter's rated current changes according to the setting value of function code F80.)

■ Instantaneous overcurrent limit (Operation selection) (H12)

H12 specifies whether the inverter invokes the current limit processing or enters the overcurrent trip when its output current exceeds the instantaneous overcurrent limiting level. Under the current limit processing, the inverter immediately turns OFF its output gate to suppress the further current increase and continues to control the output frequency.

H12 data	Function
0	Disable (An overcurrent trip occurs at the instantaneous overcurrent limiting level.)
1	Enable (An instantaneous overcurrent limiting operation is activated.)

If any problem could occur when the motor torque temporarily drops during current limiting processing, it is necessary to cause an overcurrent trip (H12 = 0) and actuate a mechanical brake at the same time.

Note
- Since the current limit operation with F43 and F44 is performed by software, it may cause a delay in control. If you need a quick response current limiting, also enable the instantaneous overcurrent limiting with H12.
- If an excessive load is applied when the current limiter operation level is set extremely low, the inverter will rapidly lower its output frequency. This may cause an overvoltage trip or dangerous turnover of the motor rotation due to undershooting. Depending on the load, extremely short acceleration time may activate the current limiting to suppress the increase of the inverter output frequency, causing hunting (undesirable oscillation of the system) or activating the inverter overvoltage trip. When specifying the acceleration time, therefore, you need to take into account machinery characteristics and moment of inertia of the load.

Note
- The torque limiter and current limiter are very similar in function. If both are activated concurrently, they may conflict with each other and cause hunting. Avoid concurrent activation of these limiters.
- Vector control with sensor itself contains the current control system, so it disables the current limiter specified by F43 and F44, as well as automatically disabling the instantaneous overcurrent limiting (specified by H12). Accordingly, the inverter causes an overcurrent trip when its output current exceeds the instantaneous overcurrent limiting level.

F50 to F52	Electronic thermal (Braking resistors protection (Discharging capacity), (Permissible average loss) and (Braking resistance value))

These function codes specify the electronic thermal overload protection feature for the braking resistor.

Set the discharging capability, allowable average loss and resistance to F50, F51 and F52, respectively. These values are determined by the inverter and braking resistor models. For the discharging capability, allowable average loss and resistance, refer to “11.4.3 Specification” in Chapter 11 “11.4 Braking Resistors (DBRs)”.

The values listed in the tables are for standard models and 10% ED models of the braking resistors which Fuji Electric provides. When using a braking resistor of any other manufacturer, confirm the corresponding values with the manufacturer and set the function codes accordingly.

Note Depending on the thermal characteristics of the braking resistor, the electronic thermal overload protection feature may act so that the inverter issues the overheat protection alarm dbH even if the actual temperature rise is not large enough. If this happens, review the relationship between the performance index of the braking resistor and settings of related function codes.

Tip Using the standard models of braking resistor or using the braking unit and braking resistor together can output temperature detection signal for overheat. Assign terminal command THR (“Enable external alarm trip”) to any of digital input terminals [X1] to [X5], [FWD] and [REV] and connect that terminal and its common terminal to braking resistor’s terminals [1] and [2]. Set OFF for function code F50.

Tip If the discharge withstand current rating and permissible average loss are unknown when using a non-Fuji inverter braking resistor, they can be obtained by calculating them from the applicable motor capacity, permissible duty cycle %ED, and maximum braking time braking resistor specifications.

$$\text{Discharge withstand current rating (kWs)} = \frac{\text{Max. braking time (s) x motor capacity (kW) x braking torque (\%)/100}}{2}$$

$$\text{Permissible average loss (kW)} = \frac{\text{Permissible duty cycle \%ED/100 x motor capacity (kW) x braking torque (\%)/100}}{2}$$

Example

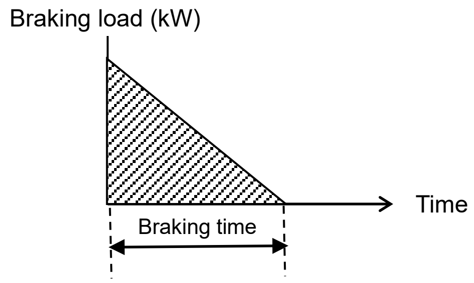
Braking resistor specifications

Motor capacity	Braking torque (%)	Max. braking time (s)	Permissible duty cycle %ED
11 kW	100%	5 s	10%

Discharge withstand current rating (kWs) = 5 s x 11 kW x 1 (100%) ÷ 2 = 27.5 kWs

Permissible average loss (kW) = 0.1 (10%) x 11 kW x 1 (100%) ÷ 2 = 0.55 kW

* The value for braking resistor braking time is estimated based on deceleration (see figure below).



Discharging capacity (F50)

The discharging capacity refers to kWs allowance for a single braking cycle.

F50 data	Function
1 to 9000	1 to 9000 (kWs)
OFF	Disables the protective function with a braking resistor electronic thermal overload.

■ **Permissible average loss (F51)**

Permissible average loss is the power capacity that can be continuously applied to the resistor.

F51 data	Function
0.001 to 99.99	0.001 to 99.99 (kW)

■ **Braking resistance value (F52)**

F52 specifies the resistance of the braking resistor.

F52 data	Function
0.01 to 999	0.01 to 999 (Ω)

F58, F59 **F32, F62, F63**	**Terminal [FM1] (Filter, Bias)** **Terminal [FM2] (Operation selection, Output gain, Function selection, Filter, Bias)**

A detailed explanation can be found in the function code F29 section.

F80	Switching between HHD, HND, HD and ND modes

It is possible to select from 4 types of running modes using function code F80. Select a running mode that is appropriate for the load equipment after checking the following table.

For this model, the default setting for function code F80 differs depending on the destination set the first time the power is turned on. For details, refer to Chapter 4 ”4.4 Destination setting.“

Double key operation (STOP key + ▲/▼ keys) is required to change function code F80 data.

F80 Data	Modes	Application	Rated current level	Ambient temperature	Overload capacity	Maximum output frequency
0	HHD mode	Heavy-duty load	Capable of driving a motor whose capacity is the same as the inverter capacity.	50°C (122°F)	150% for 1 min 200% 0.5 s	599 Hz
1 (*1)	HND mode	General load	Capable of driving a motor whose capacity is one or two ranks higher than the inverter capacity.	50°C (122°F)	120% 1 min	
4 (*2)				40°C (104°F)		
3 (*3)	HD mode	Heavy-duty load		40°C (104°F)	150% 1min	
4 (*3)	ND mode	General load		40°C (104°F)	120% 1min	

*1: Cannot be selected for all the models of Single-phase series 200 V and FRN0012, 0020E3□-2G / FRN0007 to 0012E3□-4G.

*2: Selectable only with FRN0012, 0020E3□-2G / FRN0001 to 0012E3□-7G. ND is displayed on the multi-function keypad.

*3: Cannot be selected for single-phase 200 V series or three-phase 200 V series.

For details on specific rated current values, refer to Chapter 12 “SPECIFICATIONS.”

Note
- When F80 is changed, Torque boost 1 to 2 (F09, A05) is rewritten to the HD/HHD or ND/HND setting in " Table 5.2-1 Factory default setting values by capacity” in “5.2.2 Function code tables." Current limit (operating level) F44 is also rewritten.
- For ND, HD and HND modes, the following function codes and internal processes are restricted.

Function Code	Name	Remarks
F21	DC braking 1 (Operation level)	Upper limit restriction
A10	DC braking 2 (Operation level)	
F26	Motor sound (Carrier frequency)	Upper limit restriction
F31, F35, F61, o90, o96	Terminal [FM1], [FM2], [FMP], [Ao], [CS] (Function selection)	Setting value = 2: Output current, = 6: Power consumption Monitor amount full scale changes
F44	Current limiter (Operation level)	Default setting, setting value
J68	Brake control signal (Brake-release current)	Upper limit restriction
d120	Brake control signal (brake-release current) (REV)	

For details, refer to explanation of each function code and selection guidance in Chapter 10 “10.4.2 Guidelines for selecting inverter drive mode and capacity.”

Note

- Due to the above restrictions, if writing function codes continuously in ascending order by communication with RS-485, etc., be sure to write F80 first.
- Motor capacities 1 to 2 (P02, A16) do not automatically move one rank up (or down).
  Configure to match the applicable motor capacity as required.
  Furthermore, if initializing motor constants, first set motor capacities 1 to 2 (P02, A16), then set the motor type by selecting motor 1 to 2 (P99, A39), and then initialize the motor with H03.

5.3.2 E codes (Extension terminal functions)

E01 to E05	Terminal [X1] to [X5] (Function selection) Related function code: E70 Shift key (Function selection) E98 Terminal [FWD] function selection E99 Terminal [REV] function selection

E01 to E05, E98 and E99 assign commands to general-purpose, programmable, digital input terminals, [X1] to [X5], [FWD], and [REV].

These function codes can also switch the logic system between normal and negative to define how the inverter logic interprets the ON or OFF state of each terminal. The factory default setting is normal logic system "Active ON." Functions assigned to digital input terminals [X1] to [X5], [FWD] and [REV] are as shown below. Descriptions that follow are given in normal logic system. Each signal has been described at data allocation order. However, the signal is related has been described together. Refer to the function codes in the "Related function code" column, if any.

With terminal functions for which Y is indicated for E70 (keypad Shift key) in the "5.2-3 Control input terminal setting list table" under "[2] E codes" of "5.2.2 Function code tables," by setting the same data as in E01 to E05 for function code E70, a function is assigned to the keypad Shift key that allows commands to be turned ON and OFF manually. Refer to the explanation on function code E70 for details.

⚠CAUTION

- Run commands (e.g., Run forward "FWD"), stop commands (e.g., coast to stop "BX"), and frequency change commands can be assigned to digital input terminals. Depending on the digital input terminal status, operation may start suddenly, or the speed may change significantly simply by changing the function code settings. Make changes to function code settings after sufficiently ensuring safety.
- Functions for switching run or frequency command sources (such as "SS1, SS2, SS4, SS8," "Hz2/Hz1," "Hz/PID," "IVS" and "LE") can be assigned to the digital input terminals. Depending on the conditions, changes to these signals may result in operation being started suddenly or the speed changing suddenly.

Failure to observe this could result in an accident or injury.

Data (Active) ON	Data (Active) OFF	Defined function	Signal name	Related function Code
0	1000	Select multistep frequency (1 to 15 steps)	"SS1"	C05 to C19
1	1001		"SS2"	
2	1002		"SS4"	
3	1003		"SS8"	
4	1004	Select ACC/DEC time (2 steps)	"RT1"	F07, F08, E10 to E15
5	1005	Select ACC/DEC time (4 steps)	"RT2"	
6	1006	Select self-hold	"HLD"	F02
7	1007	Coast-to-a-stop command	"BX"	—
8	1008	Alarm (error) reset	"RST"	—
1009	9	External alarm	"THR"	—
10	1010	Jogging operation	"JOG"	C20 H54, H55, d09 to d13
11	1011	Frequency setting 2/Frequency setting 1	"Hz2/Hz1"	F01, C30
12	1012	Select motor 2	"M2"	—
13	–	DC braking command	"DCBRK"	F20 to F22
14	1014	Torque limiter level 2/1	"TL2/TL1"	F40, F41 E16, E17

Data Active ON	Data Active OFF	Defined function	Signal name	Related function Code
15	—	Switch to commercial power (50 Hz)	“SW50”	-
16	—	Switch to commercial power (60 Hz)	“SW60”	—
17	1017	UP command	“UP”	Frequency command: F01, C30 PID command: J02
18	1018	DOWN command	"DOWN"	
19	1019	Allow function code editing	“WE-KP”	F00
20	1020	1020	“Hz/PID”	J01, J101, J201
21	1021	Switch normal/inverse operation	"IVS"	C53, C54, J01
22	1022	Interlock	"IL"	F14
23	1023	Cancel torque control	“Hz/TRQ”	H18
24	1024	Select link operation (RS-485, BUS option)	"LE"	H30, y98
25	1025	Universal DI	“U-DI”	—
26	1026	Select auto search for idling motor speed at starting	"STM"	H09, d67
1030	30	Forced stop	"STOP"	H56
32	1032	Pre-excitation	"EXITE"	H84, H85
33	1033	Reset PID integral and differential terms	“PID-RST”	J01, J101, J201
34	1034	Hold PID integral term	“PID-HLD”	
35	1035	Local (keypad) command selection	"LOC"	(Refer to Section 3.3.8)
38	1038	Run enable	“RE”	—
39	—	Condensation prevention	"DWP"	J21
42	1042	Activate the limit switch at start	“LS”	J73 to J88
46	1046	Enable overload stop	"OLS"	J63 to J67 J90 to J92
47	1047	Servo lock command	"LOCK"	J97 to J99
48	—	Pulse string input (valid only for terminal [X6], [X7])	"PIN"	F01, C30 d62, d63
49	1049	Pulse string sign (valid except for terminal [X6], [X7])	"SIGN"	
58	1058	UP/DOWN frequency clear	"STZ"	F01, H61
59	1059	Battery/UPS operation selection	“BATRY/UPS”	H111
60	1060	Torque bias command 1	“TB1”	H154 to H162
61	1061	Torque bias command 2	“TB2”	H154 to H162
62	1062	Hold torque bias	“H-TB”	H154 to H162
65	1065	Check brake	"BRKE"	J68 to J96, H180, d120 to d124
70	1070	Cancel line speed control	“Hz/LSC”	d41
71	1071	Hold line speed control frequency in the memory	“LSC-HLD”	

Data Active ON	Data Active OFF	Defined function	Signal name	Related function Code
72	1072	Count the run time of commercial power-driven motor 1	"CRUN-M1"	—
73	1073	Count the run time of commercial power-driven motor 2	"CRUN-M2"	
76	1076	Select droop control	"DROOP"	H28
78	1078	Select speed control parameters 1	"MPRM1"	d01 to d06
79	1079	Select speed control parameters 2	"MPRM2"	
80	1080	Cancel customizable logic	"CLC"	E01 to E05, U81 to U90
81	1081	Clear all customizable logic timers	"CLTC"	
82	1082	Cancel anti-regenerative control	"AR-CCL"	H69
83	1083	PG input switching	"PG-SEL"	d14 to d18
84	1084	Acceleration/deceleration cancel (bypass)	"BPS"	—
94	—	Forward JOG	"FJOG"	H31
95	—	Reverse JOG	"RJOG"	
97	—	Rotation direction command	"DIR"	F02
98	—	Forward rotation/Stop command (Exclusively assigned to [FWD] and [REV] terminals by E98 and E99)	"FWD"	F02
99	—	Reverse rotation/Stop command (Exclusively assigned to [FWD] and [REV] terminals by E98 and E99)	"REV"	
100	—	No assignment	"NONE"	U81 to U90 U185 to U188
119	1119	Speed regulator P operation	"P-SEL"	d201 to d299
121-129	1121-1129	Customizable logic input 1 to 9	"CLI1-9"	U01 to U70
134	—	Forced operation command	"FMS"	H116 to H121
135	1135	Displacement/absolute position switching	"INC/ABS"	d201 to d299
136	1136	Orientation command	"ORT"	
142	1142	Position preset command	"P-PRESET"	
144	1144	Positioning date change command	"POS-SET"	
145	1145	Positioning data selection 1	"POS-SEL1"	
146	1146	Positioning data selection 2	"POS-SEL2"	
147	1147	Positioning data selection 4	"POS-SEL4"	
171	1171	PID control multistage command 1	"PID-SS1"	J136 to J138
172	1172	PID control multistage command 2	"PID-SS2"	

Note

A negative logic (Active OFF) command cannot be assigned to the functions marked with "-" in the "Active OFF" column.

The "External alarm" (data = 1009) and "Force to stop" (data = 1030) are fail-safe terminal commands. In the case of "External alarm" when data = 1009, "Active ON" (alarm is triggered when ON); when data = 9, "Active OFF" (alarm is triggered when OFF).

Terminal function assignment and data setting

■ **Select multistep frequency “SS1,” “SS2,” “SS4,” and “SS8” assignment (Function code data = 0, 1, 2, and 3)**

The combination of the ON/OFF states of digital input signals “SS1,” “SS2,” “SS4” and “SS8” selects one of 16 different frequency commands.

(📖 Function codes C05 to C19)

■ **Select ACC/DEC time “RT1” and “RT2” assignment (Function code data = 4 and 5)**

These terminal commands switch between ACC/DEC time 1 to 4 (F07, F08 and E10 through E15).

(📖 Function codes F07, F08)

■ **Select self-hold “HLD” assignment (Function code data = 6)**

This is used as the self-hold signal when performing 3-wire operation with the “FWD”, “REV”, and “HLD” signals.

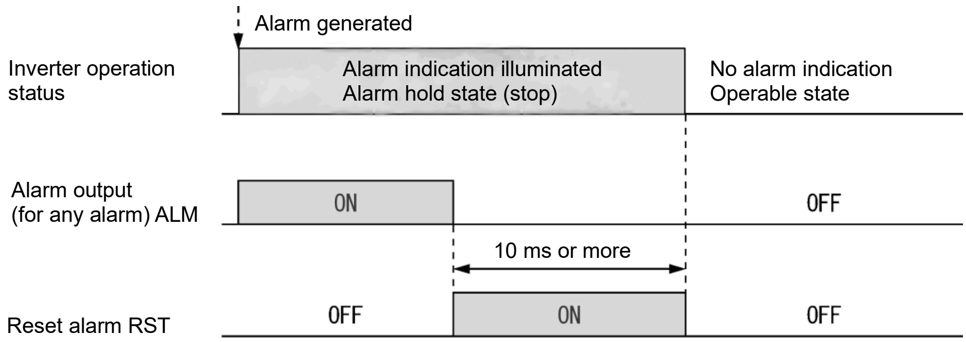
(📖 Function code F02)

■ **Coast-to-a-stop “BX” assignment (Function code data = 7)**

Turning “BX” ON immediately shuts down the inverter output. The motor free runs to a stop, without issuing any alarm.

■ **Alarm (error) reset “RST” assignment (Function code data = 8)**

Turning this terminal command ON clears the ALM state--alarm output (for any alarm). Turning it OFF erases the alarm display and clears the alarm hold state. When you turn the “RST” command ON, keep it ON for 10 ms or more. This command should be kept OFF for the normal inverter operation.



■ **External alarm “THR” assignment (Function code data = 9)**

Turning this terminal command OFF immediately shuts down the inverter output (so that the motor coasts to a stop), displays the alarm 0H2, and issues the alarm output (for any alarm) ALM. The THR command is self-held, and is reset when an alarm reset takes place.

Tip: Use this alarm trip command from external equipment when you have to immediately shut down the inverter output in the event of an abnormal situation in peripheral equipment.

■ **Jogging operation “JOG” assignment (Function code data = 10)**

This terminal command is used to jog or inch the motor for positioning a workpiece.

Turning “JOG” command ON before operating makes the inverter ready for jogging.

(📖 Function code C20)

■ **Frequency setting 2/1 “Hz2/Hz1” assignment (Function code data = 11)**

Turning “Hz2/Hz1” terminal command ON and OFF switches the frequency command source between frequency setting 1 (F01) and frequency setting 2 (C30).

(📖 Function code F01)

■ **Select motor 2 “M2” assignment (Function code data = 12)**

The "M2" signal is used to select a motor from between motor 1 and motor 2.

■ **DC braking command "DCBRK" assignment (Function code data = 13)**

Turning "DCBRK" terminal command ON gives the inverter a DC braking command.

(Requirements for DC braking must be satisfied.)

(📖 Function codes F20 to F22)

■ **Torque limiter level 2/1 "TL2/TL1" assignment (Function code data = 14)**

"TL2/TL1" signal switches between torque limiter 1-1, 1-2 (F40 and F41) and torque limiter 2-1, 2-2 (E16 and E17).

(📖 Function codes F40, F41)

■ **Switch to commercial power (50 Hz) "SW50"/(60 Hz) "SW60" assignment (Function code data = 15, 16)**

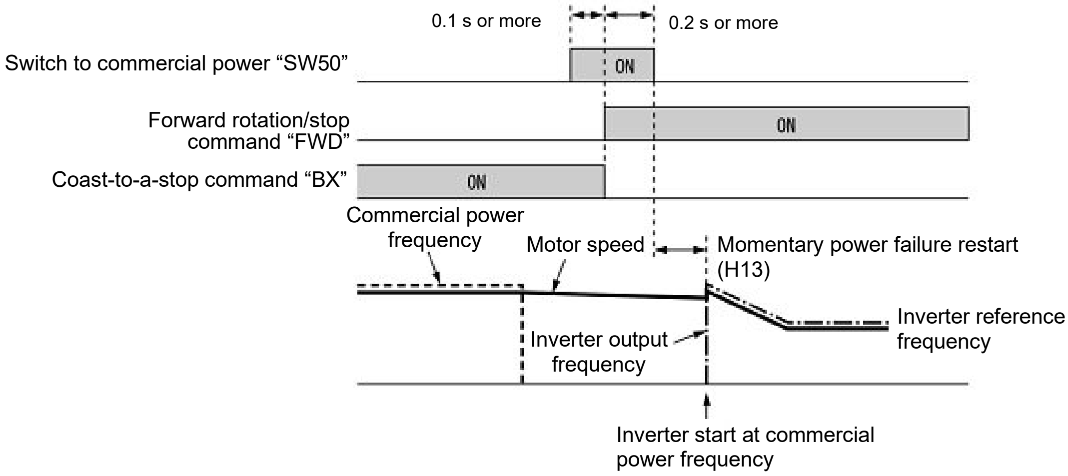
When an external sequence switches the motor drive power from the commercial line to the inverter, the terminal command "SW50" or "SW60" enables the inverter to start running the motor with the current commercial power frequency, regardless of settings of the reference/output frequency in the inverter. A running motor driven by commercial power is carried on into inverter operation. This command helps you smoothly switch the motor drive power source from the commercial power to the inverter power.

For details, refer to the table below, "Operation timing scheme," "Example of sequence circuit" and "Example of operation time scheme" on the following pages.

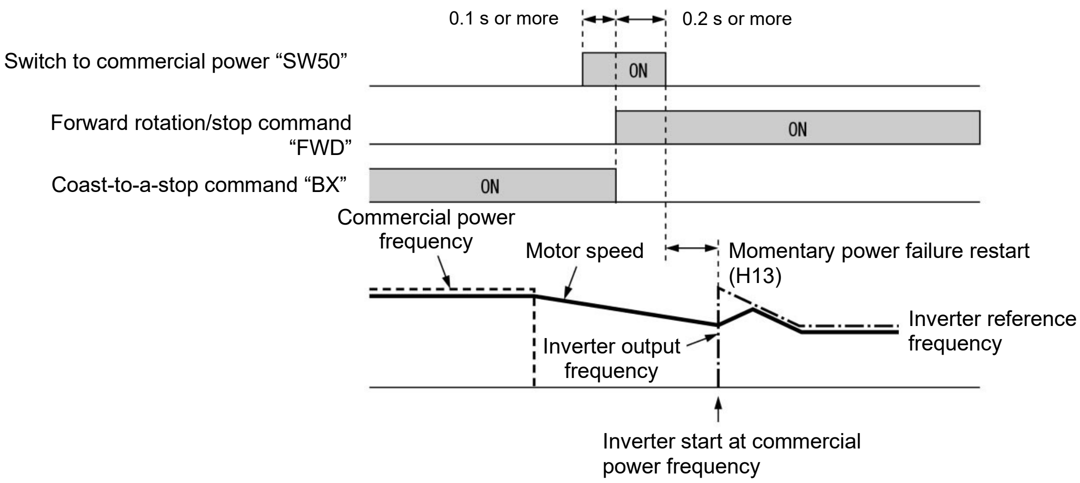
Terminal command assigned	Tuning	
Switch to commercial power for 50 Hz "SW50"	Starts at 50 Hz.	Note: Do not concurrently assign both "SW50" and "SW60." A commercial power supply cannot be used to run synchronous motors.
Switch to commercial power for 60 Hz "SW60"	Starts at 60 Hz.	

<Operation timing scheme>

- When the motor speed remains almost the same during free run:



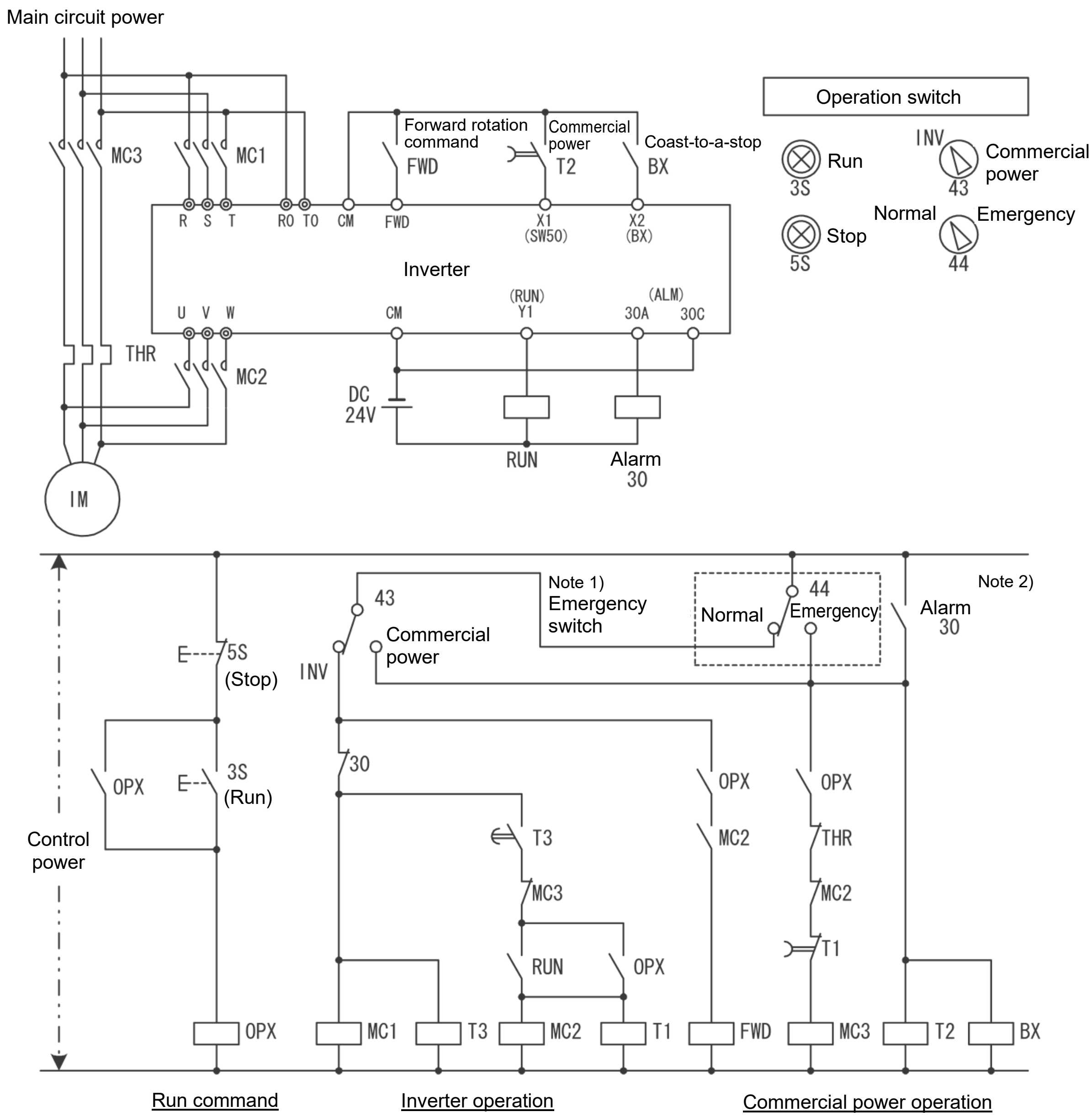
- When the motor speed decreases significantly during free run (with the current limiter activated)



Note

- Secure more than 0.1 second after turning ON the "Switch to commercial power" signal before turning ON a run command.
- Secure more than 0.2 seconds of an overlapping period with both the "Switch to commercial power" signal and run command being ON.
- If an alarm has been issued or BX has been ON when the motor drive source is switched from the commercial power to the inverter, the inverter will not be started at the commercial power frequency and will remain OFF. After the alarm has been reset or "BX" turned OFF, operation at the frequency of the commercial power will not be continued, and the inverter will be started at the ordinary starting frequency.
  If you wish to switch the motor drive source from the commercial line to the inverter, be sure to turn "BX" OFF before the "Switch to commercial power" signal is turned OFF.
- When switching the motor drive source from the inverter to commercial power, adjust the inverter's reference frequency at or slightly higher than that of the commercial power frequency beforehand, taking into consideration the motor speed down during the coast to stop period produced by switching.
- Note that when the motor drive source is switched from the inverter to the commercial power, a high inrush current will be generated, because the phase of the commercial power usually does not match the motor speed at the switching. Make sure that the power supply and all the peripheral equipment are capable of withstanding this inrush current.
- If you have enabled "Momentary power failure restart" (F14 = 3, 4, or 5), keep "BX" ON during commercial power driven operation to prevent the inverter from restarting after a momentary power failure.

<Sequence circuit example>

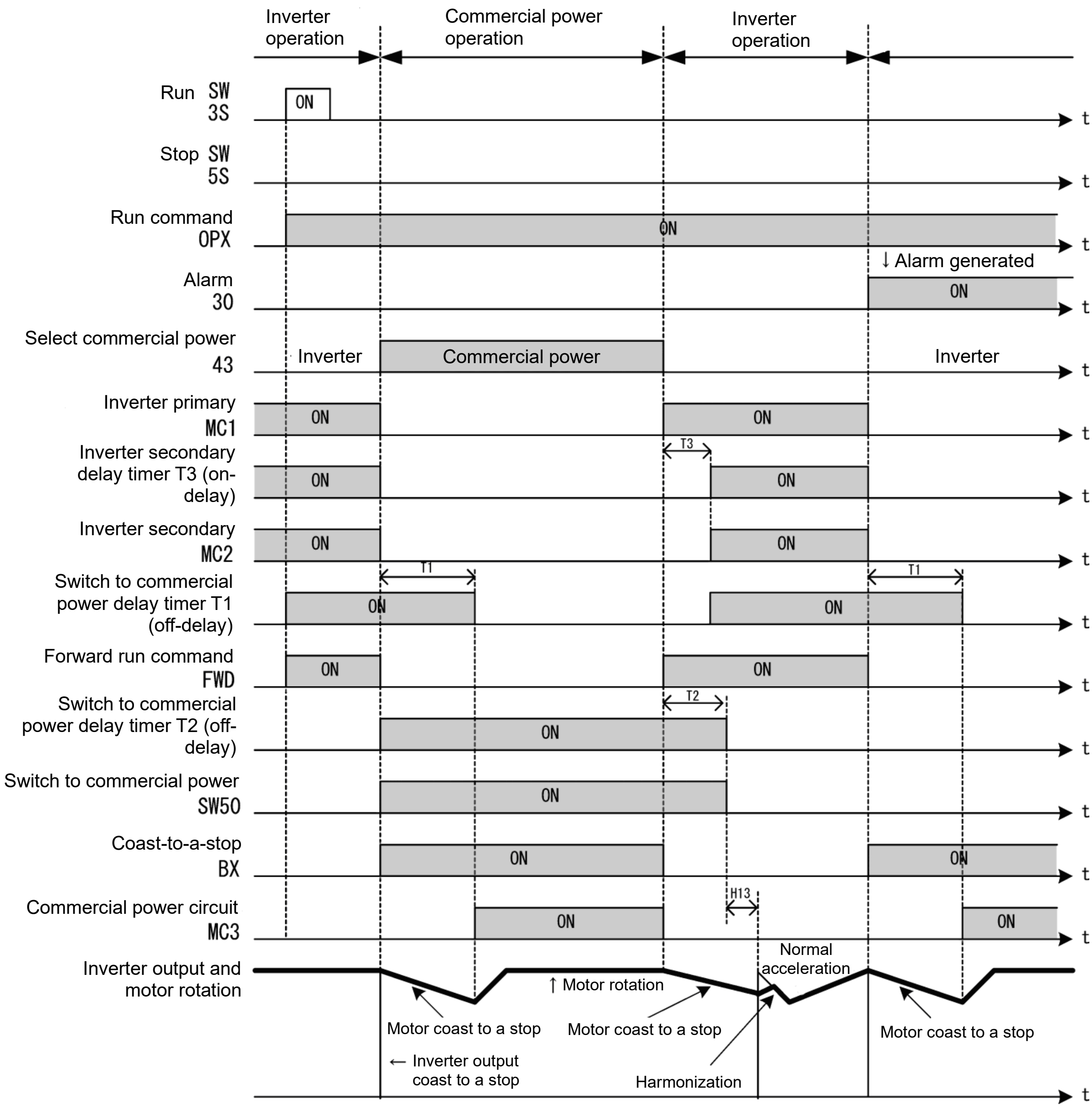


Note 1) Emergency switching

Manual switch provided for the event that the motor drive source cannot be switched normally to the commercial power due to a serious problem of the inverter.

Note 2) When any alarm has occurred inside the inverter, the motor drive source will automatically be switched to the commercial power.

<Operation chart example>



■ **"UP" (Increase output frequency) and "DOWN" (Decrease output frequency) command assignment (Function code data = 17 and 18)**

- Frequency setting: Turning the terminal command "UP" or "DOWN" ON causes the output frequency to increase or decrease, respectively, within the range from 0 Hz to the maximum output frequency.
  (🕮 Function code F01 data = 7)
- PID command: Turning the terminal command "UP" or "DOWN" ON causes the PID command value to increase or decrease, respectively, within the range from 0 to 100%.

■ **Allow function code editing "WE-KP" assignment (Function code data = 19)**

Turning the terminal command "WE-KP" OFF protects function code data from accidentally getting changed by pressing the keys on the keypad. Only when this terminal command is ON, you can change function code data from the keypad.
(🕮 Function code F00)

■ **Cancel PID control "Hz/PID" assignment (Function code data = 20)**

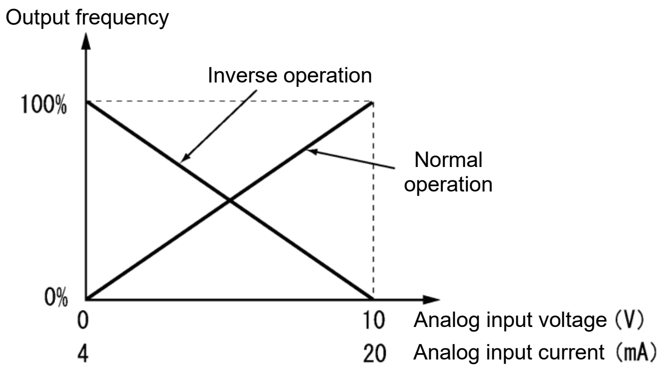
Turning this terminal command "Hz/PID" ON disables PID control. If the PID control is disabled with this command, the inverter runs the motor with the reference frequency manually set by any of the multistep frequency, keypad, analog input, etc.

Terminal command "Hz/PID"	Selected function
OFF	Enable PID control
ON	Disable PID control (Enable manual settings)

(📖 Function codes J01 to J19, J57 to J62)

■ **Switch normal/inverse operation "IVS" assignment (Function code data = 21)**

Switches between normal operation and inverse operation for analog frequency settings or PID control output signals (frequency settings).



Tip

The normal/inverse switching operation is useful for air-conditioners that require switching between cooling and heating. In cooling, the speed of the fan motor (output frequency of the inverter) is <u>increased</u> to <u>lower the temperature</u>. In heating, the speed of the fan motor (output frequency of the inverter) is <u>reduced</u> to <u>lower the temperature</u>. This switching is realized by the IVS.

- Analog frequency settings

With analog frequency settings, it is also possible to switch between normal operation and inverse operation with function codes C53 and C54. Operation will be as shown in the following table if used in combination with "IVS". C53 is a function code for F01: Frequency setting 1, and C54 is for C30: Frequency setting 2.

Reverse operation analog frequency settings

C53 (for F01), C54 (for C30) data	Terminal command "IVS"	Operation
0: Normal operation	OFF	Normal
0: Normal operation	ON	Inverse
1: Inverse operation	OFF	Inverse
1: Inverse operation	ON	Normal

- When process control is performed by the PID processor integrated in the inverter:

The terminal command "Hz/PID" ("Cancel PID control") can switch PID control between enabled (process is to be controlled by the PID processor) and disabled (process is to be controlled by the manual frequency setting). For each operation, inverse operation selection (frequency setting 1) (C53) and PID control operation selection (J01) can be combined with the normal operation/inverse operation switching "IVS" signal, and the decision as to whether to perform normal operation or inverse operation is made as shown in the following table.

When PID control is enabled: The normal/inverse operation selection for the PID processor output (reference frequency) is as follows.

PID control (Mode selection) (J01)	Terminal command "IVS"	Tuning
1: Enable (normal operation)	OFF	Normal
	ON	Inverse
2: Enable (inverse operation)	OFF	Inverse
	ON	Normal

When PID control is disabled: The normal/inverse operation selection for the manual reference frequency is as follows.

Selection of normal/inverse operation for frequency setting 1 (C53)	Terminal command "IVS"	Tuning
0: Normal operation	—	Normal
1: Inverse operation	—	Inverse

Note When process control is performed by the PID control facility integrated in the inverter, the "IVS" is used to switch the PID processor output (reference frequency) between normal and inverse, and has no effect on any normal/inverse operation selection of the manual frequency setting.

(📖 Function codes J01 to J19, J57 to J62)

■ Interlock "IL" assignment (Function code data = 22)

In a configuration where a magnetic contactor (MC) is installed in the power output (secondary) circuit of the inverter, the momentary power failure detection feature provided inside the inverter may not be able to accurately detect a momentary power failure by itself. Using a digital signal input with the interlock command "IL" assures the accurate detection. (📖 Function code F14)

Terminal command "IL"	Meaning
OFF	No momentary power failure has occurred.
ON	A momentary power failure has occurred. (Momentary power failure restart enabled)

■ Cancel torque control "Hz/TRQ" assignment (Function code data = 23)

When torque control is enabled (H18 = 2 or 3), assigning the terminal command "Hz/TRQ" (Cancel torque control) to any of the general-purpose digital input terminals (data = 23) enables switching between speed control and torque control.

Cancel torque control signal "Hz/TRQ"	Tuning
ON	Cancel torque control (Enable speed control)
OFF	Enable torque control

■ Select link operation (RS-485, BUS option) "LE" assignment (Function code data = 24)

Turning this terminal command "LE" ON gives priority to frequency commands or run commands received via the RS-485 communications link (H30) or the fieldbus option (y98).

No LE assignment is functionally equivalent to the "LE" being ON.
(📖 Function codes H30, y98)

■ **Universal DI “U-DI” assignment (Function code data = 25)**

Digital signals from the inverter's peripheral devices can be connected to the inverter's digital input and monitored via RS-485 communication or fieldbus communications link. Input terminals assigned to “U-DI” are simply monitored and do not operate the inverter.

📖 For an access to universal DI via the RS-485 or fieldbus communications link, refer to their respective Instruction Manuals.

■ **Select auto search for idling motor speed at starting “STM” assignment (Function code data = 26)**

Select whether or not to perform a search operation (search a motor that is idling without stopping it) at startup.
(📖 Function code H09)

■ **Forced stop “STOP” assignment (Function code data = 30)**

Turning this terminal command “STOP” OFF causes the motor to decelerate to a stop in accordance with the H56 data (Deceleration time for forced stop). After the motor stops, the inverter enters the alarm state with the alarm Er6 displayed.
(📖 Function code H56)

■ **Pre-excitation “EXITE” assignment (Function code data = 32)**

Turning “EXITE” terminal command ON activates the pre-excitation feature. Even if this pre-excitation command is not assigned, specifying H85 (Pre-excitation: Time) to other than “0.00” enables the inverter to automatically start pre- excitation of the motor when it is turned ON. (This function is enabled when vector control with sensor is selected.)
(📖 Function codes H84, H85)

■ **Reset PID integral and differential terms “PID-RST” assignment (Function code data = 33)**

By turning “PID-RST” ON, PID control, and PID control 1 and 2 PID controller derivative terms and integration terms are reset.

■ **Hold PID integral term “PID-HLD” assignment (Function code data = 34)**

When “PID-HLD” is ON, PID control, and PID control 1 and 2 PID controller integration terms are held.

■ **Local (keypad) command selection “LOC” assignment (Function code data = 35)**

This terminal command “LOC” switches the sources of run and frequency commands between remote and local.

📖For details of switching between remote and local modes, refer to Chapter 3 “3.3.7 Switching between remote and local modes.”

■ **Run enable "RE" assignment (Function code data = 38)**

By assigning "RE" to a digital input, the inverter is not started with run command input alone. After inputting a run command, the "AX2" signal indicating that a run command has been input is output as soon as inverter operation preparation is complete. Actual inverter operation is started for the first time by inputting run permission "RE" after inputting the run command.

Input		Output	Inverter operating status
Run command (FWD, etc.)	Run permission "RE"	Run command entered "AX2"	
OFF	OFF	OFF	Disable command
OFF	ON	OFF	Disable command
ON	OFF	ON	Disable command
ON	ON	ON	Running

<Usage example>

The following sequence illustrates a typical usage example.

(1) Run command "FWD" is sent to the inverter.

(2) When the run command is input, the inverter outputs "AX2" as a signal to indicate that a run command was input and that it is ready for operation.

(3) The host device, upon receiving the "AX2" signal of the run command, prepares peripheral equipment (damper release, etc.) for operation.

(4) When the peripheral equipment is ready for operation, a run permission "RE" signal is sent to the inverter.

(5) The inverter receives the run permission "RE" signal, and starts running.

■ **Condensation prevention "DWP" assignment (Function code data = 39)**

By turning on Condensation prevention "DWP" when the motor is stopped, DC current flows to raise the motor temperature to prevent condensation forming. (Function code J21)

■ **Activate the limit switch at start point "LS" assignment (Function code data = 42)**

This is a limit switch at start point signal used for position control.

For details on position control, refer to function codes d201 to d299.

■ **Enable overload stop "OLS" assignment (Function code data = 46)**

Turning "OLS" terminal command ON enables the overload stop function; turning it OFF disables the function. If no OLS is assigned, the function is enabled.
(Function code J63 to J67)

■ **Servo-lock command "LOCK" assignment (Function code data = 47)**

Turning this terminal command ON enables a servo-lock command; turning it OFF disables a servo-lock command.
(Function codes J97 to J99, d27, d28)

■ **Pulse string input "PIN", Pulse string sign "SIGN" assignment (Function code data = 48, 49)**

Frequency setting by pulse string input is possible with terminal [X6] and [X7]. It is necessary to assign terminal [X6] and [X7] to pulse string input "PIN". Assigning the command "SIGN" to one of the digital input terminals except [X6] and [X7] enables the pulse string sign input to specify the polarity of frequency command.
(Function code F01)

■ **UP/DOWN frequency clear "STZ" assignment (Function code data = 58)**

If set to save initial values in the frequency setting (H61 = 1, 3) with the UP/DOWN signal, the initial value is forcibly cleared to zero when this signal is turned ON.
(Function code F01)

■ **Battery/UPS operation selection "BATRY/UPS" assignment (Function code data = 59)**

The Battery operation can drive the motor during undervoltage situation. It is intended to drive a load to its normal position with a low-voltage or small-capacity emergency battery/UPS when, for example, an elevator cannot stop in its normal position due to a power failure.

Battery/UPS operation is performed as either "battery operation" or "UPS operation," depending on the model used.

Operation mode	Applicable model	Power supply method
Battery operation	FRN0088 to 0115E3S/N-2G, FRN0059 to 0072E3S/E/N-4G (Models with terminals [R0], [T0])	Main power should be supplied from the battery. Control power (either sinusoidal waveform voltage or DC voltage) should be supplied between the auxiliary power supply terminals [R0] and [T0] from the UPS.
UPS operation	FRN0001 to 0115E3S/N-2G, FRN0002 to 0072E3S/E/N-4G	Power should be supplied from the UPS.

When "BATRY/UPS" is assigned to the digital input terminal, the inverter does not enter the operation mode at momentary power failure, regardless of the F14 setting. The inverter trips upon power failure.
When "BATRY/UPS" is on, input phase loss protection operation is disabled regardless of the function code H98 bit 1 setting. Furthermore, main circuit power cutoff detection is also disabled regardless of the H72 setting.

Note

(1) Connect the battery/UPS power supply before or simultaneously with turning on the "BATRY/UPS" signal.

(2) Between the period from turning on of the "BATRY/UPS" signal and MC2 (and power supply start from the battery/UPS) to the state that the battery/UPS operation is possible, the delay time "T1" + "T2" indicated in the above "time chart" occurs.

(3) Do not turn on the "BATRY/UPS" signal when the voltage is same or higher than the specified undervoltage level (before LU is indicated after the power failure). If the "BATRY/UPS" signal is turned on with the voltage same or higher than the undervoltage value, the specified level, the short circuit for charging resistor 73X remains on.

(4) During the battery/UPS operation, avoid driving with application of the heavy load. Operate with no load or braking load.
(Sufficient torque cannot be obtained by the battery/UPS voltage, and the motor may stall in such case.)

(5) Operate the motor with battery/UPS operation at a low speed, and pay attention to the battery/UPS capacity.

In addition, when the high voltage is supplied (such as when 300 VDC power supply at 200 V series inverter and 600 VDC power supply at 400 V series inverter), operate normally without the battery/UPS.

(6) During the normal operation, it is required to turn off the "BATRY/UPS" signal. If the main power is turned on with the "BATRY/UPS" signal on, the 73X remains ON, causing the rectifier diode getting damaged.

- UPS operation (for operation with models 22 kW or below)

The motor can be operated by an inverter in a state of undervoltage by UPS power. If function code data is changed during undervoltage, an Er1 alarm or ErF alarm may occur. In this case, the initialization of all data in H03=1 is required.

Related function code	Setting range
H111: UPS operation level	120 to 220 Vdc (200 V series), 240 to 440 Vdc (400 V series)

Note **Prerequisite of UPS operation**

(1) Terminal function “BATRY/UPS” (data = 59) can be assigned to any digital input terminal.

(2) As shown in the connection diagram example below, DC link bus voltage is supplied from the UPS to the main circuit ([L1/R] - [L3/T] or [L2/S] - [L3/T]). See, Figure 5.3-7.

(3) The required power supply voltage depends on the size of the load and on the driving speed of the motor.

(4) The terminal that “BATRY/UPS” (data = 59) is assigned has to be turned on simultaneously with the MC2.

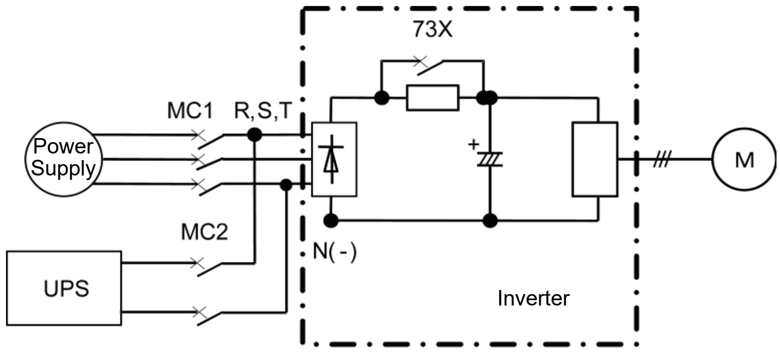


Figure 5.3-7 UPS operation connection diagram

UPS operation (when “BATRY/UPS” = ON)

(1) Once the DC intermediate voltage level exceeds the H111 setting value, the inverter can operate the motor after the elapsed time specified in (2) below. However, even if operation is possible, the “RDY” signal is not output.

(2) The circuit of the charging resistor is shorted after the delay time T1 (max. 0.2 sec.) from the “BATRY/UPS” terminal being turned ON. (73X = ON).
Then, after the delay time T2 (max. 0.1 sec.), UPS operation becomes possible.

(3) S-curve acceleration/deceleration becomes invalid.

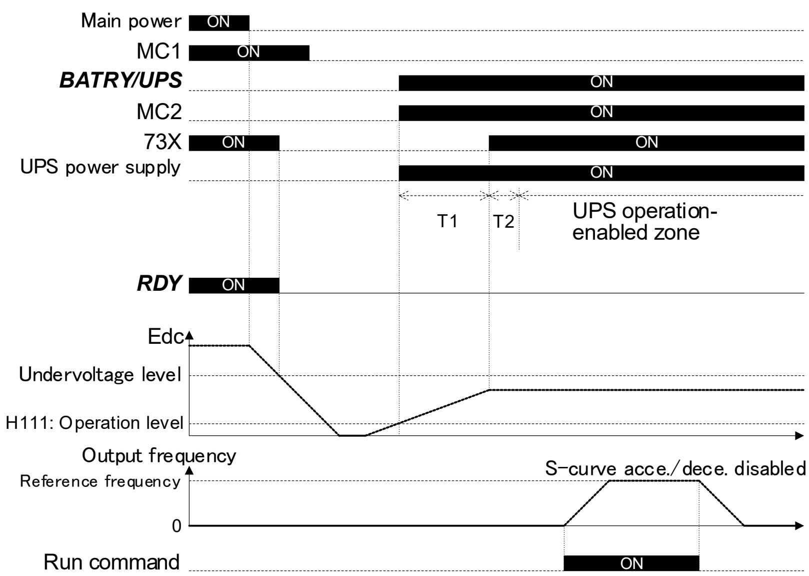


Figure 5.3-8 UPS operation timing chart

• Battery operation (for operation with FRN0088E3□-2G or above FRN0059E3□-4G or above)

The motor can be operated by an inverter in a state of undervoltage by battery power.

Note **Prerequisite of battery operation**

(1) Terminal function “BATRY/UPS” (data = 59) can be assigned to any digital input terminal.

(2) As shown in the connection diagram example below, DC power supply is supplied from the battery to the main circuit ([L1/R] - [L3/T] or [L2/S] - [L3/T]).

(3) The power supply at the specified voltage (sinusoidal waveform or DC voltage) is input to auxiliary power terminal ([R0] - [T0])

(4) The terminal that “BATRY/UPS” (data = 59) is assigned has to be turned on simultaneously with the MC2.

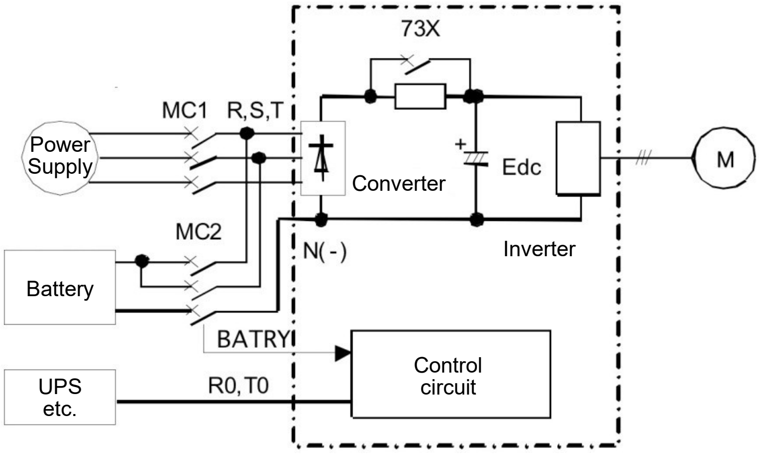


Figure 5.3-9 Battery operation connection diagram

Battery operation (when “BATRY/UPS” = ON)

(1) Undervoltage protection function (LU) is disabled.

(2) The inverter can operate the motor even when in a state of undervoltage.

(3) Inverter ready to run “RDY” signal is turned OFF.

(4) The circuit of charging resistor is shorted after the delay time T1 from the “BATRY/UPS” terminal being turned ON. (73X = ON). Then, after the delay time T2 (max. 0.1 sec.), the battery operation starts. Refer to the table “Time T1 from “BATRY/UPS” ON to 73X ON”on the next page for the T1 specifications.

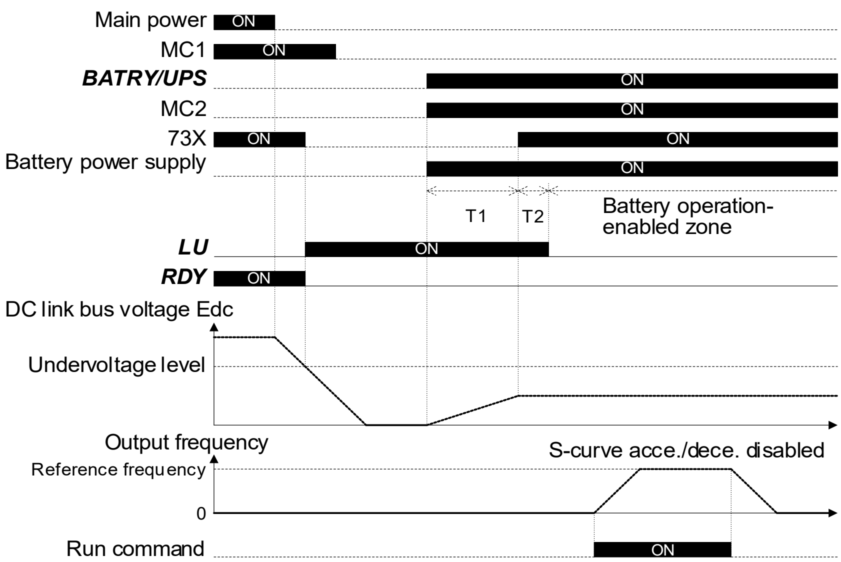


Figure 5.3-10 Battery operation timing chart

Time T1 from “BATRY/UPS” ON to 73X ON

Power supply condition	T1
Time required for turning on the control power supply, switching to the power supply from the battery, and then to turning on the charging resistor short circuit 73X	100 ms
Time required from the occurrence of momentary power failure in the control power supply ON status, switching to the power supply from the battery, and turning on of the short circuit 73X for the charging resistor	205 ms

(5) S-curve acceleration/deceleration becomes invalid.

(6) The speed at which operation is possible during battery operation is calculated based on the following formula.

$$\text{Frequency command during battery operation} \leq \frac{\text{Battery voltage -5 [V]}}{\sqrt{2}\ \text{x base voltage (F05)}} \text{x Base frequency (F04) x k}$$

Here,

Battery voltage:	24 VDC or higher (200V series) 48 VDC or higher (400V series)
Rated frequency:	F04
Rated voltage:	F05 (Motor rated voltage (V))
k:	Safety factor (less than 1. Approx. 0.8)

■ **Torque bias command 1, 2 -- “TB1”, “TB2” assignment (Function code data = 60, 61)**

The torque bias level can be selected from three types by combining the “TB1” and “TB2” signals. Only available when using vector control with sensor.

(📖 Function codes H154 to H162)

Input signal		Torque bias selection
“TB2”	“TB1”	
OFF	OFF	Disable torque-bias
OFF	ON	H155: Torque bias level 1
ON	OFF	H156: Torque bias level 2
ON	ON	H157: Torque bias level 3

■ **Hold torque bias -- “H-TB” assignment (Function code data = 62)**

Turning this terminal command ON enables a torque bias hold command. This command directs to preserve the torque bias data supplied via an analog input.

(📖 Function codes H154 to H162)

■ **Check brake “BRKE” assignment (Function code data = 65)**

If the status of the brake signal “BRKS” fails to agree with the status of the brake check signal “BRKE” during inverter operation, the inverter enters an alarm stop state with Er6.

This signal is used as a feedback signal for the brake signal “BRKS”. When the mechanical brake does not operate, it causes the inverter to trip to activate the mechanical brake. The response delay time for “BRKS” and “BRKE” can be adjusted with H180: Brake response time. Furthermore, brake settings for forward rotation and reverse rotation can be specified individually with d120 to d125.

(📖 Function codes J68 to J96, H180, d120 to d125)

■ **Cancel line speed control -- "Hz/LSC" assignment (Function code data = 70)**

Turning ON "Hz/LSC" cancels line speed control. This disables the frequency compensation of PI operation, resulting in no compensation for a take-up roll getting bigger and an increase in the winding speed. Use this signal to temporarily interrupt the control for repairing a thread break, for example.

"Hz/LSC"	Function
OFF	Enable line speed control (depending on d41 setting)
ON	Cancel line speed control (V/f control, without compensation for a take-up roll getting bigger)

(📖 Function code d41)

■ **Hold line speed control frequency in the memory -- "LSC-HLD" assignment (Function code E01 to E05, data = 71)**

If "LSC/HLD" is ON under line speed control frequency, stopping the inverter (including an occurrence of an alarm and a coast to stop command) or turning OFF "Hz/LSC" saves the current frequency command compensating for a take-up roll getting bigger, in the memory. At the time of restart, the saved frequency command is applied and the inverter keeps the line speed constant.

"LSC-HLD"	Function
OFF	Disable (No saving operation)
ON	Enable (Saving the frequency command compensating for a take-up roll getting bigger)

Note Shutting down the inverter power during operation stop loses the frequency compensation data saved in the memory. At the time of restart, therefore, the inverter runs at the frequency without compensation so that a large overshoot may occur.

■ **Input during operation with commercial power supply (Motor 1 to 2) "CRUN-M1", "CRUN-M2" assignment (Function code data = 72 to 73)**

These terminal commands enable the inverter to count the cumulative run time of motor-1 to motor-4 even when they are driven by commercial power (not by the inverter). When "CRUN-M1" or "CRUN-M2" is ON, the inverter judges that the motor-1, motor-2, motor-3, or motor-4 is driven by commercial power, respectively, and counts the run time of the corresponding motor.

(📖 Function codes H94, A51, b51, r51)

■ **Select droop control "DROOP" assignment (Function code data = 76)**

This terminal command "DROOP" toggles droop control on and off.

Terminal command "DROOP"	Droop control
ON	Enable
OFF	Disable

(📖 Function code H28)

■ **Select speed control parameters 1, 2 "MPRM1", "MPRM2" assignment (Function code data = 78, 79)**

The combination of the ON/OFF states of digital input signals "**MPRM1**" and "**MPRM2**" selects one of 4 different level speed control parameter sets. These parameters are valid under vector control with sensor, V/f control with sensor, and sensorless vector control.

(📖 Function codes d01 to d06)

Input signal		Speed control constant
"MPRM2"	"MPRM1"	
OFF	OFF	Speed control constant 1: d01 to d06
OFF	ON	Speed control constant 2: A43 to A50
ON	OFF	Speed control constant 3: b43 to b50
ON	ON	Speed control constant 4: r43 to r50

■ **Cancel customizable logic "CLC" assignment; Clear all customizable logic timers "CLTC" assignment (Function code data = 80, 81)**

Terminal command "CLC" stops the operation of customizable logic. Terminal command "CLTC" clears all customizable logic timers.

(📖 Function code U codes)

■ **Cancel anti-regenerative control "AR-CCL" assignment (Function code data = 82)**

Anti-regenerative control can be canceled with "AR-CCL." When "AR-CCL" is ON, the H69 setting is ignored, and anti-regenerative control is disabled.

(📖 Function code H69)

■ **PG input switching “PG-SEL” assignment (Function code data = 83)**

The PG option card command/feedback channel can be changed with “PG-SEL.” Switching is possible only while the inverter is stopped. If terminal operation is performed while the inverter is running, it will stop before switching. This function cannot be used with synchronous motor drive with sensor.

• If using a dual system PG option card.

Input signal “PG-SEL”	Command	Feedback
OFF	[XA]/[XB]	[YA]/[YB]
ON	[YA]/[YB]	[XA]/[XB]

• If using a single system PG option card

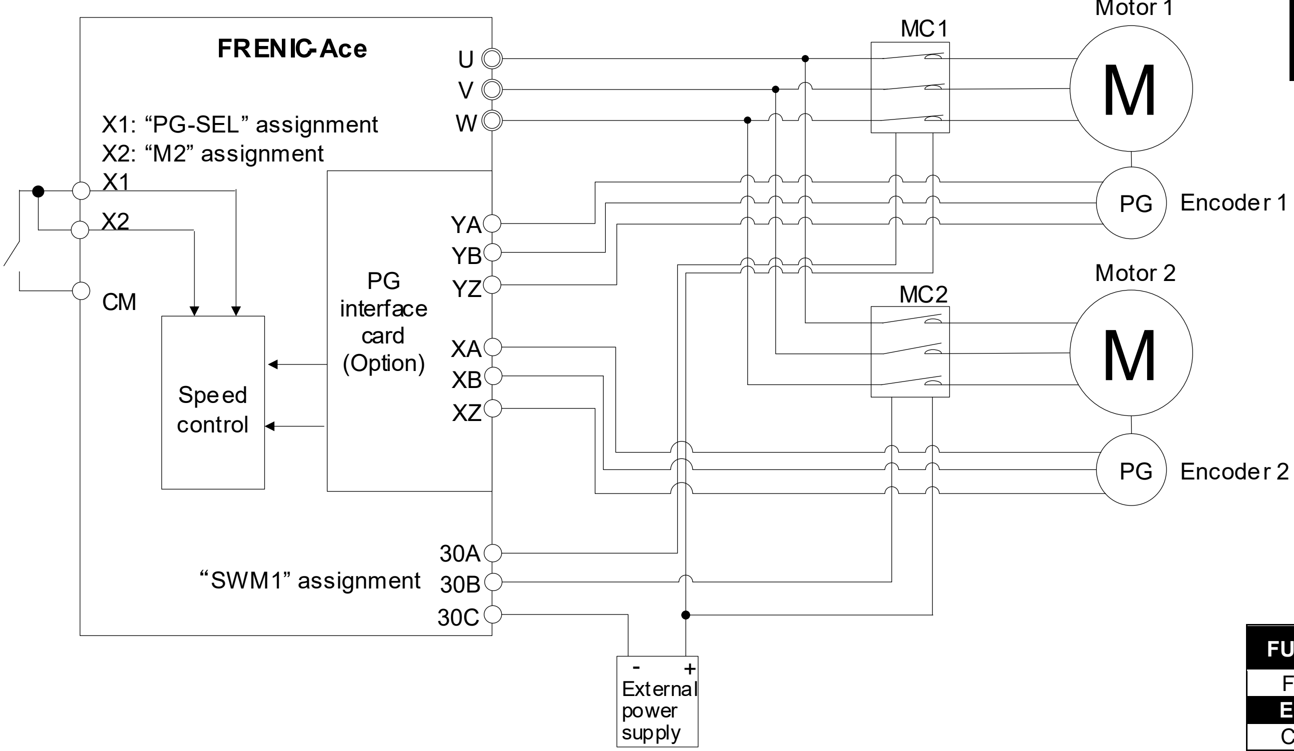
Input signal “PG-SEL”	Command	Feedback
OFF	-	[YA]/[YB]
ON	[YA]/[YB]	-

(🕮 Function code F01)

Usage example

If switching between two motors with encoders, an external switching circuit is installed for both the motors and encoders, but with dual system PG option cards, the encoder switching circuit will not be necessary if using this function.

Connection example



■ **Acceleration/deceleration cancel (bypass) “BPS” assignment (Function code data = 84)**

By turning “BPS” ON, the currently selected acceleration/deceleration time is interpreted as zero, and the set frequency is immediately output. This does not happen during PID control. This does not work for acceleration/deceleration time set individually for jogging operation or forced stop. This signal can be turned ON during operation.

(🕮 Function code F07)

■ **Forward JOG "FJOG," Reverse JOG "RJOG" assignment (Function code data = 94, 95)**

This is valid only when performing terminal block operation (F02 = 1). Jogging operation can be performed in the forward direction or reverse direction with "FJOG" and "RJOG." By turning this signal ON, the inverter runs at the frequency selected with C20. The acceleration/deceleration time is set with H54 and H55. There is no need to turn ON the "JOG" signal.

(🕮 Function code C20)

■ **Rotation direction command "DIR" assignment (Function code data = 97)**

This is valid only when performing terminal block operation (F02 = 1). By turning "DIR" ON, the command can be changed to a direction run command opposite to the run command direction set with terminals [FWD] and [REV]. Switching is possible during operation. This signal can also be used in combination with "HLD." This signal is disabled for communication commands and run commands from the keypad.

(🕮 Function code F02)

■ **Forward rotation/stop command "FWD" assignment (Function code data = 98)**

Turning "FWD" terminal command ON runs the motor in the forward direction; turning it OFF decelerates it to stop.

Tip This terminal command "FWD" can be assigned only to E98 or E99.

■ **Reverse rotation/stop command "REV" assignment (Function code data = 99)**

Turning this terminal command "REV" ON runs the motor in the reverse direction; turning it OFF decelerates it to stop.

Tip This terminal command "REV" can be assigned only to E98 or E99.

■ **No assignment "NONE" assignment (Function code data = 100)**

It allows the inverter to run unaffected by ON/OFF of signals. It is used when a signal is externally input using customizable logic. It is also used to temporarily disable a terminal function.

■ **Speed regulator P operation "P-SEL" assignment (Function code data = 119)**

Position control is performed with the P term only, and the integration term is canceled.

This is used to avoid any adverse effects caused by the integration term while the brake is ON.

🕮For details on position control, refer to function codes d201 to d299.

■ **Customizable logic input 1 to 9 "CLI1" to "CLO9" assignment (Function code data = 121 to 129)**

It allows the inverter to run unaffected by ON/OFF signals. It is used when a signal is externally input using customizable logic.

(🕮 Function code U00)

■ **Forced operation command "FMS" assignment (Function code data = 134)**

By turning "FMS" ON, almost all inverter protective operations are disabled, and inverter output continues until a fault occurs. This is used when not wishing to trip inverters in such cases as when using with emergency exhaust equipment.

(🕮 Function codes H116 to H121)

■ **Displacement/absolute position switching "INC/ABS" assignment (Function code data = 135 to 147)**

This signal is used with position control.

🕮For details on position control, refer to function codes d201 to d299.

■ **PID control multistage command 1, 2 "PID-SS1," "PID-SS2" assignment (Function code data = 171, 172)**

"PID-SS1" and "PID-SS2" can be used to select 4 different PID commands.

(🕮 Function code J136 to J138)

E10 to E15	Acceleration time 2 to 4, Deceleration time 2 to 4 (Refer to F07)

Acceleration/deceleration time 2 to 4 settings are described in detail at the function code F07 section.

E16, E17	Torque limiter 2 (driving), 2 (braking) (Refer to F40)

For the torque limiter 2 (driving) and 2 (braking) settings, refer to the description of F40.

E20 to E21 E27	Terminal [Y1] to [Y2] (Function selection) Terminals [30A/B/C] (Ry output) (Refer to E71)

E20 to E21, and E27 assign output signals to general-purpose, programmable output terminals [Y1] to [Y2] and [30A/B/C]. These function codes can also switch the logic system between normal and negative to define how the inverter interprets the ON or OFF state of each terminal.

The factory default setting is normal logic system "Active ON." Terminals [Y1] to [Y2] are transistor outputs, and [30A/B/C] are contact outputs. In normal logic, if an alarm occurs, the relay will be energized so that [30A] and [30C] will be closed, and [30B] and [30C] opened. In negative logic, the relay will be de-energized so that [30A] and [30C] will be opened, and [30B] and [30C] closed. This may be useful for the implementation of failsafe power systems.

Note

- By using the logic inversion setting, each signal is active (e.g., side at which alarm is occurring) for the period during which the inverter power is OFF. To avoid causing system malfunctions by this, interlock these signals to keep them ON using an external power supply. Furthermore, the validity of these output signals is not guaranteed for approximately 1.5 seconds (FRN0115E3☐-2G or below/FRN0072E3☐-4G or below) or 3 seconds (30 kW or later) after power-ON, so introduce such a mechanism that masks them during the transient period.
- Contact outputs (terminal [30A/B/C]) are mechanical contacts. They cannot withstand frequent ON/OFF switching. Where frequent ON/OFF switching is anticipated (For example, when using current-limiting operations by selecting signals during inverter output limiting, such as during commercial switching, direct startup, etc.), use transistor outputs [Y1] to [Y2] instead.
  The service life of a relay is approximately 200,000 times if it is switched ON and OFF at one-second intervals. For signals expected to be turned ON/OFF frequently, use terminals [Y1] to [Y2] for output.

The tables given on the following pages list functions that can be assigned to terminals [Y1] to [Y2], and [30A/B/C]. Each signal has been described at data allocation order. However, the signal is related has been described together. Refer to the function codes or signals in the "Related function codes/signals (data)" column, if any.

Explanations of each function are given in normal logic system "Active ON."

With terminal functions for which Y is indicated for E71 (keypad M-LED indicator) in the "5.2-4 Control output terminal setting list table" under "[2] E codes" in "5.2.2 Function code tables," by setting the same data as in E20 to E21 and E27 for function code E71, signals can be monitored with keypad M-LEDs. For details. refer to the explanation on function code E71.

Data		Defined function	Signal name	Related function codes/related signals (data)
Active				
ON	OFF			
0	1000	Inverter running	"RUN"	—
1	1001	Frequency (speed) arrival	"FAR"	E30
2	1002	Frequency (speed) detection	"FDT2	E31, E32
3	1003	Undervoltage detected (Inverter stopped)	"LU"	—
4	1004	Torque polarity detection	"B/D"	—
5	1005	Inverter output limiting	"IOL"	—
6	1006	Auto-restarting after momentary power failure	"IPF"	F14
7	1007	Motor overload early warning	"OL"	E34, F10, F12
8	1008	Keypad operation	"KP"	—
10	1010	Inverter ready to run	"RDY"	—
15	1015	AX terminal functions (for input side magnetic contactor)	"AX"	—

Data		Defined function	Signal name	Related function codes/related signals (data)
Active				
ON	OFF			
16	1016	Pattern operation stage transition	"TU"	C21, C22 to C28
17	1017	Pattern operation cycle completed	"TO"	C21, C22 to C28
18	1018	Pattern operation stage No. 1	"STG1"	
19	1019	Pattern operation stage No. 2	"STG2"	
20	1020	Pattern operation stage No. 4	"STG4"	
21	1021	Frequency (speed) arrival 2	"FAR2"	E29
22	1022	Inverter output limiting (with delay)	"IOL2"	IOL (5)
25	1025	Cooling fan ON-OFF control	"FAN"	H06
26	1026	Auto-resetting	"TRY"	H04, H05
27	1027	Universal DO	"U-DO"	—
28	1028	Cooling fin overheat early warning	"OH"	—
29	1029	Master-follower synchronization complete	"SY"	d17 to d78
30	1030	Lifetime alarm	"LIFE"	H42
31	1031	Frequency (speed) detection 2	"FDT2"	E32, E36
33	1033	Reference loss detection	"REF OFF"	E65
35	1035	Inverter outputting	"RUN2"	"RUN" (0)
36	1036	Overload prevention controlling	"OLP"	H70
37	1037	Current detection	"ID"	E34, E35
38	1038	Current detection 2	"ID2"	E37, E38
39	1039	Current detection 3	"ID3"	E55, E56
41	1041	Low current detection	"IDL"	E37, E38
42	1042	PID alarm output	"PID-ALM"	J11 to J13
43	1043	Under PID control	"PID-CTL"	J01
44	1044	Under PID low liquid level stop	"PID-STP"	J08, J09
45	1045	Low torque detection	"U-TL"	E89, E81
46	1046	Torque detection 1	"TD1"	E78, E79
47	1047	Torque detection 2	"TD2"	E80, E81
48	1048	Motor 1 selected	"SWM1"	—
49	1049	Motor 2 selected	"SWM2"	
52	1052	Performing forward rotation	"FRUN"	—
53	1053	Performing reverse rotation	"RRUN"	—
54	1054	In remote mode	"RMT"	(Refer to Section 3.3.8)
55	1055	Run command entered	"AX2"	—
56	1056	Motor overheat detected by thermistor	"THM"	H26, H27
57	1057	Machine brake signal control	"BRKS"	J68 to J72,□ d120 to d125
58	1058	Frequency (speed) detection 3	"FDT3"	E32, E54
59	1059	Terminal [C1] wire break detection	"C1OFF"	—
70	1070	Speed valid	"DNZS"	F25, F38
71	1071	Speed agreement	"DSAG"	d21, d22
72	1072	Frequency (speed) arrival 3	"FAR3"	E30
76	1076	Speed agreement/PG error	"PG-ERR"	d21 to d23
77	1077	Low DC link bus voltage detection	"U-EDC"	E76
79	1079	During deceleration in momentary power failure	"IPF2"	—

Data (Active) ON	Data (Active) OFF	Defined function	Signal name	Related function codes/related signals (data)
80	1080	Stop position override alarm	“OT”	J73 to J88
81	1081	Under positioning	“TO”	
82	1082	Positioning complete	"PSET"	
83	1083	Current position count over-flowed	"POF"	
84	1084	Maintenance timer	"MNT"	H44, H78, H79
87	1087	Frequency arrival and frequency detection	"FARFDT"	E30, E31, E32
89	1089	Magnetic pole position detection complete	"PTD"	P30
90	1090	Alarm content 1	“AL1”	—
91	1091	Alarm content 2	“AL2”	
92	1092	Alarm content 4	“AL4”	
93	1093	Alarm content 8	“AL8”	
95	1095	Performing forced operation	"FMRUN"	H116 to H121
98	1098	Warning	“L-ALM”	H81 to H83
99	1099	Alarm output (for any alarm)	"ALM"	—
100	—	No function assigned	"NONE"	o01 to o07, o121 to o128
101	1101	EN terminal detection circuit error	"DECF"	—
102	1102	EN terminal input OFF	"ENOFF"	
105	1105	Braking transistor error	"DBAL"	H98
111 to 124	1111 to 1124	Customizable logic output signal 1 to 14	“CLO1” to “CLO14”	U code
125	1125	Integral power pulse output	"POUT"	E57
131	1131	Performing speed limiting	"S-LIM"	—
132	1132	Torque limiting	"T-LIM"	F40, F41
133	1133	Low current detection 2	“IDL2”	E34
251	1251	Shift key ON/OFF status	"MTGL"	

Note: A negative logic (Active OFF) command cannot be assigned to the functions marked with “-” in the “Active OFF” column.

■ **Inverter running "RUN" assignment (Function code data = 0), Inverter outputting "RUN2" assignment (Function code data = 35)**

These output signals tell the external equipment that the inverter is running at a starting frequency or higher. If assigned in negative logic (Active OFF), these signals can be used to tell the "Inverter being stopped" state.

<table>
<tr><th>Output signal</th><th>Basic function</th><th>Remarks</th></tr>
<tr><td>"RUN"</td><td rowspan="2">These signals come ON when the inverter is running.
Under V/f control: These signals come ON if the inverter output frequency exceeds the starting frequency, and go OFF if it drops below the stop frequency. The "RUN" signal can also be used as a "Speed valid" signal.</td><td>Goes OFF during DC braking.</td></tr>
<tr><td>"RUN2"</td><td>Comes ON even during DC braking, pre-excitation, zero speed control.</td></tr>
</table>

■ **Frequency (speed) arrival "FAR" assignment (Function code data = 1), Frequency (speed) arrival 3 "FAR3" assignment (Function code data = 72)**

These output signals come ON when the difference between the output frequency (detected speed) and reference frequency (reference speed) comes within the frequency arrival hysteresis width specified by E30.
(: Function code E30)

■ **Frequency (speed) detection "FDT" assignment (Function code data = 2), Frequency (speed) detection 2 "FDT2" assignment (Function code data = 31), Frequency (speed) detection 3 "FDT3" assignment (Function code data = 58)**

These output signals FDT, FDT2 or FDT3 come ON when the output frequency (detected speed) reaches or exceeds the frequency detection level specified by E31, E36 or E54, respectively, and go OFF when the output frequency (detected speed) drops below the "Frequency detection level (E31, E36 or E54) - Hysteresis range (E32)."
(Function codes E31, E32)

■ **Undervoltage detected (Inverter stopped) "LU" assignment (Function code data = 3)**

This output signal comes ON when the DC link bus voltage of the inverter drops below the specified undervoltage level. When this signal is ON, the inverter cannot run even if a run command is given. It goes OFF when the voltage recovers and exceeds the undervoltage detection level. The undervoltage protection function will be triggered, and the motor error stop (trip) status will also turn ON.

■ **Torque polarity detection "B/D" assignment (Function code data = 4)**

The inverter issues the driving or braking polarity signal to this digital output judging from the internally calculated torque or torque command. This signal goes OFF when the detected torque corresponds to driving, and it goes ON when it corresponds to braking.

■ **Inverter output limiting "IOL" assignment (Function code data = 5), Inverter output limiting (with delay) "IOL2" assignment (Function code data = 22)**

The output signal IOL comes ON when the inverter is limiting the output frequency by activating any of the following actions (minimum width of the output signal: 100 ms). The output signal "IOL2" comes ON when any of the following output limiting operation continues for 20 ms or more.

- Torque limiting (F40, F41, E16 and E17, Maximum internal value)
- Current limiting by software (F43 and F44)
- Instantaneous overcurrent limiting by hardware (H12 = 1)
- Automatic deceleration (Anti-regenerative control) (H69)
- Overload stop function (J65)

Note When the "IOL" is ON, it may mean that the output frequency may have deviated from the reference frequency because of the limiting functions above.

■ Auto-restarting after momentary power failure "IPF" assignment (Function code data = 6)

This output signal is ON either during continuous running after a momentary power failure or during the period after the inverter detects an undervoltage condition and shuts down the output until restart has been completed (the output has reached the reference frequency).

(📖 Function code F14)

■ Motor overload early warning "OL" assignment (Function code data = 7)

The OL signal is used to detect a symptom of an overload condition (alarm code OL1 to OL2) of the motor so that the user can take an appropriate action before the alarm actually happens. (📖 Function code E34)

■ Keypad operation "KP" assignment (Function code data = 8)

An ON signal is output when run commands (RUN, STOP keys) from the keypad are active.

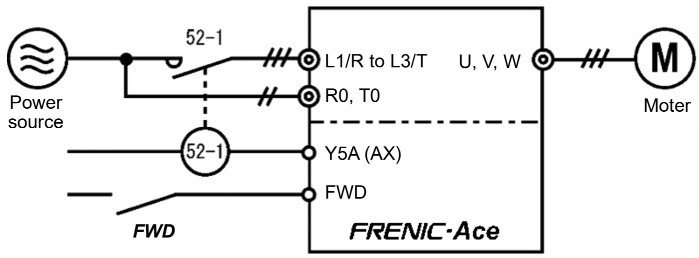
■ Inverter ready to run "RDY" assignment (Function code data = 10)

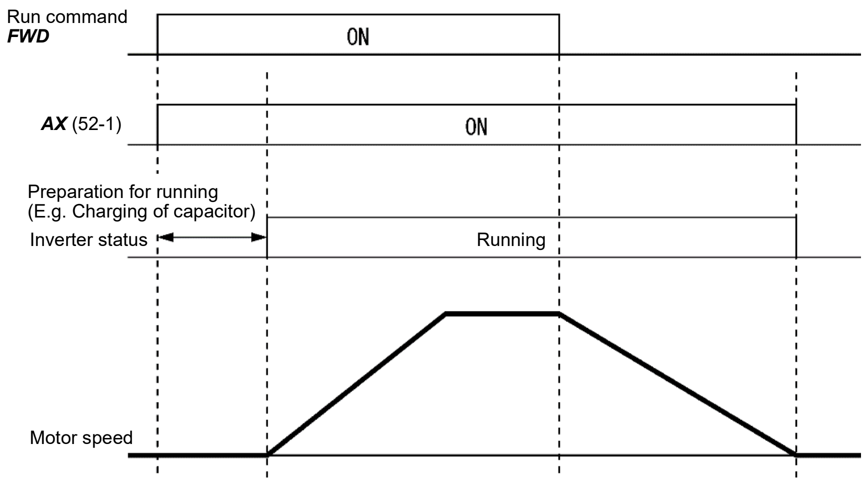
This output signal comes ON when the inverter becomes ready to run by completing hardware preparation (such as initial charging of DC link bus capacitors and initialization of the control circuit) and no protective functions are activated. "RDY" OFF conditions are shown in the following table.

"RDY" OFF conditions
Undervoltage (excl. restart after momentary power failure)
Alarm occurring
Terminal [BX] ON (coast-to-a-stop status)
Terminal [BATRY/UPS] ON (performing battery/UPS operation)
OFF across terminals [EN1] and [PLC], or across [EN2] and [PLC]

■ AX terminal functions "AX" assignment (Function code data = 15)

In response to a run command FWD, this output signal controls the magnetic contactor on the commercial-power supply side. It comes ON when the inverter receives a run command. It goes OFF after the motor decelerates to stop with a stop command received. This signal immediately goes OFF upon receipt of a free run command or when an alarm occurs.





■ **Pattern operation stage transition "TU" assignment (Function code data = 16)**

When transitioning between stages during pattern operation, a 1 shot (100 ms) ON signal is output, indicating that the stage has changed. This signal can be used with customizable logic.

■ **Pattern operation cycle completed "TO" assignment (Function code data = 17)**

A 1 shot (100 ms) ON signal is output the moment all stages 1 to 7 are complete during pattern operation. This signal can be used with customizable logic.

■ **Pattern operation stage No. 1 "STG1" assignment (Function code data = 18), Pattern operation stage No. 2 "STG2" assignment (Function code data = 19), Pattern operation stage No. 4 "STG4" assignment (Function code data = 20)**

Outputs the stage (operation process) currently performed during pattern operation.

Operation pattern stage No.	Output terminal signal		
	STG1	STG2	STG4
Stage 1	ON	OFF	OFF
Stage 2	OFF	ON	OFF
Stage 3	ON	ON	OFF
Stage 4	OFF	OFF	ON
Stage 5	ON	OFF	ON
Stage 6	OFF	ON	ON
Stage 7	ON	ON	ON

■ **Frequency (speed) arrival 2 "FAR2" assignment (Function code data = 21)**

The signals come ON when the difference between the output frequency before torque limiting and reference frequency is within the frequency arrival hysteresis width specified by E30 and the frequency arrival delay specified by E29 has elapsed.

(🕮 Function codes E29, E30)

■ **Cooling fan ON-OFF control "FAN" assignment (Function code data = 25)**

With the cooling fan ON/OFF control enabled (H06 = 1), this output signal is ON when the cooling fan is in operation, and OFF when it is stopped. This signal can be used to make the cooling system of peripheral equipment interlocked for an ON/OFF control.

(🕮 Function code H06)

■ **Auto-resetting "TRY" assignment (Function code data = 26)**

This output signal comes ON when auto resetting (resetting alarms automatically) is in progress.

(🕮 Function codes H04, H05)

■ **Universal DO "U-DO" assignment (Function code data = 27)**

Assigning this output signal to an inverter's output terminal and connecting the terminal to a digital input terminal of peripheral equipment, allows an upper controller to send commands to the peripheral equipment via the RS-485 or the fieldbus communications link. The universal DO can be used as an output signal independent of the inverter operation.

📖 For the procedure for access to Universal DO via the RS-485 or fieldbus communications link, refer to the respective instruction manual.

■ **Cooling fin overheat early warning "OH" assignment (Function code data = 28)**

This is used to take appropriate measures when signs of this are detected before an overheating trip (0H1) occurs.

ON at [(Overheat trip (0H1) temperature) -5°C (9°F)] or higher

OFF at [(Overheat trip (0H1) temperature) -8°C (14°F)] or lower

■ **Master-follower synchronization complete "SY" assignment (Function code data = 29)**

This output signal comes ON when the control target comes inside the synchronization completion detection angle in synchronous running.

(📖 Function codes d71 to d78)

■ **Lifetime alarm "LIFE" assignment (Function code data = 30)**

This output signal comes ON when it is judged that the service life of any one of capacitors (DC link bus capacitors or electrolytic capacitors on the printed circuit boards), cooling fan, or IGBT has expired. This signal should be used as a guide for replacement of the capacitors and cooling fan. If this signal comes ON, use the specified maintenance procedure to check the service life of these parts and determine whether the parts should be replaced or not.

(📖 Function code H42)

■ **Reference loss detection "REF OFF" assignment (Function code data = 33)**

This output signal comes ON when an analog input used as a frequency command source is in a reference loss state (as specified by E65) due to a wire break or a weak connection. This signal goes OFF when the normal operation under the analog input is resumed.

(📖 Function code E65)

■ **Overload prevention controlling "OLP" assignment (Function code data = 36)**

This output signal comes ON when overload prevention control is activated. (The minimum ON-duration is 100 ms.)

(📖 Function code H70)

■ **Current detection "ID" assignment, Current detection 2 "ID2" assignment, Current detection 3 "ID3" assignment (Function code data = 37, 38, 39)**

When the inverter output current exceeds the current detection (operation) level specified by E34, E37 or E55 for the current detection (timer) period specified by E35, E38 or E56, the ID, ID2 or ID3 signal turns ON, respectively. (The minimum ON-duration is 100 ms.)

(📖: Function code E34)

■ **Low current detection "IDL", "IDL2" assignment (Function code data = 41, 133)**

When the inverter output current falls to or below the current detection (operation) level specified by E34, E37 or E55 for the current detection (timer) period specified by E35, E38 or E56, the IDL or IDL2 signal turns ON, respectively (minimum output signal range: 100 ms). "IDL" turns ON if conditions are met even while the inverter is stopped. "IDL2" turns ON only while the inverter is running.

(📖: Function code E34)

■ **PID alarm output "PID-ALM" assignment (Function code data = 42)**

PID control, PID control 1 or 2 absolute value warnings and deviation warnings can be output as PID warnings.

■ **Under PID control "PID-CTL" assignment (Function code data = 43)**

An ON signal is output when PID control, or PID control 1 or 2 are enabled, and the run command is ON.

Note With PID control, or PID control 1 or 2, the inverter may stop due to the slow flowrate stopping function or other reasons. If that happens, the "PID-CTL" signal remains ON. As long as the "PID-CTL" signal is ON, PID control is effective, so the inverter may abruptly resume its operation, depending on the feedback value in PID control.

⚠WARNING

If the PDI function, or PID control 1 or 2 are selected, even if the inverter stops its output during operation because of sensor signals or other reasons, operation will resume automatically. Design your machinery so that safety is ensured even in such cases.

Failure to observe this could result in an accident.

■ **Under PID low liquid level stop "PID-STP" assignment (Function code data = 44)**

An ON signal is output when the inverter is stopped by the slow flowrate stop function during PID control, or PID control 1 or 2 control.

■ **Low torque detection "U-TL" assignment (Function code data = 45)**

This output signal comes ON when the torque value calculated by the inverter or torque command drops below the level specified by E80 (Low torque detection (Level)) for the period specified by E81 (Low torque detection (Timer)). (Minimum width of the output signal: 100 ms) (📖 Function codes E78 to E81)

■ **Torque detection 1 "TD1" assignment (Function code data = 46), Torque detection 2 – "TD2" assignment (Function code data = 47)**

This output signal TD1 or TD2 comes ON when the torque value calculated by the inverter or torque command exceeds the level specified by E78 or E80 (Torque detection (Level)) for the period specified by E79 or E81 (Torque detection (Timer)), respectively. (Minimum width of the output signal: 100 ms) (📖 Function codes E78 to E81)

■ **Motor 1, 2 switching "SWM1", "SWM2" assignment (Function code data = 48 to 49)**

The output signals turn ON corresponding to the motor selected by the signal "M2."

■ **Performing forward rotation – "FRUN" assignment, Performing reverse rotation – "RRUN" assignment (Function code data = 52, 53)**

Output signal	Assigned data	Forward rotation	Reverse rotation	Inverter stopped
"FRUN"	52	ON	OFF	OFF
"RRUN"	53	OFF	ON	OFF

■ **In remote mode "RMT" assignment (Function code data = 54)**

This output signal comes ON when the inverter switches from local to remote mode.

For details of switching between remote and local modes, refer to Chapter 3 "3.3.7 Switching between remote and local modes".

■ **Run command entered "AX2" assignment (Function code data = 55)**

By assigning run permission "RE" to a digital input, the inverter is not started with run command input alone. After inputting a run command, "AX2" is output as a signal to indicate that a run command was input, and that inverter operation preparation is complete. By inputting run permission "RE" after inputting a run command, the inverter is started for the first time.

For details on run permission "RE" and "AX2," refer to run permission "RE" for function codes E01 to E09 (data = 38).

■ **Motor overheat detected by thermistor "THM" assignment (Function code data = 56)**

When the PTC thermistor on the motor detects an overheat, the inverter turns this signal ON and continues to run, without entering the alarm 0H4 state. This feature applies only when H26 data is set to "2." (Function codes H26, H27)

■ **Machine brake signal control "BRKS" assignment (Function code data = 57)**

This signal outputs a brake control command that releases or applies the brake. (Function codes J68 to J72, d120 to d125)

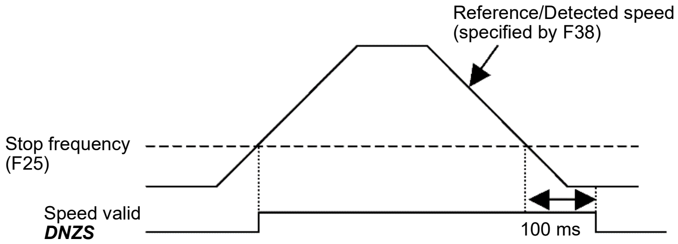
■ **Current input disconnection detection (terminal [C1] and [C2]) "C1OFF" assignment (Function code data = 59)**

This output signal comes ON when the inverter detects that the input current to terminal [C1] (C1 function) drops below 2 mA interpreting it as the terminal [C1] wire broken.

■ **Speed valid "DNZS" assignment (Function code data = 70)**

This output signal comes ON when the reference speed or detected one exceeds the stop frequency specified by function code F25. It goes OFF when the speed is below the stop frequency for 100 ms or longer.

Under vector control with speed sensor, F38 switches the decision criterion between the reference speed and actual speed. Under vector control without speed sensor, the reference speed is used as a decision criterion. (Function codes F25, F38)



■ **Speed agreement "DSAG" assignment (Function code data = 71)**

This output signal comes ON when the deviation of the detected speed from the speed command after the acceleration/deceleration processor is within the allowable range specified by d21. It goes OFF when the deviation is beyond the range for longer than the period specified by d22. This feature allows you to check whether the speed controller is working correctly. (Function codes d21, d22)

■ **Speed agreement/PG error "PG-ERR" assignment (Function code data = 76)**

This output signal comes ON when the inverter detects a PG error with the d23 (PG error processing) data being set to "0: Continued operation," in which the inverter does not enter the alarm state. (Function codes d21 to d23)

■ **Low DC link bus voltage detection “U-EDC” assignment (Function code data = 77)**

This output signal comes ON when the DC intermediate voltage drops below E76 (DC link bus low-voltage detection level), and it goes OFF when the DC intermediate voltage exceeds E76.

(📖: Function code E76)

■ **During decelerating in momentary power failure “IPF2” assignment (Function code data = 79)**

When F14 is 2 or 3, signal turns ON when the intermediate DC voltage will drop to or below the H15 “continued operation level”, and the motor continues to run. The signal turns OFF after power has been restored, and the intermediate DC voltage reaches the “voltage set at H15 + 10 V or more”.

Even when F14 data is set to 4 or 5, the signal comes ON when the DC intermediate voltage drops below the undervoltage level. And it goes OFF when the DC intermediate voltage becomes “at least 10 V higher than the undervoltage level”.

(📖 Function codes F14, H15)

■ **Positioning control signals “OT,” “TO,” “POF” assignment (Function code data = 80, 81, 83)**

These signals are used with positioning control.

📖 Refer to function codes J73 to J88.

■ **Positioning complete “PSET” assignment (Function code data = 82)**

This output signal comes ON as a positioning completion signal. This signal is used when in-position with the position control function, and when settling is complete with servo lock function.

📖 For details on the servo lock function, refer to function codes J97 to J99. For details on the position control function, refer to d201 to d299.

■ **Maintenance timer “MNT” assignment (Function code data = 84)**

Once the inverter’s cumulative run time or the startup times for the motor 1 exceeds the previously specified count, this output signal comes ON.
(📖 Function codes H78, H79)

■ **Frequency arrival and frequency detection “FARFDT” assignment (Function code data = 87)**

The “FAR”/“FDT”, which is an AND composite signal of FAR and FDT, comes ON when both signal conditions are met.
(📖 Function codes E30, E31, E32)

■ **Magnetic pole position detection complete signal “PTD” assignment (Function code data = 89)**

An ON signal is output if the magnetic pole position is detected when a synchronous motor starts running.

■ **Alarm content “AL1”, “AL2”, “AL4”, “AL8” assignment (Function code data = 90, 91, 92, 93)**

Outputs the state of operation of the inverter protective functions.

Alarm content (inverter protective function)	Alarm code	Output terminal			
		AL1	AL2	AL4	AL8
Instantaneous overcurrent protection	OC1 to OC3	ON	OFF	OFF	OFF
Overvoltage protection	OU1 to OU3	OFF	ON	OFF	OFF
Undervoltage protection, input phase loss	LU Lin	ON	ON	OFF	OFF
Motor overload, electronic thermal (motors 1 to 2)	OL1 to OL2	OFF	OFF	ON	OFF
Inverter overload	OLU	ON	OFF	ON	OFF
Cooling fin overheat, inverter internal overheat, charging resistor overheat	OH1 OH3 OH6	OFF	ON	ON	OFF
External alarm, Braking resistor overheat, motor protection (OTC thermistor)	OH2 dbH OH4	ON	ON	ON	OFF
Memory error, CPU error, data saving error during undervoltage, hardware error	Er1 Er3 ErF ErH	OFF	OFF	OFF	ON
Keypad communication error, option communication error	Er2 Er4	ON	OFF	OFF	ON
Option error	Er5	OFF	ON	OFF	ON
Charging circuit error, operation error, EN circuit error, braking transistor failure	PbF Er6 ECF dbA	ON	ON	OFF	ON
Tuning error, output phase loss detection	Er7 OPL	OFF	OFF	ON	ON
RS485 communication error	Er8 ErP	ON	OFF	ON	ON
Overspeed protection, PG wire break, speed inconsistency/excessive speed deviation, positioning control error	OS PG ErE Ero	OFF	ON	ON	ON
Current input terminals [C1], [C2] signal line break, simulated failure, other alarms	CoF Err	ON	ON	ON	ON

* No terminal outputs a signal during normal operation.

■ **Performing forced operation “FMRUN” assignment (Function code data = 95)**

An ON signal is output during forced operation. (📖 Function codes H116 to H121)

■ **Warning “L-ALM” assignment (Function code data = 98)**

This output signal comes ON when a warning occurs. (📖 Function codes H81 to H83)

■ **Alarm output (for any alarm) “ALM” assignment (Function code data = 99)**

This output signal comes ON if any of the protective functions is activated and the inverter enters Alarm mode.

■ **No function assigned “NONE” assignment (Function code data = 100)**

This output signal is used to disable the output terminal functions of the OPC-RY2 and OPC-DO options.

■ **EN terminal detection circuit error “DECF” assignment (Function code data = 101)**

The signal comes ON when any error is detected in the circuit for EN terminal.

■ **EN terminal input OFF “ENOFF” assignment (Function code data = 102)**

The signal comes ON when the EN terminal is turned OFF.

■ **Braking transistor error “DBAL” assignment (Function code data = 105)**

If the inverter detects a breakdown of the braking transistor, it displays the braking transistor alarm (dbA) and also issues the output signal “DBAL”. Detection of the breakdown of a braking transistor can be canceled by H98. (📖 Function code H98)

Note: A breakdown of the braking transistor could lead to a damage of the braking resistor or inverter’s internal units. To prevent the secondary damage, use “DBAL” to cut off power to the magnetic contactor in inverter primary circuits upon detection of a breakdown of the built-in braking transistor.

■ **Customizable logic output signal 1 to 14 "CLO1" to "CLO14" assignment (Function code data = 111 to 124)**

Outputs the result of customizable logic operation.
(🕮 Function code U codes)

■ **Integral power pulse output "POUT" assignment (Function code data = 125)**

A 0.15 s pulse is output each time the increase in integral power consumption increases by the unit of electric energy selected with function code E57.
(🕮: Function code E57)

■ **Performing speed limiting "S-LIM" assignment (Function code data = 131)**

Under vector control, the speed limiting function is enabled when performing droop control or torque control. This signal turns ON if speed limiting occurs.
(🕮 Function codes H18, H28)

■ **Torque limiting "T-LIM" assignment (Function code data = 132)**

This signal turns ON if torque limiting occurs.
(🕮 Function code F40)

■ **Shift key ON/OFF status "MTGL" assignment (Function code data = 251)**

Indicates the ON/OFF status of the Shift key function assigned with function code E70.

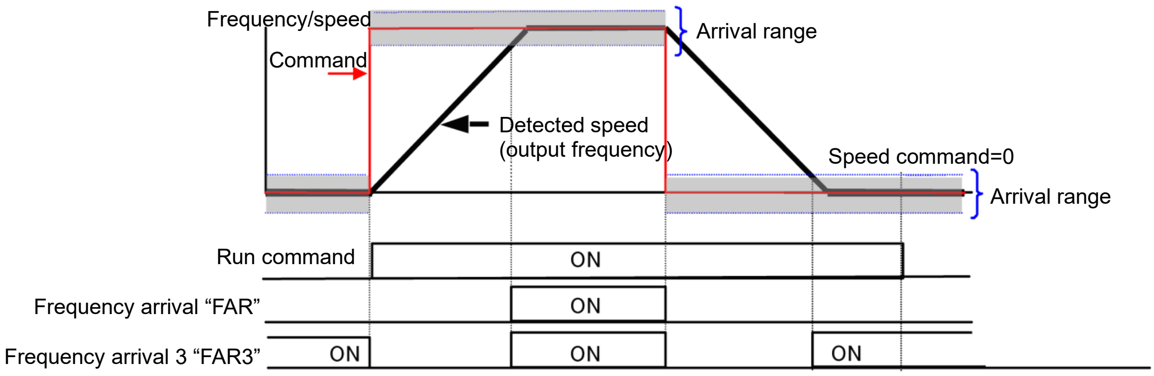
E29 E30	Frequency arrival delay (FAR2) Frequency arrival detection range (Detection range)

E30 specifies the detection level for the Frequency (speed) arrival signal “FAR,” Frequency (speed) arrival signal 2 “FAR2” and the Frequency (speed) arrival signal 3 “FAR3”.

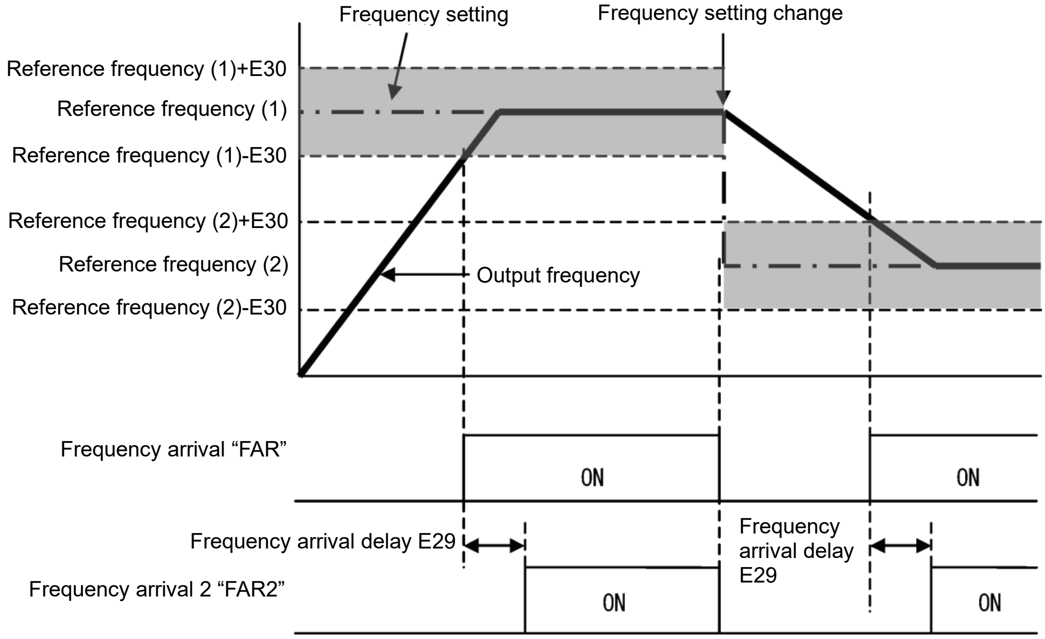
Output signal	E20 to E24, E27 Assigned data	Operating condition 1	Operating condition 2
“FAR”	1	The signals come ON when the difference between the output frequency (estimated/actual speed) and the reference frequency (reference speed) comes within the frequency arrival width specified by E30.	FAR always goes OFF when the run command is OFF or the reference speed is “0.”
“FAR3”	72		When the run command is OFF, the inverter regards the reference speed as “0,” so FAR3 comes ON as long as the output frequency (estimated/ actual speed) is within the range of “0 ± the frequency arrival width specified by E30.”
“FAR2”	21	The signal comes ON when the difference between the output frequency (before torque and current limiting) and the reference frequency (reference speed) comes within the frequency arrival width specified by E30.	This signal always goes OFF when the run command is OFF or the reference speed is “0.” The delay can be specified by E29.
“FARFDT”	87	“FAR” and “FDT” AND signals. An ON signal is output if both are ON.	

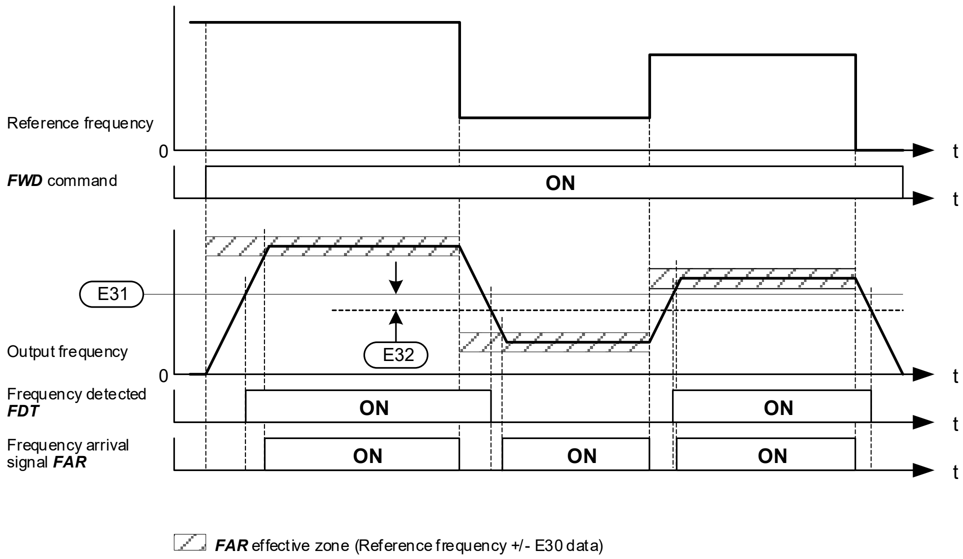
- Data setting range: E30: 0.0 to 10.0 (Hz), E29: 0.01 to 10.00 (s)

The operation timings of each signal are as shown below.



FUNCTION CODES
Chap 5


Frequency setting
Frequency setting change
Reference frequency (1)+E30
Reference frequency (1)
Reference frequency (1)-E30
Reference frequency (2)+E30
Reference frequency (2)
Output frequency
Reference frequency (2)-E30
Frequency arrival "FAR"
ON
ON
Frequency arrival delay E29
Frequency arrival delay E29
Frequency arrival 2 "FAR2"
ON
ON

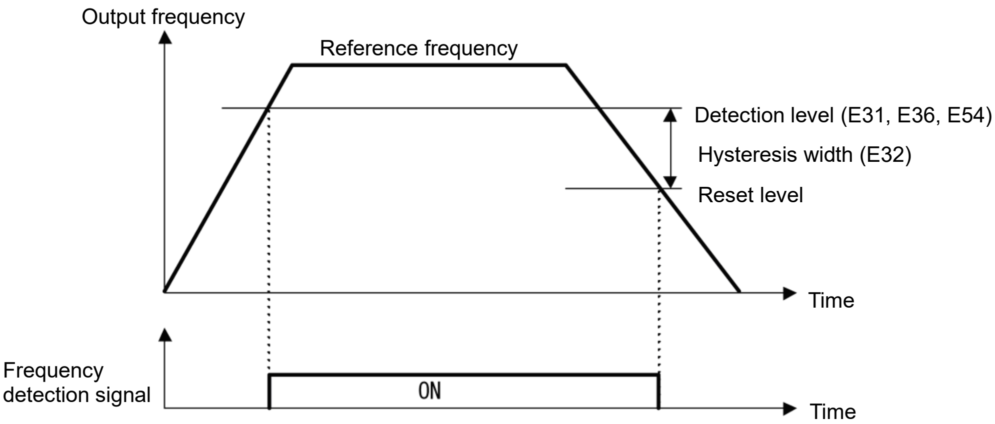

Reference frequency
0
t
FWD command
ON
t
E31
E32
Output frequency
0
t
Frequency detected FDT
ON
ON
t
Frequency arrival signal FAR
ON
ON
ON
t
FAR effective zone (Reference frequency +/- E30 data)

E31, E32	**Frequency detection (Operation level and hysteresis range)** **Related function code: E36 (Frequency detection 2, level), E54 (Frequency detection 3, level)**

When the output frequency exceeds the frequency detection level specified by E31, the “Frequency (speed) detection signal” comes ON; when it drops below the “Frequency detection level minus Hysteresis range specified by E32,” it goes OFF.

The following three settings are available.

Name	Output signal	E20 to E24, E27 Assigned data	Detection level	Hysteresis range
			Range: 0.0 to 599.0 Hz	Range: 0.0 to 599.0 Hz
Frequency detection	“FDT2	2	E31	E32
Frequency detection 2	“FDT2”	31	E36	
Frequency detection 3	“FDT3”	58	E54	
Frequency arrival and frequency detected	“FARFDT”	87	“FAR” and “FDT” AND signal	



E34, E35	**Overload early warning/Current detection (Operation level and Timer time)** **Related function code: E37, E38 (Current detection 2/Low current detection (Operation level and Timer time)) E55, E56 (Current detection 3 (Operation level and Timer time))**

These function codes define the operation level and time for the Motor overload early warning “OL,” Current detection “ID,” Current detection 2 “ID2,” Current detection 3 “ID3,” Low current detection “IDL,” and Low current detection 2 “IDL2” output signals.

Output signal	E20 to E24, E27 assignment data	Operation level	Timer	Motor characteristics	Thermal time constant
		Range: See below	Range: 0.01 to 600.00 s	Range: See below	Range: 0.5 to 75.0 min
“OL”	7	E34	-	F10	F12
“ID”	37	E34	E35	-	-
“ID2”	38	E37	E38		
“ID3”	39	E55	E56		
“IDL”	41	E37	E38		
“IDL2”	133	E37	E38		

- Data setting range

  Operation level: 0.00 A (disable), current value of 1 to 200% of inverter rated current set in A (ampere) units

  Motor characteristics 1: Enable (For a general-purpose motor with self-cooling fan)

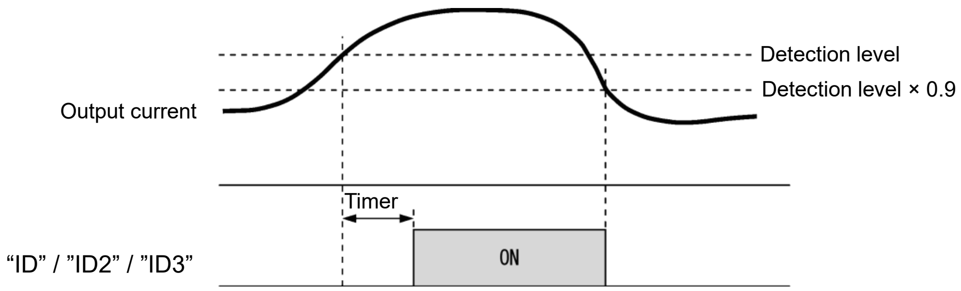
  2: Enable (For an inverter-driven motor, non-ventilated motor, or motor with separately powered cooling fan)

■ **Motor overload early warning – "OL"**

The OL signal is used to detect a symptom of an overload condition (alarm code OL1) of the motor so that the user can take an appropriate action before the alarm actually happens. The OL signal turns ON when the inverter output current exceeds the level specified by E34. In typical cases, set E34 data to 80 to 90% against F11 data (Electronic thermal 1 (Motor protection) (Operation level)). Set the temperature characteristics of the motor with electronic thermal (motor characteristics selection, thermal time constant).

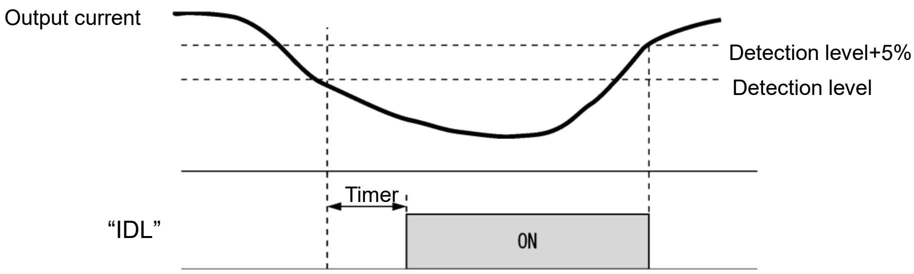
■ **Current detection "ID," Current detection 2 "ID2" and Current detection 3 "ID3"**

When the inverter output current exceeds the current detection (operation) level specified by E34, E37 or E55 for the current detection (timer) period specified by E35, E38 or E56, the ID, ID2 or ID3 signal turns ON, respectively. When the output current drops below 90% of the specified detection level, the ID, ID2 or ID3 turns OFF. (The minimum ON-duration is 100 ms.)



■ **Low current detection "IDL", Low current detection 2 "IDL2"**

This signal turns ON when the output current drops below the current detection (operation) level specified by E37 for the current detection (timer) period specified by E38. When the output current exceeds the "Low current detection level plus +5% of the inverter rated current," it goes OFF (minimum output signal range: 100 ms). "IDL" is output even when the inverter is stopped. "IDL2" is valid only during inverter output ("RUN" ON).



Inverter rated current is switched based on the setting of F80: "Switching between ND, HD, HND and HHD drive modes."
For rated current values, refer to Chapter 12 "SPECIFICATIONS" for each type.

E36	Frequency detection 2 (Refer to E31)

Refer to the description of E31.

E37, E38	Current detection 2/Low current detection (Operation level and Timer time) (Refer to E34)

For details about Current detection 2/Low current detection (Operation level, Timer), refer to the description of E34.

E39	Constant feed time coefficient time Related function code: E50, A61 (Display coefficient for speed monitor)

E39 specifies the constant-rate feeding time, load shaft speed, coefficient for line speed setting, and coefficient for output status monitor indication.

- Data setting range: 0.000 to 9.999

Calculation formula (when motor 1 selected)

$$\text{Constant feeding rate time (min)} - \frac{\text{Display coefficient for transport time (E50)}}{\text{Frequency x constant rate of feeding coefficient (E39)}}$$

$$\text{(Load speed, line speed)} = \text{(Output frequency 1)} \times \frac{\text{E50}}{\text{E39}}$$

The "Frequency" in the above formula is set frequency when each indication is the setting value (constant-rate feeding time setting, load shaft speed setting, and line speed setting), whereas it is output frequency before slip compensation when the indication is output status monitor.

When the constant-rate feeding time is 999.9 (min) or greater, or the denominator on the above formula is 0, "999.9" is displayed.

E50 is the speed display coefficient applied when motor 1 is selected. A60, b60, r60, respectively, are applied when motor 2, 3, or 4 is selected.

E42	LED display filter

Excluding speed monitor (when E43 = 0), E42 specifies a filter time constant to be applied for displaying the output frequency, output current and other running status monitored on the LED monitor on the keypad. If the display varies unstably so as to be hard to read due to load fluctuation or other causes, increase this filter time constant.

- Data setting range: 0.0 to 5.0 (s)

If the speed monitor (E43 = 0) is set for the LED monitor display selection, the E42 setting value becomes valid based on the setting value of the speed monitor selection (E48) as shown in the following table.

E48 (LED monitor details) setting	LED monitor detailed items	E42 (LED display filter)
0	Output frequency 1 (before slip compensation)	-
1	Output frequency 2 (after slip compensation)	Enable
2	Reference frequency	-
3	Motor speed	Enable
4	Load shaft speed	Enable
5	Feed speed (line speed)	Enable
6	Constant feed time	-
7	Speed (%)	Enable

E43	LED monitor (Item selection) Related function code: E48 LED monitor details (Speed monitor selection)

Selects the operating state monitor information displayed on the keypad LED.

Specifying the speed monitor with E43 provides a choice of speed-monitoring formats selectable with E48 (LED monitor).

Monitor items	Display sample on the LED monitor	LED indicator	Unit	Meaning of displayed value	E43 data
Speed monitor	Function code E48 specifies what to be displayed on the LED monitor and LED indicators.				0
Output frequency 1	50.00	●Hz○A○kW	Hz	Output frequency (before slip compensation) (Hz)	(E48=0)
Output frequency 2	50.00	●Hz○A○kW	Hz	Output frequency (after slip compensation) (Hz)	(E48=1)
Reference frequency	50.00	●Hz○A○kW	Hz	Reference frequency (Hz)	(E48=2)
Motor speed	1500	●Hz●A○kW	min^{-1}	(Output frequency / Maximum output frequency) x 100 Output frequency (Hz) $\times \frac{120}{P01}$	(E48=3)
Load shaft speed	300.0	●Hz●A○kW	min^{-1}	Output frequency (Hz) x E50/E39 Note	(E48=4)
Feed speed (line speed)	300.0	○Hz●A●kW	m/min	Output frequency (Hz) x E50/E39 Note	(E48=5)
Constant feed time	50.00	○Hz○A○kW	min	E50 Note/(Output frequency x E39)	(E48=6)
Speed (%)	50.0	○Hz○A○kW	%	(Output frequency / Maximum output frequency) x 100	(E48=7)
Output current	12.34	○Hz●A○kW	A	Current output from the inverter in RMS	3
Output voltage	200U	○Hz○A○kW	V	Voltage output from the inverter in RMS	4
Calculated torque	50	○Hz○A○kW	%	Motor output torque (Calculated value)	8
Input power	10.25	○Hz○A●kW	kW	Input power to the inverter	9
PID command value	10.00.	○Hz○A○kW	–	PID command/feedback amount converted to a physical quantity of the object to be controlled (e.g. temperature)	10
PID feedback value	9.00.	○Hz○A○kW	–		12
Timer value	100	○Hz○A○kW	s	Timer value (remaining run time)	13
PID output	100.0.	○Hz○A○kW	%	Displays PID output as a percentage, with the maximum output frequency being 100%.	14
Load factor	50L	○Hz○A○kW	%	Load factor of the motor in % as the rated output being at 100%	15
Motor output	9.85	○Hz○A●kW	kW	Motor output (kW)	16
Analog input monitor	82.00	○Hz○A○kW	–	An analog input to the inverter in a format suitable for a desired scale. Refer to the following function codes. Terminal [12]: C59, C60 Terminal [C1] (C1 function): C65, C66 Terminal [V2]: C71, C72 Terminal [C1] (V3 function): C85, C86	17
Current position	1234	○Hz○A○kW	pulse	Current position pulse	21
Positioning deviation	2345	○Hz○A○kW	pulse	Command current position and feedback current position deviation indicated with user value	22

Monitor items	Display sample on the LED monitor	LED indicator	Unit	Meaning of displayed value	E43 data
Torque current	48	○Hz○A○kW	%	Torque current command value or calculated torque current	23
Magnetic flux command value	50	○Hz○A○kW	%	Magnetic flux command value (Available only under vector control with sensor)	24
Input watt-hour	100.0	○Hz○A○kW	kWh	Input watt-hour (kWh) / 100	25
Stop target position	2345	○Hz○A○kW	–	Stop target position indicated with user value	28
PID deviation	1.00.	○Hz○A○kW	–	PID command value and PID feedback value deviation converted into physical quantities of the object to be controlled	29
Torque bias	25	○Hz○A○kW	%	Torque bias value display	30
Customizable logic output	82.00	○Hz○A○kW	–	Display of output content for specific customizable logic step Refer to function codes U98 and U99 for details.	32

● ON, ○ OFF

Note: The function code applied when the motor changes will also change.

E44 LED monitor (Display when stopped)

Selects monitor information displayed with the keypad LEDs while the inverter is stopped. If E44 = 0, the set frequency is displayed, and when E44 = 1, the output frequency is displayed. The display format is that selected with Speed monitor E48.

E48 data	Monitored item	Inverter stopped	
		E44 = 0: Reference frequency display	E44 = 1: Output frequency display
0	Output frequency 1 (before slip compensation)	Reference frequency	Output frequency (before slip compensation)
1	Output frequency 2 (after slip compensation)	Reference frequency	Output frequency (after slip compensation)
2	Reference frequency	Reference frequency	Reference frequency
3	Motor speed	Rotation speed set value	Motor speed
4	Load shaft speed	Reference load rotation speed	Load shaft speed
5	Feed speed (line speed)	Reference feed speed (line speed)	Feed speed (line speed)
6	Constant feed time	Constant feed time set value	Constant feed time
7	Speed (%)	Reference speed	Speed

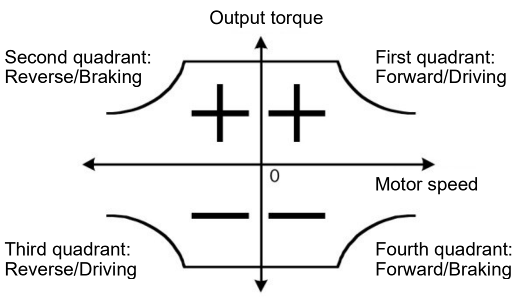
E48 LED monitor details (Speed monitor selection) (Refer to E43)

For details about LED Monitor (Speed monitor item), refer to the description of E43.

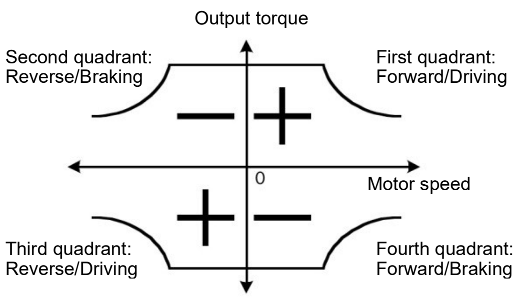
E49 Torque command monitor (Polarity selection)

The polarity of calculated torque value in v/f control or the torque command value in vector control is normally + for driving and – for braking. However, in the case of hoisting load, when the motor rotation direction changes from forward direction to reverse direction, the torque polarity also changes from driving to braking. When tracing torque data with FRENIC-Loader4, the polarity of the torque command value changes in conjunction with the polarity of the speed, so the data is not continuous. If E49 is set to 0, the torque monitor data becomes + for forward/driving and reverse/braking, - for forward/braking and reverse/driving. Therefore, we can monitor the continuous torque data around zero speed.

E49 data	Torque monitor polarity
0	Torque polarity (+ for forward/driving and reverse/braking, - for forward/braking and reverse/driving)
1	Plus for driving, Minus for braking



E49 = 0: Torque polarity



E49 = 1: Plus for driving, Minus for braking

Related data is the following. These data are displayed and submitted with polarity. Judge the meaning of the polarity by E49 setting.

Torque data	Data	Related data
Keypad LED monitor	E43=8	Calculated torque
	E43=23	Torque current
Keypad operation monitor	3_04	Calculated torque
Keypad alarm information	6_03	Calculated torque when alarm occurs (latest up to previous 3 alarms)
Analog input option OPC-AIO	o90 = 4	Output torque (only o93=0: Bipolar)
Torque monitor function code	M02	Torque command (final command value)
	M03	Torque current command (final command value)
	M07	Output torque
	M08	Torque current
	M28	Torque command when alarm occurs (final command value)
	M29	Torque current command when alarm occurs (final command value)
	M33	Output torque when alarm occurs
	M34	Torque current when alarm occurs
	W07	Actual torque value
	W24	Torque current
	X23	Latest information when alarm occurs (torque calculation value)
	X63	Previous information when alarm occurs (torque calculation value)
	Z03	Information from 2 times ago when alarm occurs (torque calculation value)
	Z53	Information from 3 times ago when alarm occurs (torque calculation value)
	Z81	Torque real value

E50 A60	**Display coefficient for speed monitor** **Speed display coefficient 2**	**Related function code: E39, A61** **(Constant feed time coefficient/** **Speed display auxiliary coefficient)**

E50 specifies the coefficient that is used when the load shaft speed or line speed is displayed on the LED monitor. (Refer to the description of E43.)

By selecting a motor, the applied speed display coefficient changes.

If motor 1 is selected:

Load shaft speed [min-1] = (E50: Display coefficient for speed monitor) x (Output frequency Hz)

Line speed [m/min] = (E50: Display coefficient for speed monitor) x (Output frequency Hz)

- Data setting range: 0.01 to 200.00

Selected motor	Applied speed display coefficient	Remarks
Motor 1	E50/E39	
Motor 2	A60/A61	

E51	**Display coefficient for "Input watt-hour data"**

E51 specifies a display coefficient (multiplication factor) for displaying the input watt-hour data (5_10) in a part of maintenance information on the keypad.

Integral power data = Display coefficient (E51 data) x Integral power consumption (kWh)

- Data setting range: 0.000 (cancel/reset) 0.001 to 9999

Note By setting E51 = 0.000, integral power consumption and integral power data can be cleared to zero. Setting E51 data to 0.000 clears the input watt-hour and its data to "0." After clearing, be sure to restore E51 data to the previous value; otherwise, input watt-hour data will not be accumulated.

E52	**Keypad menu selection**

E52 provides a choice of three menu display modes for the standard keypad as listed below.

E52 data	Menu display mode	Menus to be displayed
0	Function code data setting mode	Menus # 0, Menus # 1, Menus # 7
1	Function code data check mode	Menus #2 and #7
2	Full-menu mode	Menus #0 through #7

Selects the menus displayed on the standard keypad. There are eight menus as shown in the table below.

Menu #	LED monitor indication	Function	Description
0	0.FnC	"Favorites"	Favorite function code
1	1.F__	"Data setting F to K"	F to K group function code
2	2.rEP	"Data Checking"	Modified function code
3	3.oPE	"Drive Monitoring"	Operation status indication
4	4.I_o	"I/O Checking"	DIO, AIO status indication
5	5.ChE	"Maintenance Information"	Maintenance information indication
6	6.AL	"Alarm Information"	Alarm information indication
7	7.CPY	"Data Copying"	Copy function (option keypad only)
8	8.dES	"Destination"	Sets the region (overseas) in which the product is used.
9	9.S__ 9.Add 9.dAt	Communication monitor	Codes communicated back and forth between the host device can be monitored, and communication commands can be entered. Refer to the RS-485 Communication User's Manual for details.

For details on the content of each menu item, refer to Chapter 3 "OPERATION USING THE KEYPAD".

E54	**Frequency detection 3 (Operation level)** **(Refer to E31)**

For details, refer to the description of E31.

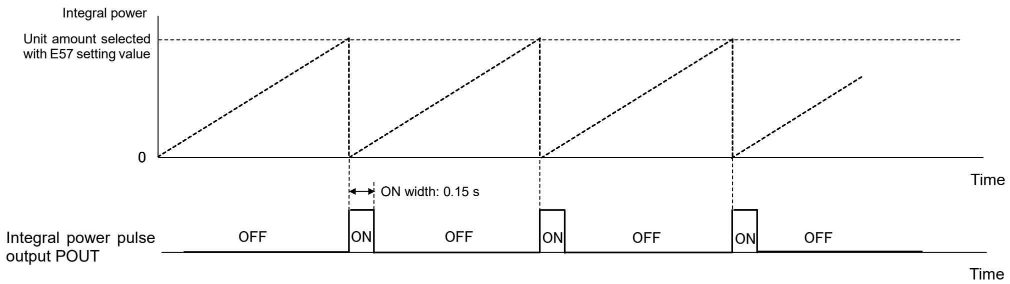
E55, E56	**Current detection 3 (Operation level and Timer time)** **(Refer to E34)**

For details about Current detection 3 (level) (timer), refer to the description of function code E34.

E57 Integral power pulse output unit

By setting "POUT" integral power pulse output to the digital output terminals with E20 to E24, or E27, a 0.15 s pulse can be output each time the integral power consumption increase reaches the unit amount selected with this function code. Accuracy is not so good, and therefore this cannot be used as data for making business deals.

E57 data	Integral power pulse output unit amount
0	0.1 kWh
1	1 kWh
2	10 kWh
3	100 kWh
4	1000 kWh



(📖 Function code E20 to E24, E27, data = 126)

E61 to E63 Terminal [12], [C1] (C1 function), [C1] (V2 function) (Extension function selection)

If other than a frequency setting signal is assigned to analog input terminals, change this function code. The same function cannot be set for another terminal.

E61, E62, E63 data	Function	Description
0	None	-
1	Auxiliary frequency setting 1	Auxiliary frequency input to be added to the reference frequency given by frequency setting 1 (F01). Will not be added to any other reference frequency given by frequency setting 2 and multistep frequency commands, etc. 100%/full scale Effective range: -100% to 100%
2	Auxiliary frequency setting 2	Auxiliary frequency input to be added to all frequency commands. Will be added to frequency command 1, frequency command 2, multistep frequency commands, etc. 100%/full scale Effective range: -100% to 100%
3	PID command 1	Inputs command sources such as temperature and pressure under PID control 1/2. You also need to set function code J02/J102/J202. 100%/full scale Effective range: -100% to 100%
5	PID feedback value 1	Inputs feedback values such as temperature and pressure under PID control 1. 100%/full scale Effective range: -110% to 110%

E61, E62, E63 data	Function	Description
6	Ratio setting	Multiplies the final frequency command value by this value, for use in the constant line speed control by calculating the winder diameter or in ratio operation with multiple inverters. 100%/full scale Effective range: -200% to 200%
7	Analog torque limiter A	Used when analog inputs are used as torque limiters. (Function code F40) 200%/full scale. Effective range: -300% to 300%
8	Analog torque limiter B	Used when analog inputs are used as torque limiters. (Function code F40) 200%/full scale. Effective range: -300% to 300%
9	Torque bias	Used when analog inputs are used as torque bias. (Function code H154) 100%/full scale Effective range: -300% to 300%
10	Torque command	Analog inputs to be used as torque commands under torque control. (Function code H18) 100%/full scale Effective range: -300% to 300%
11	Torque current command	Analog inputs to be used as torque current commands under torque control. (Function code H18) 100%/full scale Effective range: -300% to 300%
12	Acceleration/deceleration time ratio setting	Multiplies the ratio based on the analog input amount by the acceleration/deceleration time. (Function code F07) Effective range: -400% to 400%
13	Upper limit frequency	The frequency obtained by multiplying the maximum output frequency by the analog input amount is used as the upper limit frequency. (Function code F15) Effective range: 0% to 100%
14	Lower limit frequency	The frequency obtained by multiplying the maximum output frequency by the analog input amount is used as the lower limit frequency. (Function code F15) Effective range: 0% to 100%
15	Auxiliary frequency setting 3	This is added immediately after adding auxiliary frequency setting 1. 100%/full scale (refer to block diagram) Effective range: -100% to 100%
16	Auxiliary frequency setting 4	This is added immediately after adding auxiliary frequency setting 2. 100%/full scale (refer to block diagram) Effective range: -100% to 100%
17	Speed limit for forward (FWD) rotation	The motor speed limit value can be set with terminal [12] and terminal [C1] (C1/V3 functions) under torque control. To limit the motor speed to the maximum output frequency, set the analog input (maximum input) to the maximum value. If using this function, it is recommended that it be used in combination with d35 (overspeed detection level). Note: Function codes C31 to C45 (analog input adjustment) are applied to these analog inputs. Effective range: 0% to 100%
18	Speed limit for reverse (REV) rotation	

E61, E62, E63 data	Function	Description
20	Analog input monitor	By inputting analog signals from various sensors such as the temperature sensors in air conditioners to the inverter, you can monitor the state of external devices via the communications link. By using an appropriate display coefficient, you can also have various values to be converted into physical quantities such as temperature and pressure before they are displayed. 100%/full scale

Note If the same setting is specified for a different terminal, priority is given in the order E61, E62, E63.

E64	**Saving of digital reference frequency**

E64 specifies how to save the reference frequency specified in digital format by the ▲/▼ keys on the keypad as shown below.

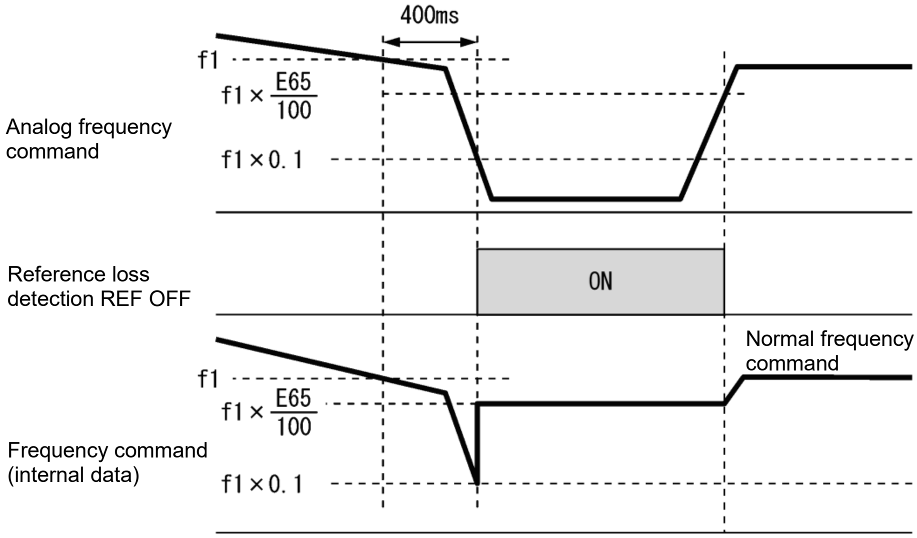
E64 data	Save method
0	The reference frequency will be automatically saved when the main power is turned OFF. At the next power-on, the reference frequency at the time of the previous power-off applies.
1	Pressing the FUNC/DATA key saves the reference frequency. If the control power is turned OFF without pressing the FUNC/DATA key, the data will be lost. At the next power-ON, the inverter uses the reference frequency saved when the FUNC/DATA key was pressed.

E65	Reference loss detection (continued operation frequency)

When the analog frequency command (setting with terminal [12], [C1] (C1 function), or [C1] (V2 function) has dropped below 10% of the reference frequency within 400 ms, the inverter presumes that the analog frequency command wire has been broken and continues its operation at the frequency determined by the ratio specified by E65 to the reference frequency. And "REF OFF" signal comes on.

(📖 Function code E20 to E24, E27, data = 33)

When the frequency command level (in voltage or current) returns to a level higher than that specified by E65, the inverter presumes that the broken wire has been fixed and continues to run following the frequency command.



In the diagram above, f1 is the level of the analog frequency command sampled at any given time. The sampling is repeated at regular intervals to continually monitor the wiring connection of the analog frequency command.

- Data setting range: 0 (Decelerate to stop), 20 to 120 (%), 999 (Disable)

Note

Avoid an abrupt voltage or current change for the analog frequency command. An abrupt change may be interpreted as a wire break.

Setting E65 data at "999" (Disable) allows the REF OFF signal ("Reference loss detected") to be issued, but does not allow the reference frequency to change. (The inverter runs at the analog frequency command as specified.)

When E65 = "0" or "999," the reference frequency level at which the broken wire is recognized as fixed is "f1 x 0.2."

When E65 = "100" (%) or higher, the reference frequency level at which the wire is recognized as fixed is "f1 x 1."

The reference loss detection is not affected by the setting of analog input adjustment (filter time constants: C33, C38, C43).

E70 E71	Shift key (Function selection) M-LED indicator (Function selection)

By setting the same value as E01 for E70, the same commands (with certain exceptions) as those for the X terminal function can be assigned to the Shift key on the standard keypad, and M/Shift key on the optional remote keypad TP-E2. For details on selectable command signals by type and each command signal, refer to the description of function code E01, and E70 (Shift key) in Table 5.2-3 Control input terminal setting list table. These function codes are OFF immediately after turning ON the power. These selections toggle between ON and OFF by holding down the key for 1 s or longer while in Running mode. In Programming mode, the cursor moves between data and the function code number (shift function), and command signal operation is disabled.

When toggling between ON and OFF, the following is displayed temporarily.

When OFF → ON: M.On

When ON → OFF: M.OFF

* This is displayed regardless of the E70 function assignment.

By setting the same value as E20 for E71, the same monitor signals (with certain exceptions) as those for the Y terminal function can be lit up on the optional remote keypad TP-E2 M-LED. For details on selectable command signals by type and each command signal, refer to the description of function code E20, and E71 (M-LED indicator) in Table 5.2-4 Control output terminal setting list table.

E76	DC link bus low-voltage detection level

"U-EDC" signal comes ON when the DC intermediate voltage drops below E76 (DC link bus low-voltage detection level). "U-EDC" signal goes OFF when the DC intermediate voltage exceeds E76.

(📖 Function code E20 to E24, E27, data = 77)

E78, E79 E80, E81	Torque detection 1 (Operation level and Timer time) Torque detection 2 (Operation level and Timer time)

Specifies the operation level and timer time for torque detection 1 "TD1," torque detection 2 "TD2" or low torque detection "U-TL."

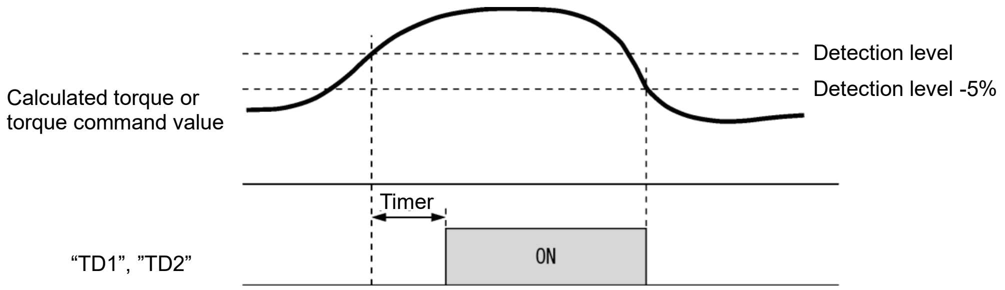
In the inverter's low frequency operation, a substantial error in torque calculation occurs, so no low torque can be detected within the operation range at less than 20% of the base frequency (F04). (In this case, the result of recognition before entering this operation range is retained.) The U-TL signal goes off when the inverter is stopped.

Since the motor parameters are used in the calculation of torque, it is recommended that auto-tuning be applied by function code P04 to achieve higher accuracy.

Output signal	Assigned data	Operation level	Timer time
		Range: 0 to 300%	Range: 0.01 to 600.00 s
"TD1"	46	E78	E79
"TD2"	47	E80	E81
"U-TL"	45	E80	E81

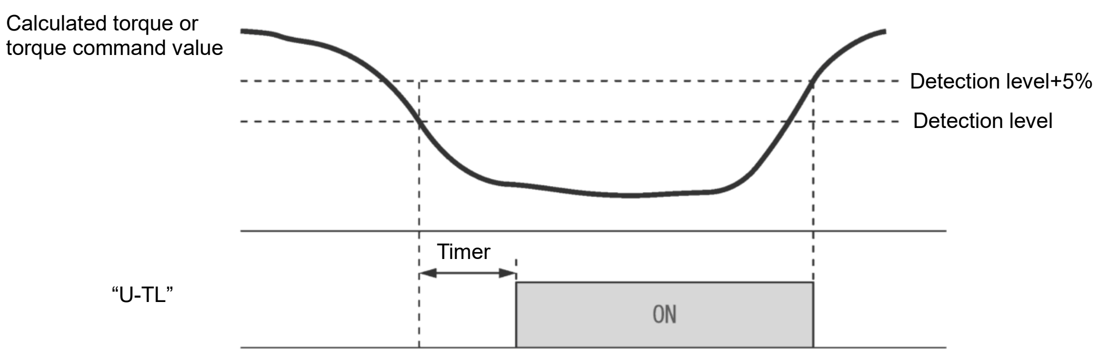
■ **Torque detection 1 "TD1", Torque detection 2 "TD2"**

The output signal TD1 or TD2 comes ON when the torque value calculated by the inverter or torque command exceeds the level specified by E78 or E80 (Torque detection (Operation level)) for the period specified by E79 or E81 (Torque detection (Timer time)), respectively. The signal turns OFF when the calculated torque drops below "the level specified by E78 or E80 minus 5% of the motor rated torque." (The minimum ON-duration is 100 ms.)



■ **Low torque detected "U-TL"**

This output signal comes ON when the torque value calculated by the inverter or torque command drops below the level specified by E80 (Low torque detection (Operation level)) for the period specified by E81 (Low torque detection (Timer time)). The signal turns OFF when the calculated torque exceeds "the level specified by E78 or E80 plus 5% of the motor rated torque." (The minimum ON-duration is 100 ms.)



E98, E99	Terminal [FWD] (Function selection), Terminal [REV] (Function selection) (Refer to E01 to E05)

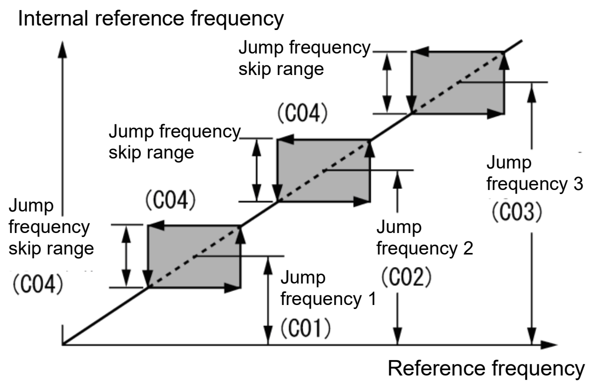
For details of the terminal settings for [FWD] and [REV], refer to the descriptions of E01 to E05.

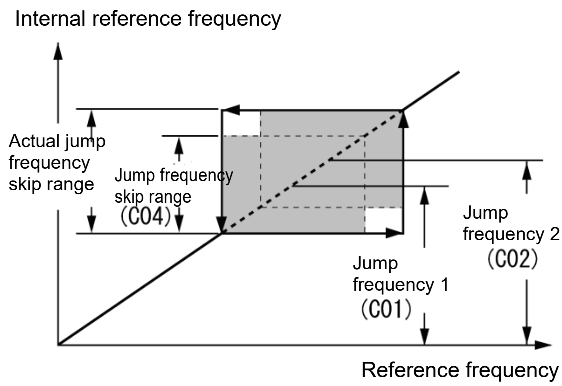
5.3.3 C codes (Control Functions)

C01 to C04 C94 to C96	Jump frequency 1, 2 and 3, Jump frequency (Skip range) Jump frequency 4 to 6

Up to six jump frequency bands can be set for the output frequency in order to avoid resonance caused by the motor speed and natural frequency of the driven machinery (load).

- While increasing the reference frequency, the moment the reference frequency reaches the bottom of the jump frequency band, the inverter keeps the output at that bottom frequency. When the reference frequency exceeds the upper limit of the jump frequency band, the internal reference frequency takes on the value of the reference frequency. When decreasing the reference frequency, the situation will be reversed. Refer to the left figure below.
- When more than two jump frequency bands overlap, the inverter actually takes the lowest frequency within the overlapped bands as the bottom frequency and the highest as the upper limit. Refer to the right figure below.





■ **Jump frequency 1 to 6 (C01 to C03, C94 to C96)**

Specify the center of the jump frequency band.

- Data setting range: 0.0 to 599.0 (Hz) (Setting to 0.0 results in no jump frequency band.)

■ **Jump frequency skip width (C04)**

Specify the jump frequency skip range.

- Data setting range: 0.0 to 30.0 (Hz) (Setting to 0.0 results in no jump frequency band.)

C05 to C19	Multistep frequency 1 to 15

■ **These function codes specify 15 frequencies required for driving the motor at frequencies 1 to 15.**

Turning terminal commands “SS1,” “SS2,” “SS4” and “SS8” ON/OFF selectively switches the reference frequency of the inverter in 15 steps. To use this features, you need to assign “SS1,” “SS2,” “SS4” and “SS8” (“Select multistep frequency”) to the digital input terminals with E01 to E05 (data = 0, 1, 2, and 3).

■ **Multistep frequency 1 to 15 (C05 through C19)**

- Data setting range: 0.00 to 599.0 (Hz)

The combination of “SS1”, “SS2”, “SS4” and “SS8” and the selected frequencies is as follows.

“SS8”	“SS4”	“SS2”	“SS1”	Selected frequency
OFF	OFF	OFF	OFF	Other than multistep frequency*
OFF	OFF	OFF	ON	C05 (Multistep frequency 1)
OFF	OFF	ON	OFF	C06 (Multistep frequency 2)
OFF	OFF	ON	ON	C07 (Multistep frequency 3)
OFF	ON	OFF	OFF	C08 (Multistep frequency 4)
OFF	ON	OFF	ON	C09 (Multistep frequency 5)
OFF	ON	ON	OFF	C10 (Multistep frequency 6)
OFF	ON	ON	ON	C11 (Multistep frequency 7)
ON	OFF	OFF	OFF	C12 (Multistep frequency 8)
ON	OFF	OFF	ON	C13 (Multistep frequency 9)
ON	OFF	ON	OFF	C14 (Multistep frequency 10)
ON	OFF	ON	ON	C15 (Multistep frequency 11)
ON	ON	OFF	OFF	C16 (Multistep frequency 12)
ON	ON	OFF	ON	C17 (Multistep frequency 13)
ON	ON	ON	OFF	C18 (Multistep frequency 14)
ON	ON	ON	ON	C19 (Multistep frequency 15)

* “Other than multistep frequency” includes frequency setting 1 (F01), frequency setting 2 (C30) and other frequency command sources except multistep frequency commands.

C20	**Jogging frequency** **Related function codes: H54 and H55 Acceleration/deceleration time (Jogging operation)** **d09 to d13 Speed control (JOG)**

C20 specifies the operating condition (frequency) to apply in jogging operation.

Function codes		Permissible setting range	Description
C20	Jogging frequency	0.00 to 599.0 (Hz)	Reference frequency for jogging operation
H54	Acceleration time (Jogging)	0.00 to 6000 s	Acceleration time for jogging operation
H55	Deceleration time (Jogging)	0.00 to 6000 s	Deceleration time for jogging operation
d09	Speed control (JOG) Speed command filter	0.000 to 5.000 s	Speed control system adjustment element when performing jogging operation under sensorless vector control/vector control with sensor See d01 to d06 for adjustment method.
d10	Speed control (JOG) Speed detection filter	0.000 to 0.100 s	
d11	Speed control (JOG) P gain	0.1 to 200.0 times	
d12	Speed control (JOG) I integral time	0.001 to 1.000 s	
d13	Speed control (JOG) Output filter	0.000 to 0.100 s	

For details of jogging, refer to Chapter 3 “3.3.6 Performing jogging operations with the keypad.”

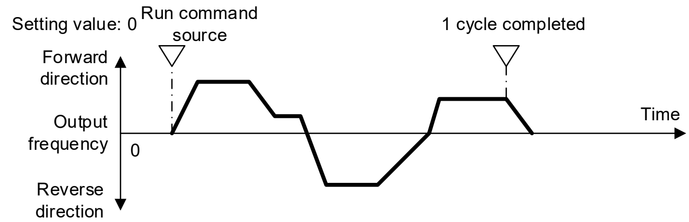
C21 C22 to C28	Pattern operation/Timed operation (Mode selection) Stage 1 to 7

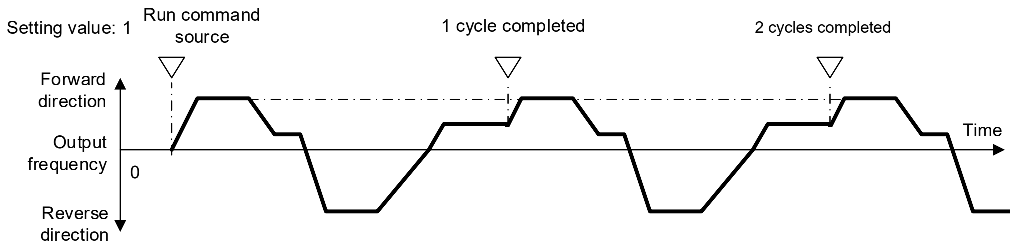
Pattern operation is a function of automatic operation according to the predefined run time, rotational direction, acceleration/deceleration time and reference frequency.

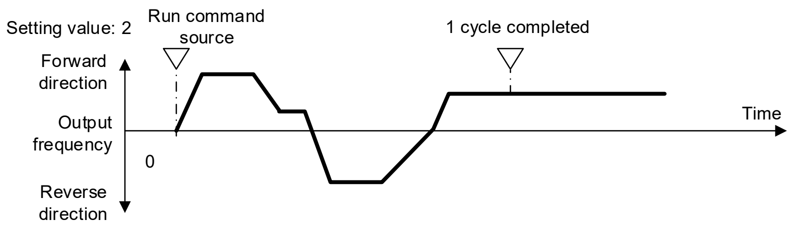
When using this function, set the frequency setting (F01) to 10 (pattern operation).

The following operation patterns are available:

C21: Setting	Operation pattern
0	Pattern operation performed for one cycle and stopped after the cycle.
1	Pattern operation repeatedly performed and immediately stopped with a stop command
2	Pattern operation performed for one cycle and operation continued at the reference frequency after the cycle.
3	Timed operation







■ **C22 to C28 Stage 1 to Stage 7**

Specify the run time, rotation direction, and acceleration/deceleration time for Stage 1 to Stage 7.

Press the FUNC/DATA key three times for each function code to set the following three data.

Setting	Content
1st	Specifies the run time between 0.00 to 6000 s.
2nd	2nd: Specifies the rotational direction F (forward) or r (reverse)
3rd	3rd: Specifies the acceleration/deceleration time between 1 and 4. 1 : F07/F08, 2 : E10/E11, 3 : E12/E13, 4 : E14/E15

If the FUNC/DATA key is pressed to exit the function code before the three data are specified by pressing the PRG/RESET key three times, no data are updated.

For any unused stage, specify 0.00 as the run time. The stage is skipped and the next stage becomes ready for setting.

If a run time greater than 0.01 s and less than 0.40 s is specified, operation is limited internally to 0.40 s.

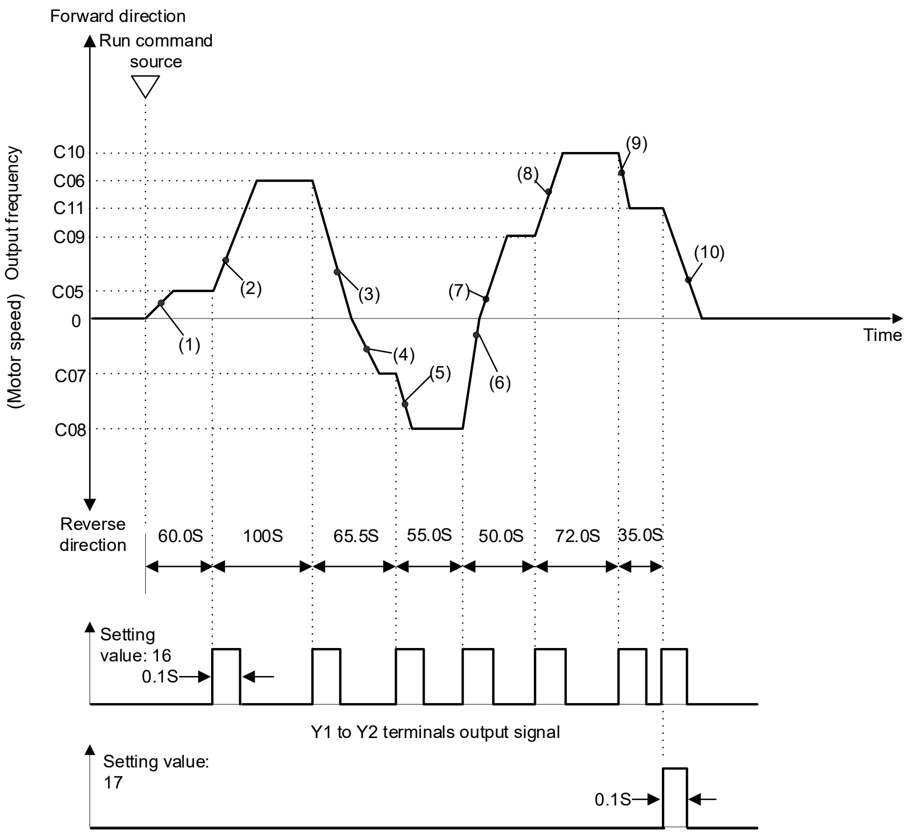
■ Reference frequency

Multistep frequencies 1 to 7 are assigned to the reference frequency of Stage 1 to 7.

■ Example of pattern operation setting

C21 (Operation selection)	Stage No.	Run time	Rotational direction	Acceleration/deceleration time	Operation (reference) frequency
		Setting	Setting	Setting	
0	Stage 1	60.0	F	2	C05 Multistep frequency 1
	Stage 2	100	F	1	C06 Multistep frequency 2
	Stage 3	65.5	r	4	C07 Multistep frequency 3
	Stage 4	55.0	r	3	C08 Multistep frequency 4
	Stage 5	50.0	F	2	C09 Multistep frequency 5
	Stage 6	72.0	F	4	C10 Multistep frequency 6
	Stage 7	35.0	F	2	C11 Multistep frequency 7

The figure below illustrates the operation.



Set according to (1) to (10)
Acceleration time or deceleration time

(1)	Acceleration time: E10
(2)	Acceleration time: F07
(3)	Deceleration time: E15
(4)	Acceleration time: E14
(5)	Acceleration time: E12
(6)	Deceleration time: E11
(7)	Acceleration time: E10
(8)	Acceleration time: E14
(9)	Deceleration time: E11
(10)	Deceleration time: F08

“F08 Deceleration time 1” setting is used as deceleration time for decelerate-to-a-stop after the completion of one cycle.

To run or stop, use input from the RUN key of the keypad or by switching the control terminal. Taking the keypad as an example, the motor starts running when the RUN key is pressed. By pressing the STOP key, stage advance is paused. Press the RUN key again to resume operation according to the stages from the point where it was suspended. For alarm stop, press the PRG RESET key to reset the inverter protective functions. Then press the RUN key. The suspended progression of the cycle resumes. If a need arises for operation from the first stage "C22 (Stage 1 runtime)" and "C82 (Stage 1 rotational direction and acceleration/deceleration time)" during operation, input a stop command and press the PRG RESET key.

When operation from the first stage is necessary after an alarm stop, press the PRG RESET key for resetting the protective functions and press the PRG RESET key again. For the PRG RESET key operation with input terminals, use of the "RST" terminal (set "8 (Active ON)" or "1008 (Active OFF)" for any of E01 to E05) function the same way.

Tip

- Pattern operation can be started by either a forward run command (specify F02 = 2 and press the RUN key, or specify F02 = 1 and turn the terminal [FWD] ON) or reverse run command (specify F02 = 3 and press the RUN key, or specify F02 = 1 and turn the terminal [REV] ON). However, the direction of rotation is the direction set by C82 to C88 in both cases of starting by a FWD or REV command.
- When using terminal [FWD] or terminal [REV], the run command self-hold function does not work. Please use the alternate-type switch.

⚠CAUTION

When pattern operation is started by specifying C21 = 0 and turning the terminal [FWD (REV)] ON, the motor stops after the completion of the last stage even if the terminal [FWD (REV)] is kept turned ON.

In this case, modifying the value for F01 or C30 or switching the control terminal "Hz2/Hz1" ON/OFF without turning the FWD (REV) terminal OFF causes the operation to be immediately resumed according to the reference frequency after the change.

Failure to observe this could result in an accident or injury.

■ Timed operation (C21 = 3)

Select this for timed operation, in which simply specifying the run time and inputting a run command starts motor operation and stops the operation after the specified period has elapsed.

Tip

- To stop the timed operation, press the STOP key during timer countdown.
- When the timer period is 0, pressing the RUN key does not start operation if C21 = 3.
- An external signal ("FWD" or "REV") can also be used to start operation.

Example of timed operation

Pre-configuration

- To indicate the timer value on the LED monitor, set the data for E43 (LED monitor) to "13" (timer value) and data for C21 to "3."
- Specify the reference frequency for timed operation. When the reference frequency is specified by keypad operation and the timer value is indicated, press the FUNC DATA key to switch to speed monitor display and modify the reference frequency.

Timed operation (to start operation with the RUN key)

(1) While checking the timer value on the LED monitor, press the ▲/▼ key to specify the timer period (in seconds). (The timer value is indicated as an integer without a decimal point on the LED monitor.)

(2) Press the RUN key to start motor operation. The timer period counts counted down. After the timer period has elapsed, the operation stops without the need for pressing the STOP key. (Timed operation is possible even when the LED monitor indication is not the timer value.)

Note

For operation by turning the FWD terminal ON, the indication alternates between "End" and LED monitor display (0 for timer value) when the timed operation has been completed with deceleration to stop. Turning "FWD" OFF brings back the LED monitor display.

C30	Frequency setting 2 (Refer to F01)

For details on Frequency setting 2, refer to the description for function code F01.

C31 to C35	Analog input adjustment (terminal [12]) (Offset, Gain, Filter, Gain base point, Polarity selection)
C36 to C40	Analog input adjustment (terminal [C1] (C1 function)) (Offset, Gain, Filter, Gain base point, Mode selection)
C41 to C45	Analog input adjustment (terminal [C1] (V2 function)) (Offset, Gain, Filter, Gain base point, Polarity selection) Refer to F01 for details on frequency settings.

C55, C56	Bias (for PID, Frequency setting 2 (terminal [12])) (Bias, Bias base point) (Refer to F01)
C61, C62	Bias (for PID, Frequency setting 2 (terminal [C1]) (C1 function)) (Bias, Bias base point) (Refer to F01)
C67, C68	Bias (for PID, Frequency setting 2 (terminal [C1]) (V2 function)) (Bias, Bias base point) (Refer to F01)

You can adjust the gain, bias, polarity, filter time constant and offset which are applied to analog inputs (voltage inputs to terminals [12], and [C1] (V2 function) and current input to terminal [C1] (C1 function)).

Adjustable items for analog inputs (excluding those for frequency command 1)

Input terminal	Input range	Bias		Gain		Polarity	Filter	Offset
		Bias	Base point	Gain	Base point			
[12]	0 to +10 V, -10 to +10 V	C55	C56	C32	C34	C35	C33	C31
[C1] (C1)	4 to 20 mA, 0 to 20 mA	C61	C62	C37	C39	C40	C38	C36
[C1] (V2)	0 to +10 V	C67	C68	C42	C44	C45	C43	C41

■ Offsets (C31, C36, C41)

C31, C36, C41, and C74 set offsets for analog input voltage and current. The offset from signals sent from the external equipment can also be compensated.

Data setting range: -5.0 to +5.0 (%)

■ Filters (C33, C38, C43)

C33, C38, C43, and C76 provide the filter time constants for analog input voltage and current. The larger the time constant, the slower the response. Specify the proper filter time constant taking into account the response speed of the machine (load). If the input voltage fluctuates due to line noise, increase the time constant.

- Data setting range: 0.00 to 5.00 (s)

■ Polarity selection for terminal [12] (C35)

C35, C45, and C78 configure the polarity, and therefore the input range for analog input voltage.

C35 data	Terminal input specification
0	-10 to +10 V
1	0 to +10 V (Negative value of voltage is regarded as 0 V)

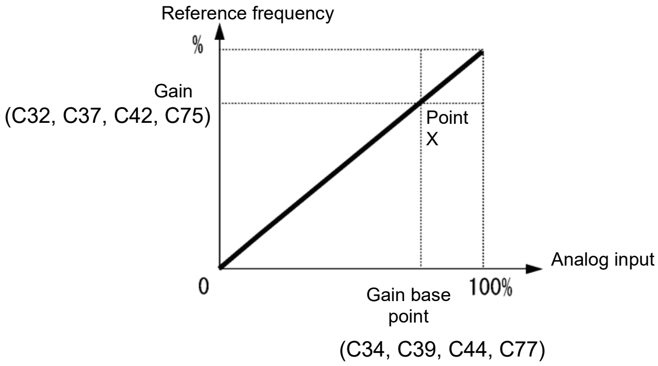
■ **Polarity selection for terminal [C1] (V2 function) (C45)**

C35, C45, and C78 configure the polarity, and therefore the input range for analog input voltage.

C40 data	Terminal input specification
0	-10 to +10 V When bias values are set to minus, below 0 point as minus value is enabled.
1	0 to +10 V When bias values are set to minus, below 0 point is limited with 0.

■ **Gain**

Sets the gain for analog input.
• Data setting range: -400.00 to 400.00 (%)



Note To input bipolar (0 to ±10 VDC) analog voltage at analog input (terminal [12]), set function code C35 to "0". When the data of C35 is "1", only 0 to +10 VDC effective and negative polar input 0 to -10 VDC regarded as 0 (Zero) V.

■ **Terminal [C1] (C1 function) Mode selection (C40)**

Selects the mode of current input terminal [C1](C1 function).

C40 data	Terminal input range	Handling when bias value is set to minus
0	4 to 20 mA	Limit below 0 point with 0
1	0 to 20 mA	
10	4 to 20 mA	Enable below 0 point as minus value.
11	0 to 20 mA	

In order to use terminal [C1] with the C1 function and V3 function, the following settings are necessary.

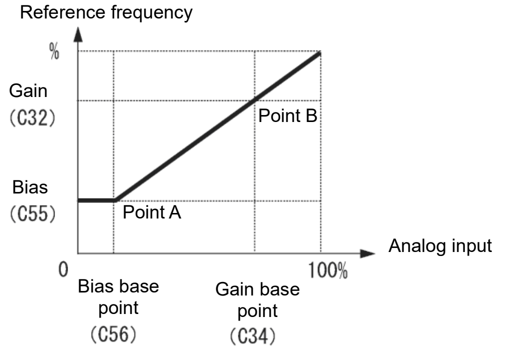
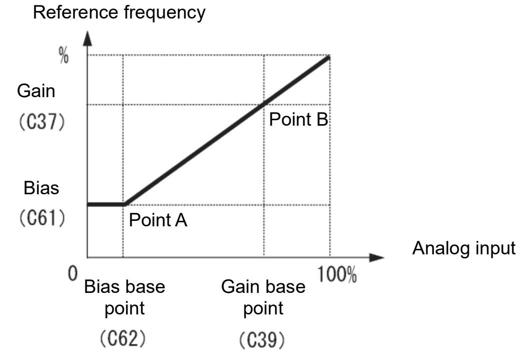
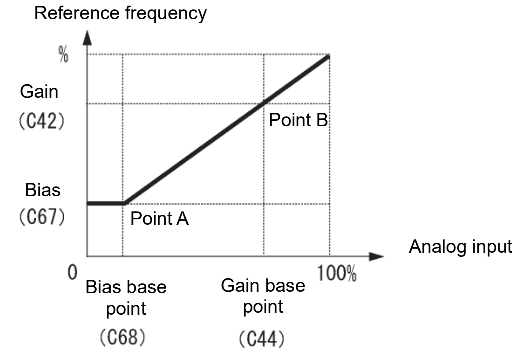
[C1] terminal	SW3	SW4	C40	H26
When using C1 function (4 to 20 mA)	C1 side	AI side	0 (unipolar) 10 (bipolar)	0
When using C1 function (0 to 20 mA)	C1 side	AI side	1 (unipolar) 11 (bipolar)	0
When using V2 function (0 to +10 V)	V2 side	AI side	Either	0
When PTC function used	C1 side	PTC side	Either	1 or 2

For details on SW3 or SW4, refer to Chapter 2 "2.2.7 Switching switches."

Exercise caution as expected operation may not result if the setting above is not conducted accurately.

Note E61, E62, E63, E66 Gain can be used up to the maximum of 400.00% only for terminals for which "Terminal [12], [C1] (C1 function), and [C1] (V2 function) (extension function selection)" data is set to 10 or 11.
With other functions, the gain value is limited to 200.00% internally even if a large gain value is set.

■ **Gain, bias**

Terminal	PID command, feedback, analog monitor
[12]	
[C1] (C1 function)	
[C1] (V2 function)	

These are biases and bias base points used for PID command, PID feedback, frequency command 2 and analog monitor. For details, refer to the description of F01 and J01.

Bias (C55, C61, C67, o66, o82)

- Data setting range: -200.00 to 200.00 (%)

Bias base point (C56, C62, C68)

- Data setting range: 0.00 to 1.00 (%)

Specifying the bias as a negative value allows an input to be specified as bipolar for a unipolar analog input. By setting C40 data to 10 or 11 for terminal [C1] (C1 function), the input value takes negative polarity with an analog input of 0 point or lower.

C50	Bias (for frequency setting 1) (Bias base point) (Refer to F01)

For details on Frequency setting 1 bias reference point settings, refer to the description for function code F01.

C53 C54	Forward/reverse operation selection (Frequency setting 1) Forward/reverse operation selection (Frequency setting 2)

Switches between the analog frequency setting forward operation and reverse operation.

For details on operation, refer to E01 to E05 (data = 21) for the terminal command IVS ("■ Switch Normal/inverse operation switching "IVS" assignment normal/inverse operation - "IVS"").

C58 C64 C70	Analog input adjustment (for analog monitor (terminal [12])) (Display unit) Analog input adjustment (for analog monitor (terminal [C1])) (C1 function) (Display unit) Analog input adjustment (for analog monitor (terminal [V2])) (Display unit)

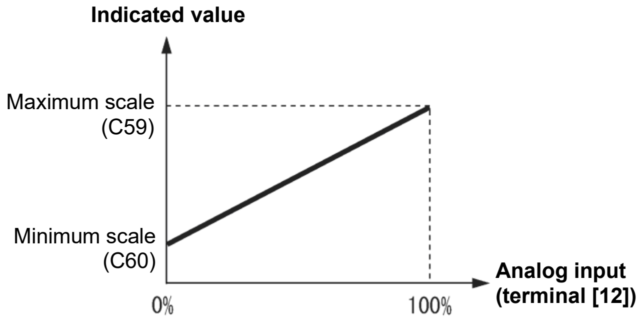
The units for the respective analog inputs can be displayed when a multi-function keypad (TP-A2SW) is used. Set these codes to use for command and feedback values of the PID control and the analog input monitor. Use the multi-function keypad to display the SV and PV values of the PID control and the analog input monitor on the main and sub-monitors. Indications are given in the specified units.

Setting	Display unit	Setting	Display unit	Setting	Display unit	Setting	Display unit
1	No unit	[Flow]		[Pressure]		[Torque]	
2	%	20	m^3/s	40	Pa	65	Nm
4	r/min	21	m^3/min	41	kPa	66	lb Ft
7	kW	22	m^3/h	42	MPa	[Length]	
8	HP	23	L/s	43	mbar	70	mm
[Speed]		24	L/min	44	bar	71	cm
10	mm/s	25	L/h	45	mmHg	72	m
11	mm/m	26	GPS	46	PSI	73	km
12	mm/h	27	GPM	47	mWG	74	in
13	m/s	28	GPH	48	inWG	75	Ft
14	m/min	29	CFS	49	inHg	76	Yd
15	m/h	30	CFM	50	WC	77	mi
16	FPS	31	CFH	51	Ft WG	[Concentration]	
17	FPM	32	kg/s	52	ATM	80	ppm
18	FPH	33	kg/m	[Temperature]		[Volume]	
19	SPM	34	kg/h	60	K	90	m^3
		35	lb/s	61	℃	91	L
		36	ib/m	62	℉	92	GAL
		37	ib/h			93	OZ
		38	AF/Y				

C59, C60 C65, C66 C71, C72	**Analog input adjustment (terminal [12]) (Maximum scale, Minimum scale)** **Analog input adjustment (terminal [C1] (C1 function)) (Maximum scale, Minimum scale)** **Analog input adjustment (terminal [V2]) (Maximum scale, Minimum scale)**

Values of the analog input monitor (terminals [12], [V2], and [C1] (C1 and V3 functions) can be converted into easily recognizable physical quantities for display. This function can also be used for PID feedback and PID command values.

- Data setting range: (Max. scale and min. scale) -999.0 to 0.00 to 9990.0



C89 C90	**Frequency compensation 1 through communication (Numerator)** **Frequency compensation 2 through communication (Denominator)**

A compensation value can be set for frequency settings via RS-485 communication or field bus communication. This is used if wishing to manually compensate the frequency determined by the system. By displaying these function codes with the keypad, values are displayed in hexadecimal format. If data 0 is set, it is handled as 1.

- Data setting range: -32768 to 32767 (keypad display: h.8000 to h.7FFF)

$$\text{Final frequency setting} = \text{Frequency setting through communication} \times \frac{\text{C89: Frequency compensation 1 (Numerator)}}{\text{C90: Frequency compensation 2 (Denominator)}}$$

C94 to C96	**Jump frequency 4 to 6 (Refer to C01)**

A detailed explanation can be found in the explanation for function code C01.

C99	**Digital reference frequency (Refer to F01)**

Displays the digital reference frequency set with the keypad ▲/▼ key. C99 is copied using the keypad or FRENIC-Loader4, allowing the digital reference frequency to be copied.

5.3.4 P codes (Motor 1 parameters)

To use the integrated automatic control functions such as auto torque boost, torque calculation monitoring, auto energy saving operation, torque limiter, automatic deceleration (anti-regenerative control), auto search for idling motor speed, slip compensation, vector control without speed sensor (torque vector), droop control, and overload stop, it is necessary to build a motor model in the inverter by specifying proper motor parameters including the motor capacity and rated current. Consequently, it is necessary to correctly set not only the motor capacity and rated current, but also all constants.

FRENIC-Ace is equipped with constants for Fuji standard motor 8-series motors, Fuji standard high-efficiency premium motors, and Fuji standard synchronous motors. To use these Fuji motors, it is enough to specify motor parameters for P99 (Motor 1 selection). If the cabling between the inverter and the motor is long (generally, 20 m (66 ft) or longer) or a reactor is inserted between the motor and the inverter, however, the apparent motor parameters are different from the actual ones, so auto-tuning or other adjustments are necessary.

Refer to Chapter 4 “4.8.1 Driving an Induction Motor (Induction motor)” and “4.8.2 PMSM operation” for details on the auto tuning procedure.

When using a motor made by other manufacturers or a Fuji non-standard motor, obtain the datasheet of the motor and specify the motor parameters manually or perform auto-tuning.

P01	Motor 1 (Poles)

P01 specifies the number of poles of the motor. Enter the value given on the nameplate of the motor. This setting is used to display the motor speed on the LED monitor and to control the speed (refer to E43). The following expression is used for the conversion.

Motor rotational speed (min^{-1}) = 120/No. of poles x Frequency (Hz)

- Data setting range: 2 to 128 (poles)

P02	Motor 1 (Capacity)

P02 specifies the rated capacity of the motor. Enter the rated value given on the nameplate of the motor.

P02 data	Unit	Function
0.01 to 1000	kW	When P99 (Motor 1 selection) = 0, 3 to 5, 20 to 23
	HP	When P99 (Motor 1 selection) = 1

When changing P02 with the keypad, take into account that the following function code data will be automatically rewritten with the initial values.

Applicable function codes: P03, P06 to P20, P30, P53 to P56, P60 to P65, P74, P85, P87, P90, H46

P03	Motor 1 (Rated current)

P03 specifies the rated current of the motor. Enter the rated value given on the nameplate of the motor.

- Data setting range: 0.00 to 2000 (A)

P04	Motor 1 (Auto tuning)

The inverter automatically detects the motor parameters and saves them in its internal memory. If using a Fuji standard motor (incl. old model IE1 induction motors and synchronous motors) with a standard connection method, there is generally no need to perform tuning.

There are two types of auto-tuning as listed below. Select the appropriate one considering the limitations in your equipment and control method. In the following table, IM indicates induction motor, and PM indicates synchronous motor.

P04 data	Auto tuning method	Operation	Motor parameters to be tuned (*1)	
0	Disable	---	---	
1	Tuning with the motor stopped	Tunes while the motor is stopped.	IM	Primary resistance %R1 (P07) Leakage reactance %X (P08) Rated slip frequency (P12) %X correction factor 1 (P53)
			PM	Magnetic pole position detection method (P30) *2 Armature resistance (P60) d-axis inductance (P61) q-axis inductance (P62) For adjustment by manufacturer (P84, P88)
2	Tuning with the motor running	After tuning the motor in a stopped state, retunes it running at 50% of the base frequency.	IM	No-load current (P06) Primary resistance %R1 (P07) Leakage reactance %X (P08) Rated slip frequency (P12) %X correction factor 1 (P53) Magnetic saturation factor 1 to 5 (P16 to P20)
			PM	Magnetic pole position detection method (P30) *2 Armature resistance (P60) d-axis inductance (P61) q-axis inductance (P62) Motor induced voltage (P63) For adjustment by manufacturer (P84, P88)
4	Synchronous motor magnetic pole position offset tuning	The motor is run at the speed set with d80, and tuning is performed.	PM	Magnetic pole position offset (P95)
5	Tuning with the motor stopped (%R1, %X only)	Tunes while the motor is stopped.	IM	Primary resistance %R1 (P07) Leakage reactance %X (P08) %X correction factor 1 (P53*)

*1 Refer to the motor 2 constants in "Table 5.3-2 Switching function code list" in "5.3.7 A codes (Motor 2 parameters)" for the motor constants for motor 2.

*2 Only applicable when tuning is performed when P30 = 1 is set.

For details on the auto-tuning procedure, refer to Chapter 4 "4.8.1 Driving an Induction Motor (Induction motor)" and "4.8.2 PMSM operation."

Note In any of the following cases, perform auto-tuning since the motor parameters are different from those of Fuji standard motors so that the best performance cannot be obtained under some conditions. In cases such as this, perform auto tuning.

- The driven motor is a non-Fuji or a Fuji non-standard one.
- The wiring distance between the inverter and the motor is too long (generally 20 m (65.6 ft) or more).
- A reactor is installed between the inverter and the motor.

Other applicable cases

Note If tuning is performed when P04 = 2 or 4 under vector control with sensor (F42 = 16), the motor may be driven in the opposite direction from the command direction. If this is not permissible, set the H08 rotation direction restriction.

Functions whose performances are affected by the motor parameters

Function	Related function codes (representative)
Auto torque boost	F37
Output torque monitor	F31
Load factor monitor	F31
Auto energy-saving operation	F37
Torque limiter	F40
Anti-regenerative control	H69
Auto search	H09
Slip compensation	F42
Dynamic torque vector control	F42
Dynamic torque vector control with sensor	F42
Vector control with sensor	F42
Sensorless vector control	F42
Sensorless vector control (synchronous motors)	F42
Vector control with sensor (synchronous motors)	F42
Torque control	H18
Droop control	H28
Torque detection	E78 to E81
Contacting the stopper	J90 to J92
Brake signal (Brake-release torque)	J95

P05	Motor 1 (Online tuning)

When vector control without speed sensor (dynamic torque vector) or slip compensation control is used for long-time operation, the motor parameters change along with motor temperature rise.

If motor parameters change, the amount of speed compensation may change to cause the motor speed to be different from the initial speed.

Enabling online tuning allows the identification of the motor parameters that match the change in the motor temperature, which minimizes the motor speed variation.

To use this function, specify “2” for auto-tuning (P04).

Note Online tuning is enabled only when F42 = 1 (Vector control without speed sensor) or F42 = 2 (V/f control with slip compensation active) and F37 = 2, 5 (auto torque boost).

P06 to P08	Motor 1 (No-load current, %R1 and %X)

P06 through P08 specify no-load current, %R1 and %X, respectively. Obtain the appropriate values from the test report of the motor or by calling the manufacturer of the motor. Performing auto-tuning automatically sets these parameters.

- No-load current: Input the value obtained from the motor manufacturer.
- %R1: Enter the value calculated by the following expression.

$$\%R1 = \frac{R1 + \text{Cable } R1}{V/(\sqrt{3}\times I)} \times 100(\%)$$

R1: Primary resistance of the motor (Ω)

Cable R1: Resistance of the output cable (Ω)

V: Rated voltage of the motor (V)

I: Rated current of the motor (A)

- %X: Enter the value calculated by the following expression.

$$\%X = \frac{X1 + X2 \times XM / (X2 + XM) + \text{Cable } X}{V/(\sqrt{3}\times I)} \times 100(\%)$$

X1: Primary leakage reactance of the motor (Ω)

X2: Secondary leakage reactance of the motor (converted to primary) (Ω)

XM: Exciting reactance of the motor (Ω)

Cable X: Reactance of the output cable (Ω)

V: Rated voltage of the motor (V)

I: Rated current of the motor (A)

Note For reactance, use the value at the base frequency (F04).

P09 to P11	Motor 1 (Slip compensation gain for driving, Slip compensation response time, Slip compensation gain for braking)

Adjusts P09 and P11 determine the slip compensation amount in % for driving. Separate settings can be made for drive mode and braking mode. Setting to 100% fully compensates for the rated slip of the motor. Excessive compensation (100 % or more) may cause hunting (undesirable oscillation of the system), so carefully check the operation on the actual machine.

P10 determines the response time for slip compensation. Basically, there is no need to modify the default setting. If you need to modify it, consult your Fuji Electric representatives.

Function codes		Operation (slip compensation)
P09	Slip compensation gain (for driving)	Adjust the slip compensation for driving. Slip compensation amount when driving = Rated slip x Slip compensation gain (when driving)
P11	Slip compensation gain for braking	Adjust the slip compensation amount when braking. Slip compensation amount when braking = Rated slip x Slip compensation gain (when braking)
P10	Slip compensation response time	Set the slip compensation response time. Basically, there is no need to modify the setting.

For details about slip compensation control, refer to the description of F42.

P12	Motor 1 (Rated slip frequency)

Sets the motor rated slip. Obtain the appropriate values from the test report of the motor or by calling the manufacturer of the motor. Performing auto-tuning automatically sets these parameters.

- Rated slip: Convert the value obtained from the motor manufacturer to Hz.

(Note: The motor rated value on the nameplate sometimes shows a larger value.)

$$\text{Rated slip frequency (Hz)} = \frac{(\text{Synchronous speed} - \text{Rated speed})}{\text{Synchronous speed}} \times \text{Base freqency}$$

For details about slip compensation control, refer to the description of F42.

P13	Motor 1 (Iron loss coefficient 1)

Input the characteristics of the exciting current required to create the magnetic flux produced inside the motor, and the characteristics of the produced magnetic flux.

The combination of P99 (Motor 1 selection) and P02 (Motor 1 rated capacity) data determines the standard value.

Basically, there is no need to modify the setting.

P16 to P20	Motor 1 (Magnetic saturation coefficient 1 to 5)

Input the characteristics of the exciting current required to create the magnetic flux produced inside the motor, and the characteristics of the produced magnetic flux. The combination of P99 (Motor 1 selection) and P02 (Motor 1 rated capacity) data determines the standard value. Performing auto-tuning while the motor is rotating (P04 = 2) sets the value of these factors automatically.

P30	**Motor 1 (Synchronous motor magnetic pole position detection method)** **Related function codes: P74: Synchronous motor 1 (Current command value on startup)** **P87: Synchronous motor 1 (NS discrimination current command value)** **d80: Synchronous motor 1 (Synchronous motor magnetic pole position pull-in frequency)**

P30 specifies the magnetic pole position detection mode. Select the appropriate mode that matches the synchronous motor to be used.

P30 data	Function
0: Current draw	Magnetic pole position detection is not performed. At the start of driving the motor, the inverter supplies current specified by P74 to pull in the magnetic pole position. In this position detection mode, the motor may rotate slightly in the direction opposite to the commanded direction depending upon the current motor shaft position.
1: For IPMSM (interior permanent magnet synchronous motor)	The inverter starts the motor with the magnetic pole position detection suitable for synchronous motors. The reference current for polarity discrimination specified by P87 applies. Usually it is not necessary to change the factory default.
2: For SPMSM (Surface permanent magnet synchronous motor)	The inverter starts the motor with the magnetic pole position detection suitable for surface magnet type synchronous motors.
3: Current draw method for IPMSM	The inverter starts the motor with the magnetic pole position detection suitable for synchronous motors causing no magnetic saturation. In this position detection mode, the motor may rotate slightly in the direction opposite to the commanded direction depending upon the current motor shaft position.
4: High-frequency superimposing method for IPMSM	By superimposing high-frequency voltage on the motor control voltage, the saliency of the IPM (interior permanent magnet) motor inductance is used to improve the sensorless detection accuracy at low speed, and to improve the speed control and torque limiting performance. Depending on the synchronous motor characteristics, it may not be possible to use this method. This method can be used with the Fuji Electric standard synchronous motor GNB2 series.

Tip The reference current for polarity discrimination specified by P87 applies. Usually it is not necessary to change the factory default.

Note During the magnetic pole position pull-in operation or the magnetic pole position detection operation, the motor is unable to generate enough torque. When applying to an application which requires torque when starting, use the brake signal "BRKS" and magnetic pole position detection complete signal "PTD" to ensure that the machine brake is not released until the magnetic pole position draw-in operation is complete. (Function code E20)

When adopting vector control with sensor for synchronous motors, the starting operation will be as shown in the following table based on each function code combination.

F42 data	d14 data	P95 data	P30 data	Operation when starting
16: Vector control with sensor (synchronous motors)	2: A, B phase 90° phase difference, Z phase	999 (Offset not set)	0: Current draw 3: Current draw method for IPMSM	<Disabled at start> An ErC alarm occurs, and the motor does not start. Adjust P95.
			1, 4: Method for IPMSM 2: Method for SPMSM	<Magnetic pole position detection start> The motor starts from 0 Hz following magnetic pole position detection.
		0.0 to 359.9° (Offset adjusted)	0, 3	<Magnetic pole position draw-in start> The magnetic pole position draw-in operation is performed at the frequency set at d80 when turning ON the inverter power for the first time. The motor accelerates to the command speed after magnetic pole position draw-in is complete. The motor starts (normal start) from 0 Hz from the next time onward. The time required for the magnetic pole position draw-in operation is a maximum of one machine angle rotation. (📖 Function code d80)
			1, 2, 4	<Magnetic pole position detection start> The motor starts from 0 Hz following magnetic pole position detection when turning ON the inverter power for the first time. The motor starts (normal start) from 0 Hz from the next time onward.

Note During the magnetic pole position draw-in operation or the magnetic pole position detection operation, the motor is unable to generate enough torque. When applying to an application which requires torque when starting, use the brake signal "BRKS" and magnetic pole position detection complete signal "PTD" to ensure that the machine brake is not released until the magnetic pole position draw-in operation and magnetic pole position detection operation are complete. (📖 Function code E20)

P40, P41	For adjustment by manufacturer

These function codes are for adjustment by the manufacturer. Do not access these function codes.

P53	Motor 1 (%X correction factor 1)

This is a factor for correcting leakage reactance %X. Basically, there is no need to modify the setting.

P55	Motor 1 (Torque current under vector control)

Sets the torque current rated value under vector control with sensor.
The combination of P99 (Motor 1 selection) and P02 (Motor 1 rated capacity) data determines the standard value.
To change the standard value, do so after specifying these settings.
Basically, there is no need to modify the setting.

P56	Motor 1 (Induced voltage factor under vector control)

Sets the induced voltage under vector control with sensor.
The combination of P99 (Motor 1 selection) and P02 (Motor 1 rated capacity) data determines the standard value.
To change the standard value, do so after specifying these settings.
Basically, there is no need to modify the setting.

P57	Motor 1 (For adjustment by manufacturer)

This function code is for adjustment by the manufacturer. Do not access these function codes.

P60 to P64	Motor 1 (For synchronous motors (Armature resistance, d-axis inductance, q-axis inductance, Induced voltage, Iron loss))

Set armature resistance, d-axis inductance, q-axis inductance, induced voltage (base speed), and iron loss (base speed) of the motor, respectively. Obtain the appropriate values from the test report of the motor or by calling the manufacturer of the motor. Furthermore, P60 to P63 are set automatically by performing auto tuning.

P65, P85	Motor 1 (For synchronous motors (q-axis inductance magnetic saturation correction, Flux limitation value))

These are the control parameter for PMSMs. Normally, it is not necessary to change the data of these function codes.

P74	Motor 1 (For synchronous motors (current command value on startup))

When the motor starts, the set starting current flows in the area at or below the output frequency level set with P89, the magnetic pole position is drawn in, and operation is performed. Increase the setting value if the torque is insufficient.

P87	Synchronous motor 1 (NS discrimination current command value)

Refer to the explanation for P30.

P82, P83, P84, P86, P88	Motor 1 (For adjustment by manufacturer)

These function codes are for adjustment by the manufacturer. Do not access these function codes.

P89 | Motor 1 (Control switching level)

These are the control parameters for PMSMs. Normally, it is not necessary to change the data of these function codes.

P90 | Motor 1 (Overcurrent protection level)

Sets the synchronous motor demagnetization limit current value with an effective value. Check the demagnetization limit current value with the motor manufacturer.

Synchronous motors have a current limit to prevent demagnetization of permanent magnet. If a current exceeding that limit flows through the motor, it weakens the magnet force of permanent magnet so that the motor does not get the desired characteristics.

To prevent it, P90 specifies the overcurrent protection level. If a current flows exceeding the level, the inverter causes an overcurrent protection alarm OC1, OC2 or OC3.

P95 | Motor 1 (Magnetic pole position sensor offset)

Adjust the offset between the actual magnetic pole position of the synchronous motor with sensor and the Z-phase detection position.
This can be adjusted automatically by auto tuning.

P99 | Motor 1 selection

P99 specifies the motor type to be used.

P99 data	Function
0	Motor characteristics 0 (Fuji standard motors, 8-series)
1	Motor characteristics 1 (Representative HP motor models)
3	Motor characteristics 3 (Fuji standard IM, 6-series Refer to “Note” below)
4	Other (Induction motors)
5	Motor characteristics 5 (Fuji premium efficiency motors)
20	Other synchronous motors
21	Fuji standard synchronous motors (GNB2 series)
23	Fuji standard synchronous motors (GNP1 series)

The setting range is 0 to 5 when F42 = 0 to 6, and 20 to 23 when F42 = 15 or 16.

To select the motor drive control or to run the inverter with the integrated automatic control functions such as auto torque boost and torque calculation monitoring, it is necessary to specify the motor parameters correctly.

<u>Change procedure</u>
First select the motor type with P99 from Fuji standard motors 8-series, set P02 (capacity) and then initialize the motor parameters with H03. The required motor parameters (P01, P03, P06 to P23, P53, P55 to P65, P74, P83 to P85, P87 to P90, H46) are automatically set.
The data of F09 (Torque boost 1), H13 (Momentary power failure restart (Waiting time)), and F11 (Electronic thermal 1 (Motor protection) (Operation level)) depends on the motor capacity, but the process stated above does not change them. Specify and adjust the data during a test run if needed.

Note: If using the Fuji standard IM, 6-series, set P99 = 3 and carry out the change procedure above. Then, either perform auto-tuning (P04 = 1: Tune the motor while it is stopped) or set the motor constants nanually.

High induction motor efficiency (premium efficiency motors)

A “Top Runner system” was established and made obligatory in Japan through the Energy Conservation Act in 2015, and Fuji has since then been selling premium efficiency motors which conform to efficiency class IE3.
In comparison to conventional induction motors (IE1), premium efficiency motors (IE3) have the following features.

Table 5.3.1 Typical comparison of induction motors (IE1) and premium efficiency motors (IE3)

Item	Induction motor (IE1)	Premium efficiency motors (IE3)
Armature resistance	Large	Small
Moment of inertia	Small	Large
Rated slip	Large	Small

Points to bear in mind and remedies for phenomena that occur when combining premium efficiency motors (IE3) with inverters

If changing a combination of a conventional induction motor (IE1) and inverter to a premium efficiency motor (IE3) and inverter, or if a conventional induction motor (IE1) driven by a commercial power supply is changed to a premium efficiency motor (IE3) and inverter, the following phenomena may occur. These phenomena should be handled with the remedies indicated.

No.	Phenomenon	Remedy	Point to bear in mind
1	• Overcurrent protection OC1 is triggered when the motor starts. • The frequency does not increase. • Motor thermal protection OL1 is triggered, and continued operation is no longer possible at low speed.	• Reduce torque boost (Fuji Electric inverter function code [F09]).	• Since the armature resistance tends to drop as shown in Table 5.3.1 under acceleration, constant velocity, and deceleration characteristics, in the case of commonly used V/F control, motor current increases, and in the worst case, motor thermal protection may be triggered.
2	• Overvoltage protection OU2 is triggered when decelerating. • Deceleration time increases.	• Enable strong break control under deceleration characteristics (set Fuji Electric inverter function code [H71] to 1 or 2). • Increase the deceleration time (Fuji Electric inverter function code [F08]). • Or set torque limiting anti-regenerative control (Fuji Electric inverter function code [H69]).	• Since the moment of inertia tends to increase, regenerative energy increases with the current deceleration time in the case of commonly used V/F control under deceleration characteristics, and in the worst case, overvoltage protection is triggered.
3	• The equipment speed is too fast, or the fan air flow is too high.	• Readjust the rated slip (Fuji Electric inverter function code [P12]) (when slip compensation enabled). • Lower the set frequency (when slip compensation disabled).	• The rated slip has decreased, and therefore if the machine conditions are the same, the motor rotation speed may become higher than before.
4	• An Er7 alarm occurred during motor tuning.	• Reduce torque boost (Fuji Electric inverter function code [F09]).	• The armature resistance tends to be lower than conventional induction motors (IE1), and therefore at the factory default torque boost (Fuji Electric inverter function code [F09]), the motor current will be high, and an Er7 alarm may occur.

5.3.5 H codes (High-performance Functions)

H02, H03	Data initialization (Initial value selection, Target) Related function codes: H193, H194 User-set initial value (Save, Protection)

Returns function code data to the factory default settings. The motor parameters are also initialized.
To change the H02/H03 data, it is necessary to press the STOP + ▲/▼ keys (simultaneous keying).

H03 data	Function
0	Disable initialization (Will not initialize.)
1	Initialize all function codes (initialization based function code H02 setting)
2	Initialize motor 1 constants based on function codes F42 (Control method selection 1), P02 (Capacity) and P99 (Motor 1 selection)
3	Initialize motor 2 constants based on function codes F42 (Control method selection 2), A16 (Rated capacity) and A39 (Motor 2 selection)
11	Initialize all function codes except link function [y codes] and [o2 codes]. (Communication can be continued even after initialization.)
12	Limited initialization (initialization of customizable logic function U codes only)
13	Clear of favorites

- When all function codes are initialized, select the initialization method in advance with function code H02.

H02 selection		Initialization method when 1 is set to H03
Data = 0	Fuji standard initial value	Initialize all function codes with the Fuji Electric standard factory defaults.
Data = 1	User-set initial value	Initialize the value with the user setting value saved by H194. If the user preference dataset is not saved, initialize it with Fuji standard initial value (H02 = 0).

For saving the user preference dataset, refer to items in function codes H193 and H194.

- To initialize the motor parameters, set the related function codes as follows.

Step	Item	Content	Function codes	
			Motor 1	Motor 2
(1)	Motor type	Selects the motor type.	P99	A39
(2)	Motor capacity	Sets the capacity (kW/HP).	P02	A16
(3)	Data initialization	Initializes motor parameters	H03＝2	H03＝3

- When initialization is complete, the function code H03 data returns to "0."
- If P02/A16 data is set to a value other than the standard nominal applied motor rating, data initialization with H03 internally converts the specified value parameters values to the standard nominal applied motor rating. (Refer to Table 5.2 2 Motor constant).

- Motor parameters to be initialized are for motors listed below under V/f control. When the base frequency, rated voltage, and the number of poles are different from those of the listed motors, or when non-Fuji motors or non-standard motors are used, change the rated current data to that printed on the motor nameplate.

Motor selection P99/A39		V/f setting
Data = 0, 3, 4	Fuji standard motor 8-series, other	4 poles, 200 V/50 Hz, 400 V/50 Hz
Data = 1	HP rating motors	4 poles, 230 V/60 Hz, 460 V/60 Hz
Data = 2	Fuji dedicated motors for vector control	4 poles, individual
Data = 5	Fuji premium efficiency motors	4 poles, 200 V/50 Hz, 400 V/50 Hz
Data = 20	Other (PMSMs)	6 poles, individual
Data = 21, 23	Fuji PMSMs	6 poles, individual

Data can only be set to 20 to 23 with P99.

Note By changing P02 with the keypad, take into account that the P02 data automatically updates data of P03, P05 to P20, P30, P40 to P90, and H46. Similarly, when accessing function code A16 for motor 2 to 4, data of related function codes for each are automatically updated.

The function codes initialized by performing motor constant initialization are as follows.

Motor selection	Motor 1	Motor 2
Data: 0, 1, 3 to 5 20 to 23	F09, F11, P01, P03, P05 to P23, P30, P40 to P90, H46, d90	A05, A07, A15, A17, A19 to A37, A53 to A56
Data: 2	The above function codes + F04, F05	The above function codes + A02, A03

H193, H194	**User-set initial value (Save, Protection)** **Related function codes: H02 and H03 Data initialization (Initial value selection, Target)**

The value can be saved in the non-volatile memory in the inverter so that customers may use the setting value changed from the Fuji Electric standard factory default value as the initial value for inverter initialization.

The setting value saved and protected here can be selected as the user preference dataset for initialization with function code H03. When this function is used, set H02 data = 1.

If initialization is performed without saved/protected setting data, it is initialized to the Fuji Electric standard factory default regardless of the H02 value.

For data initialization, refer to function codes H02 and H03.

To change the data of function codes H02, H193 and H194, it is necessary to operate double keys "STOP key + ▲ / ▼ key."

To save the user setting value, set 1 (saved as the user preference dataset) to function code H02 in advance. In addition, function code H194 must be set to 0 (save enable).

H02 data	H194 data	Function when 1 is set to H193
0	Optional	User setting value is not saved.
1	0: Save enable	User setting value is saved.
	1: Protected (save disable)	User setting value is not saved.

User preference dataset save procedures

① Set all function codes and determine the user setting value for initialization.

② Set H02 = 1 and H194 = 0.

③ Set H193 = 1. The user setting value is saved.

④ Set H194 = 1. The user setting value is protected.

Note: When the setting value of the function code has already saved by H193 and the step of H193 is repeated again, the saved data is overwritten. Be careful of erroneous operation. To prevent overwriting by error, it is recommended to protect the data with H194 data = 1 after saving.

H04, H05	Auto-reset (Times and reset interval)

H04 and H05 specify the auto-reset function that makes the inverter automatically attempt to reset the tripped state and restart without issuing an alarm output (for any alarm) even if any protective function subject to reset is activated and the inverter enters the forced-to-stop state (tripped state). If the protective function is activated in excess of the times specified by H04, the inverter will issue an alarm output (for any alarm) and not attempt to auto-reset the tripped state.

Listed below are the protective functions subject to auto-reset.

Protective function	Alarm display	Protective function	Alarm display
Overcurrent protection	OC1 OC2 OC3	Breaking resistor overheat	dbH
Overvoltage protection	OU1, OU2, OU3	Motor overload	OL1 to OL2
Cooling fin overheat	OH1	Inverter overload	OLU
Inverter internal overheat	OH3	Step-out/magnetic pole position detection failure	Erd
Motor overheat	OH4	Charging resistor overheat	OH6

■ Number of reset times (H04)

H04 specifies the number of reset times for the inverter to automatically attempt to escape the tripped state. When H04 = 0, the auto-reset function will not be activated.

- Data setting range: 0, 1 to 20 (times) (0: auto-reset function disable)

⚠CAUTION

If the inverter stops due to a trip by selecting the auto-reset function, it may automatically restart, and the motor may rotate depending on the cause of the trip. Design machines in such a way as to ensure the safety of the human body and surrounding area even when operation is resumed.

Failure to observe this could result in an accident.

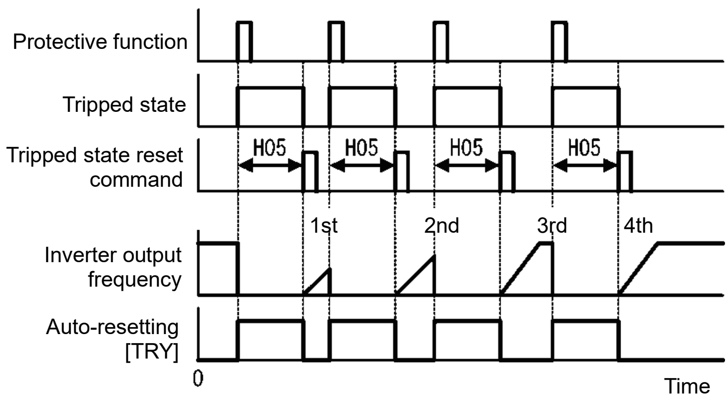
■ Reset interval (H05)

- Data setting range: 0.5 to 20.0 (s)

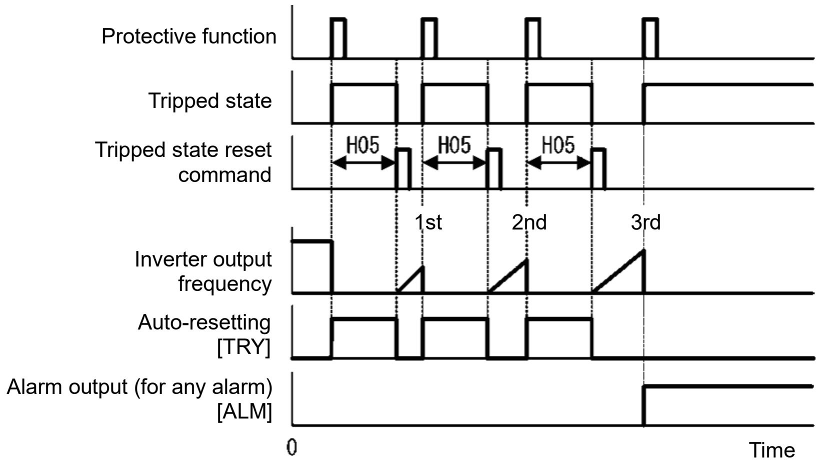
H05 specifies the reset interval time between the time when the inverter enters the tripped state and the time when it issues the reset command to attempt to auto-reset the state. Refer to “Operation timing scheme” below.

<Operation chart>

- In the figure below, normal operation restarts in the 4-th retry.



- If the retry count exceeds 3 times (H04 = 3), and an integrated alarm is output



- The auto-reset operation can be monitored from the external equipment by assigning the digital output signal TRY to any of the programmable, output terminals [Y1] to [Y4], [Y5A/C] or [30A/B/C]. Set function code E20 to E21 or E27 to “26” (during “TRY” retry operation).

H06 Cooling fan ON-OFF control

To prolong the service life of the cooling fan and reduce fan noise during running, the cooling fan stops when the temperature inside the inverter drops below a certain level while the inverter stops.

H06 specifies whether to keep running the cooling fan all the time or to enable ON/OFF control.

H06 data	Function
0	Disable (Always fan ON)
1	Enable (Cooling fan ON/OFF controllable)

■ **Cooling fan ON-OFF control “FAN” assignment (Function code E20 to E21, E27 data = 25)**

With the cooling fan ON/OFF control enabled (H06 = 1), this output signal is ON when the cooling fan is in operation, and OFF when it is stopped. This signal can be used to make the cooling system of peripheral equipment interlocked for an ON/OFF control.

H07 Curvilinear acceleration/ deceleration (Refer to F07)

Curve acceleration/deceleration settings are described in detail in the function code F07 section.

H08 Rotational direction limitation

H08 inhibits the motor from running in an unexpected rotational direction due to miss-operation of run commands, miss-polarization of frequency commands, or other mistakes.

H08 data	Function
0	Disable
1	Enable (Reverse rotation inhibited)
2	Enable (Forward rotation inhibited)

Under sensorless vector control, the motor may rotate slightly in the direction other than that specified due to an error in the estimated speed caused by a motor constant error.

H09, d67	**Startup characteristics (Auto search mode)** **Related function codes: H49 (Startup characteristics (Auto search time 1))** **H46 (Startup characteristics (Auto search time 2))**

Specify the mode for auto search without stopping the idling motor. The mode can be specified for each restart after momentary power failure and each start of normal operation. The starting mode can be switched by assigning starting characteristic selection “STM” to a general-purpose digital input signal. If it is not assigned, “STM” is regarded to be OFF. (Data = 26)

■ H09/d67 (Startup characteristics (Auto search mode) and starting characteristic selection terminal command “STM” (“Select auto search for idling motor speed at starting”)

The combination of starting characteristics H09 and d67 data and the “STM” signal determines whether to perform the auto search when starting.

Function codes	Active mode	Remarks
H09	V/f control (F42 = 0 to 2)	
d67	Sensorless vector control (F42 = 5,15)	

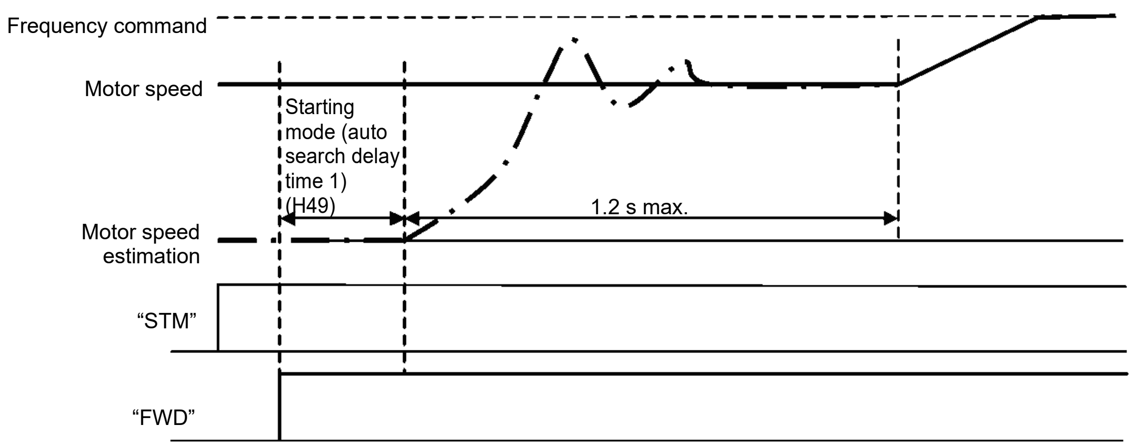
H09/d67 data	Starting characteristic selection “STM”	Starting characteristic	
		Momentary power failure restart (F14 = 3 to 5)	For normal startup
0: Disable	OFF	Auto search disable	Auto search disable
1: Enable	OFF	Auto search enable	Auto search disable
2: Enable	OFF	Auto search enable	Auto search enable
—	ON	Auto search enable	Auto search enable

When “STM” is assigned and ON, auto search for idling motor speed at starting is enabled regardless of the H09 setting. (📖 Function code E01 to E05, data = 26)

By setting 15 for F42, d67 is automatically set to 2: Enabled (At normal start and at momentary power failure restart).

Auto search

Starting the inverter with auto search enabled searches for the idling motor speed for a maximum of 1.2 seconds while the motor is idling without stopping it. After completion of the auto search, the inverter accelerates the motor up to the reference frequency according to the frequency command and the preset acceleration time.



■ Startup characteristics (Auto search time 1) (H49)

- Data setting range: 0.0 to 10.0 (s)

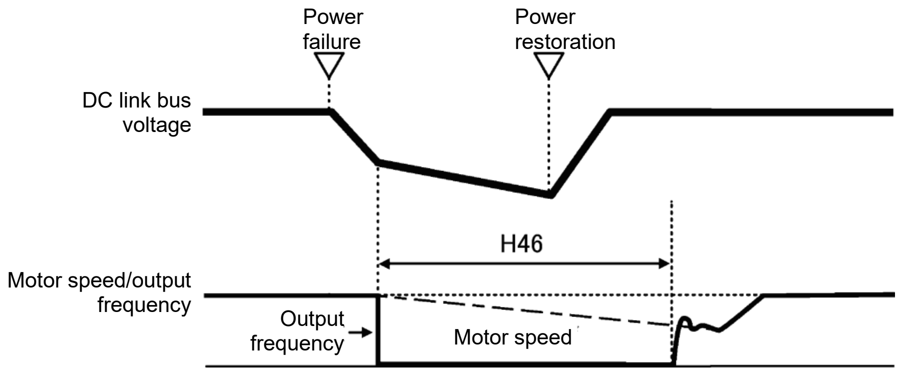
Auto search may fail if there is any motor residual voltage.
If so, it is necessary to secure the time until residual voltage runs out.

When operation is started by turning a run command ON, auto search is started after the period specified with the starting mode (auto search delay time 1) (H49) has elapsed. When switching between two inverters for controlling one motor and if the motor is coasting to stop at the time of switching to start by auto search, by specifying H49 eliminates the need for timing the run command.

■ **Startup characteristics (Auto search time 2) (H46)**

- Data setting range: 0.1 to 20.0 (s)

At the restart after a momentary power failure, at the start by turning the terminal command “BX” (“Coast-to-a-stop”) OFF and ON, or at the restart by auto-reset, the inverter applies the auto search time specified by H46. Even if starting conditions are satisfied, the inverter does not start unless auto-search delay time elapses after inverter goes into OFF state. The inverter starts after elapse of auto search delay time.



Under auto search control, the inverter searches the motor speed with the voltage applied at the motor start and the current flowing in the motor, based on the model built with the motor parameters. Therefore, the search is greatly influenced by the residual voltage in the motor.

H46 is available for motor 1 only. At factory shipment, H46 data is preset to a correct value according to the motor capacity for the general-purpose motor, and basically there is no need to modify the data.

Depending on the motor characteristics, however, it may take time for residual voltage to disappear (due to the secondary thermal time constant of the motor). In such a case, the inverter starts the motor with the residual voltage remaining, which will cause an error in the speed search and may result in occurrence of an inrush current or an overvoltage alarm.

If it happens, increase the value of H46 data and remove the influence of residual voltage.
(If possible, it is recommended to set the value around two times as large as the factory default value allowing a margin.)

Note
- Be sure to auto-tune the inverter preceding the start of auto search for the idling motor speed.
- When the estimated speed exceeds the maximum output frequency or the upper limit frequency, the inverter disables auto search and starts running the motor with the maximum output frequency or the upper limit frequency, whichever is lower.
- During auto search, if an overcurrent or overvoltage trip occurs, the inverter restarts the suspended auto search.
- If the inverter starts when the motor is idling with auto search disabled, an OC, etc. may occur, and the inverter may be unable to start.

Note Note that auto search may not fully provide the performance depending on load conditions, motor parameters, wiring length, and other external factors.

H11	Deceleration mode

H11 specifies the deceleration mode to be applied when a run command is turned OFF.

H11 data	Tuning
0	Normal deceleration
1	Coast-to-a-stop (The inverter immediately shuts down its output, so the motor stops according to the inertia of the motor and machinery (load) and their kinetic energy losses.)

Note When reducing the reference frequency, the inverter decelerates the motor according to the deceleration commands even if H11 = 1 (Coast-to-a-stop).

H12	Instantaneous overcurrent limit (Operation selection) (Refer to F43)

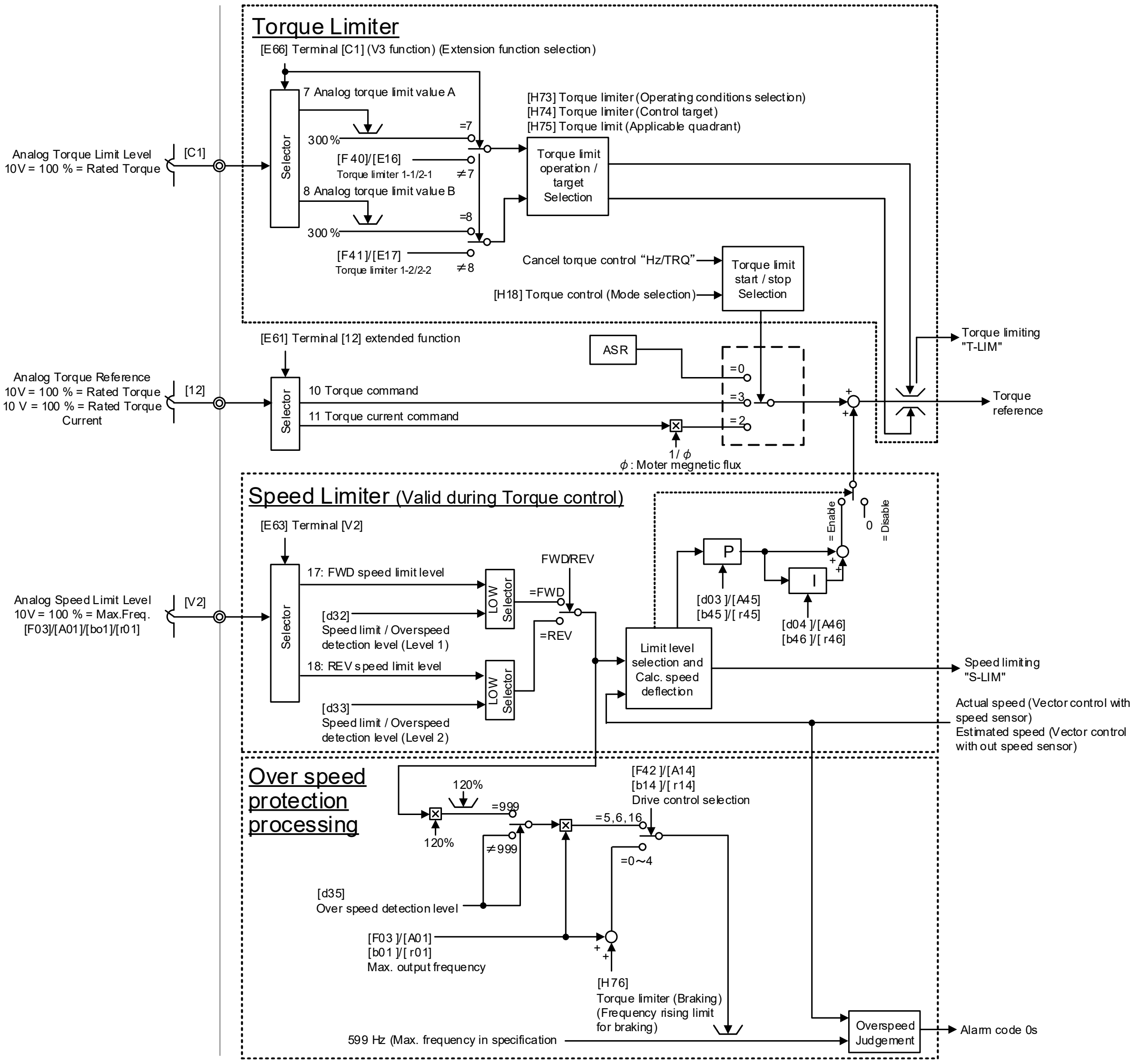
Refer to function code F43 and F44 sections for details on the instantaneous overcurrent limit (operation selection).

H13, H14 **H15, H16**	**Momentary power failure restart (Waiting time, Frequency fall rate)** **Momentary power failure restart (Continued operation level, Allowable momentary power failure time)** **(Refer to F14)**

For how to set these function codes (Waiting time, Frequency fall rate, Continued operation level and Allowable momentary power failure time), refer to the description of function code F14.

H18	**Torque control (Operation selection)** **Reference function codes:** **F40, F41 (Torque limit 1-1, 1-2)** **d32, d33 (Speed limit/Overspeed level 1 and 2)**

When vector control (sensorless, with sensor) is selected, the inverter can control the motor-generating torque according to a torque command sent from external sources. Under torque control, the speed is automatically calculated based on the torque command, and output from the inverter.



Block diagram of torque control

The following functions are disabled during torque control.
Speed control based on speed command, auto energy-saving operation, jogging operation, DC braking, condensation prevention, PID control, servo lock, droop, pattern operation, overload prevention control, anti-regenerative control, brake signals

FUNCTION CODES
Chap 5
FUNCTION
F Codes
E Codes
C Codes
P Codes
H Codes
A Codes
b Codes
r Codes
J Codes
d Codes
U Codes
y Codes
o Codes
K Codes

■ Torque control (Operation selection) (H18)

H18 specifies whether to enable or disable the torque control. Enabling the torque control offers two choices: with torque current command and with torque command.

H18 data	Available control
0	Disable (Speed control)
2	Enable (Torque control with torque current command)
3	Enable (Torque control with torque command)

■ Torque command

Torque commands can be given as analog voltage input (via terminals [12] and [C1] (V2 function)) or analog current input (via terminal [C1] (C1 function)), or via the communications link (communication-dedicated function codes S02 and S03). To use analog voltage/current inputs, it is necessary to set E61 (for terminal [12]), E62 (for terminal [C1] (C1 function)), E63 (for terminal [C1] (V2 function)) data to "10" or "11."

Input	Command form	Function code setting	Specifications
Terminal [12] (-10 V to 10 V)	Torque command	E61 = 10	Motor rated torque: ±200%/±10 V
	Torque current command	E61 = 11	Motor rated torque current: 200%/±10 V
Terminal [C1] (C1 function) (4 to 20 mA, 0 to 20 mA)	Torque command	E62 = 10	Motor rated torque: 200%/20 mA
	Torque current command	E62 = 11	Motor rated torque current: 200%/20 mA
Terminal [C1] (V2 function) (0 V to 10 V)	Torque command	E63 = 10	Motor rated torque: +200%/+10 V
	Torque current command	E63 = 11	Motor rated torque current: +200%/+10 V
S02 (-327.68 to 327.67 %)	Torque command	—	Motor rated torque: ±100.00%/±10000
S03 (-327.68 to 327.67 %)	Torque current command	—	Motor rated torque current: ±100.00%/±10000

■ Cancel torque control "Hz/TRQ" (E01 to E05, data = 23)

When torque control is enabled (H18 = 2 or 3), assigning the terminal command "Hz/TRQ" (Cancel torque control) to any of the general-purpose digital input terminals (data = 23) enables switching between speed control and torque control.

Cancel torque control signal "Hz/TRQ"	Tuning
ON	Cancel torque control (Enable speed control)
OFF	Enable torque control

■ Speed limits 1 and 2 (d32, d33)

Torque control mode controls the motor-generating torque directly, not the speed. The speed is determined secondarily by torque of the load, inertia of the machinery, and other factors. To prevent a dangerous situation, therefore, the speed limit functions (d32 and d33) are provided inside the inverter.

The speed limit levels can be set to forward or reverse individually.

- Forward speed limit level = Maximum output frequency (F03/A01) x Speed limit 1 (d32) (%)
- Reverse speed limit level = Maximum output frequency (F03/A01) x Speed limit 2 (d33) (%)

Note If switching between torque control and speed control, ensure that d35 ≠ 999. If the overspeed level is not set, set to 120%. If d35 = 999, the overspeed level setting will be 1 or 2 under speed control, and an overspeed OS will occur at 120% of the level set at d32 and d33.

■ Performing speed limiting "S-LIM" (E20 to E21, E27, data = 131)

If the motor speed reaches the speed limit value during torque control (H18 = 2, 3), "S-LIM" will turn ON during speed limiting. Speed limiting (when H18 ≠ 2 or 3, or when torque control cancel signal "Hz/TRQ" = ON) will be disabled (OFF).

■ Analog speed limit value (E61, E62, E63)

You can also enter from the analog input the speed limit value. For details, refer to E61, E62, and E63.

- Forward speed limit level = Maximum output frequency (F03/A01) x FWD speed limit value (analog input) (%)
- Reverse speed limit level = Maximum output frequency (F03/A01) x FWD speed limit value (analog input) (%)

■ Overspeed detection level (120% of the specified speed limit levels)

If a regenerative load (which is not generated usually) is generated under droop control or function codes are incorrectly configured, then the motor may rotate at an unintended high speed. To protect the machinery, it is possible to specify the overspeed level with d32 and d33 as follows.

- Forward overspeed detection level = Maximum output frequency (F03/A01) x Speed limit 1 (d32) x 120 (%)
- Reverse overspeed detection level = Maximum output frequency (F03/A01) x Speed limit 2 (d33) x 120 (%)

When performing speed control, d32 and d33 are used as the overspeed (OS) detection level for the forward rotation side and reverse rotation side, respectively. If switching between torque control and speed control, use d35 if an overspeed protection alarm (OS) occurs.

Note **Running/stopping the motor**

Under torque control, the inverter does not control the speed, so it does not perform acceleration or deceleration by soft-start and stop (acceleration/deceleration time) at the time of startup and stop. Turning ON a run command starts the inverter to run and output the commanded torque. Turning it OFF stops the inverter so that the motor coasts to a stop.

When starting torque control under sensorless vector control, the starting operation will differ depending on whether function code (d67) auto search is enabled or disabled.

d67 data	Tuning
0: Disable 1: Enable (Only at restart after momentary power failure)	When starting up, the motor starts from zero frequency. Acceleration starts based on the torque command. When starting up, be sure to use with an application that involves the motor stopping.
2: Enable (At normal start and at restart after momentary power failure)	When starting up, auto search is performed and after finding the motor as it rotates, torque control begins.

H26	**Thermistor (for motor 1, 2) (Operation selection)**
H27	**Thermistor (for motor 1, 2) (Operation level)**

These function codes specify the PTC (Positive Temperature Coefficient) thermistor embedded in the motor. The thermistor is used to protect the motor from overheating or outputting an alarm signal. If using this function in conjunction with motor switching, use PTC thermistors with identical characteristics for each motor, and switch motors before inputting data to terminal [C1].

■ **Thermistor (for motor 1, 2) (Operation selection) (H26)**

H26 selects the function operation mode (protection or alarm) for the PTC thermistor as shown below.

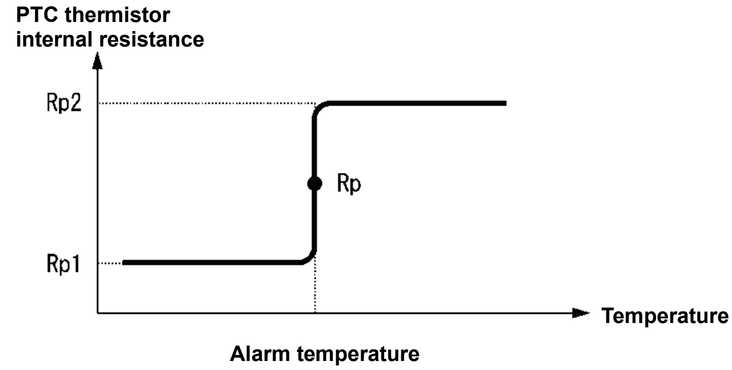
H26 data	Operation
0	Disable
1	When the voltage sensed by PTC thermistor exceeds the detection level, motor protective function (alarm OH4) is triggered, causing the inverter to enter an alarm stop state.
2	When the voltage sensed by the PTC thermistor exceeds the detection level, a motor alarm signal is output but the inverter continues running. You need to assign the “Motor overheat detected by thermistor” signal (“THM”) to one of the digital output terminals beforehand, by which a temperature alarm condition is indicated to the peripheral equipment (E20 to E21 and E27, data = 56).

■ **Thermistor (for motor1, 2) (Operation level) (H27)**

H27 specifies the operation level (expressed in voltage) for the PTC thermistor.

- Data setting range: 0.00 to 5.00 (V)

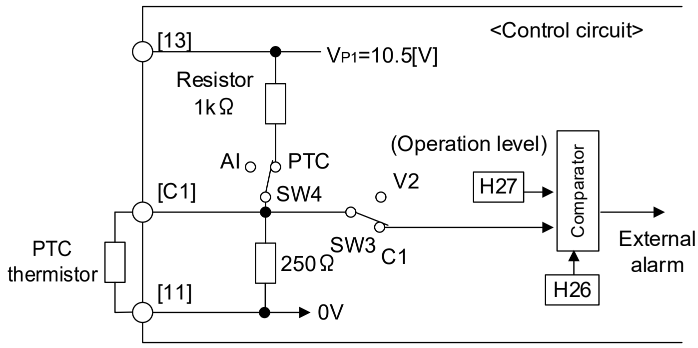
The alarm temperature at which the overheat protection becomes activated depends on the characteristics of the PTC thermistor. The internal resistance of the thermistor will significantly change at the alarm temperature. The operation level (voltage) is specified based on the change of the internal resistance.



Suppose that the internal resistance of the PTC thermistor at the alarm temperature is Rp, the operation level (voltage) V_{C1} is calculated by the expression below. Set the value of V_{c1} to function code H27.

$$V_{C1}=\frac{R_p}{1000+5\times R_p}\times 10.5(V)$$

Connect the PTC thermistor as shown below. The voltage obtained by dividing the input voltage on terminal [C1] with a set of internal resistors is compared with the operation level voltage specified by H27.



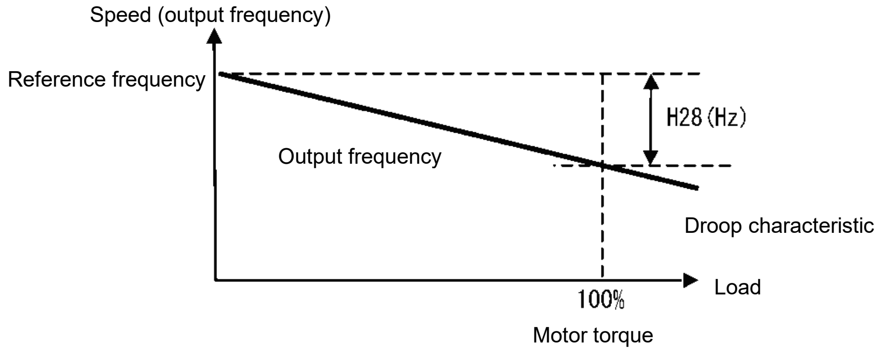
Note: When using the terminal [C1] for PTC thermistor input, it is necessary to change with switch (SW4) on the control PCB. For details, refer to Chapter 2 “2.2.7 Switching switches.”

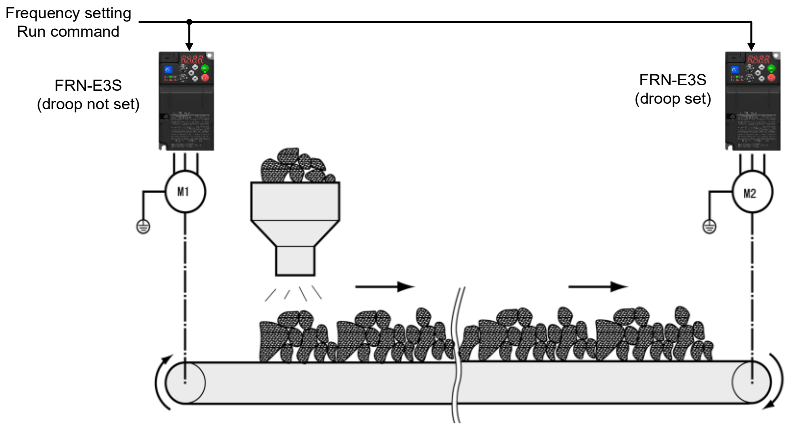
H28	Droop control

In a system in which two or more motors drive single machinery, any speed gap between inverter-driven motors results in some load unbalance between motors. Droop control allows each inverter to drive the motor with the speed droop characteristic for increasing its load, eliminating such kind of load unbalance. This function is disabled while the starting frequency is maintained, and during deceleration.

- Data setting range: -60.0 to 0.0 (Hz), (0.0: Disable)

Tip The approximate rated slip frequency for the applicable motor should be used for the H28 setting value as a guide.





■ **Select droop control "DROOP" (Function code E01 to E05, data = 76)**

The terminal command "DROOP" toggles droop control on and off.

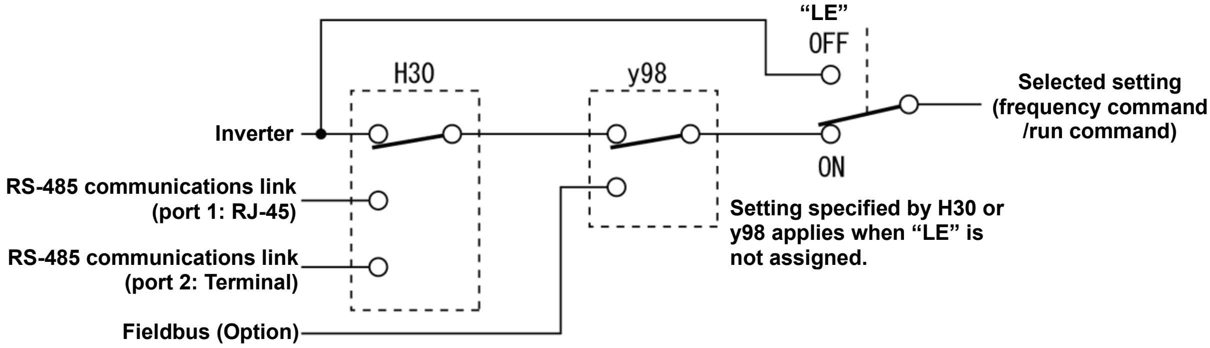
Terminal command "DROOP"	Droop control
ON	Enable
OFF	Disable

Note To use droop control, be sure to auto-tune the inverter for the motor.

Under V/f control, to prevent the inverter from tripping even at an abrupt change in load, droop control applies the acceleration/deceleration time to the frequency obtained as a result of droop control. This may delay reflection of the frequency compensated during droop control on the motor speed, thereby running the inverter as if droop control is disabled. Under sensorless vector control and vector control with sensor, the inverter is equipped with a current control system, and does not trip even following an abrupt change in load, ensuring that acceleration and deceleration time are not affected. Consequently, load balance can be achieved with droop control even during acceleration and deceleration.

H30 **H31**	**Link functions (Operation selection)** **Link functions (Actual terminal operation selection)** **Related function codes: y94 Link function (X terminal operation selection)** **y98 Bus function (Operation selection)**

Using the RS-485 communications link, built-in CAN communications link, or fieldbus (option) allows you to issue frequency settings and run operation commands (equivalent to stop running/digital input terminal) from a computer or PLC at a remote location, as well as monitor the inverter running information and the function code data. It is possible to set the source that specifies the frequency settings and run operation commands with H30, y94, and y98. H30 selects RS-485 communication, and y94 and y98 select the fieldbus setting procedure.



Command sources selectable

Command source	Content
Inverter itself	Sources except RS-485 communications link and fieldbus Frequency setting: Specified by F01/C30, or multistep frequency command Run operation command: Keypad, External signal (digital input) set at F02
Via RS-485 communications link (port 1)	Via RJ-45 connector for keypad connection
Via RS-485 communications link (port 2)	Via terminal block ([DX+], [DX-], [SD])
Via fieldbus (Option)	Via fieldbus (DeviceNet, PROFIBUS DP, etc.)

Command sources specified by H30 (Communications link function, Mode selection)

H30 data	Frequency setting	Operation command
0	Inverter itself (F01/C30)	Inverter itself (F02)
1	RS-485 communications link (port 1)	Inverter itself (F02)
2	Inverter itself (F01/C30)	RS-485 communications link (port 1)
3	RS-485 communications link (port 1)	RS-485 communications link (port 1)
4	RS-485 communications link (port 2)	Inverter itself (F02)
5	RS-485 communications link (port 2)	RS-485 communications link (port 1)
6	Inverter itself (F01/C30)	RS-485 communications link (port 2)
7	RS-485 communications link (port 1)	RS-485 communications link (port 2)
8	RS-485 communications link (port 2)	RS-485 communications link (port 2)

Command sources specified by y98 (Bus link function, Mode selection)

y98 data	Frequency setting	Operation command
0	Follow H30 data	Follow H30 data
1	Via fieldbus	Follow H30 data
2	Follow H30 data	Via fieldbus *1
3	Via fieldbus	Via fieldbus *1

*1 Among the operation commands, if specifying run/stop commands ([FWD], [REV]) via actual terminals, and other digital input commands via a fieldbus, set F02 = 1 and y94 = 1.

H30 and y98 settings by combination of sources

		Frequency setting			
		Inverter itself	RS-485 communications (Port 1)	RS-485 communications Port 2	Via fieldbus (Option)
Operation setting	Inverter itself	H30 = 0 y98 = 0	H30 = 1 y98 = 0	H30 = 4 y98 = 0	H30 = 0 (1, 4) y98 = 1
	Via RS-485 communications link (port 1)	H30 = 2 y98 = 0	H30 = 3 y98 = 0	H30 = 5 y98 = 0	H30 = 2 (3, 5) y98 = 1
	Via RS-485 communications link (port 2)	H30 = 6 y98 = 0	H30 = 7 y98 = 0	H30 = 8 y98 = 0	H30 = 6 (7, 8) y98 = 1
	Via fieldbus (Option)	H30 = 0 (2, 6) y98 = 2	H30 = 1 (3, 7) y98 = 2	H30 = 4 (5, 8) y98 = 2	H30 = 0 (1 to 8) y98 = 3

For details, refer to the RS-485 Communication User’s Manual or the Various types of field Bus cards (Option) Instruction Manual.

- When the terminal command “LE” (“Select link operation (RS-485, BUS option)”) is assigned to a digital input terminal, turning “LE” ON makes the settings of H30 and y98 enabled. (When disabled, those settings are disabled so that both frequency settings and run operation commands specified from the inverter itself take control.)

  (Function code E01 to E05, data = 24)

  Not assigning LE is functionally equivalent to “LE” being ON.

■ **H31: Link functions (Actual terminal operation selection)**

By selecting RS-485 or fieldbus for the run command source with H30 or y98, the majority of digital input terminals on the inverter actual terminal block are disabled. By setting this function code to 1, digital input terminals with the link function and terminal [X1] to [X5] on the actual terminal block can be used together.

H31 data	Actual terminal command
0	Only some actual terminal commands are enabled when performing run command source communication.
1	All actual terminal commands are enabled when performing run command source communication.

The same operation is performed for the following digital input terminals, regardless of the function code setting. For digital input terminal functions other than those below, by setting 1 for this function code, use in combination with terminal [X1] to [X5] on the actual terminal block is also possible. For details, refer to the "RS-485 Communication User's Manual."

Terminal command assigned No.	Run command symbol	Name	Command through communications	Command from actual terminal
24	"LE"	Select link operation	Disable	Enable
35	"LOC"	Local (keypad) command selection	Disable	Enable
48	"PIN"	Pulse string input	Disable	Enable
94	"FJOG”	Forward JOG	Enable	Disable
95	"RJOG”	Reverse JOG	Enable	Disable
98	"FWD”	Forward rotation/stop command	Enable	Disable
99	"REV”	Reverse rotation/stop command	Enable	Disable

■ **y94: Link function (X terminal operation selection)**

Bus command enable/disable is selected all at once with a run operation command (stop running/digital input) with y98 and H30, but if setting stop running ([FWD], [REV]) to commands with actual terminals, set F02 = 1 and y94 = 1.

H42, H43, H48	**Capacitance of DC link bus capacitor, Cumulative run time of the cooling fan Cumulative run time of capacitors on PCBs** **Related function codes: H47 Initial capacitance of DC link bus capacitor H98 Protection/maintenance functions** **Reference function code: H81 Warning selection 1**

■ **Life prediction function**

The inverter has the life prediction function for some parts which measures the discharging time or counts the voltage applied time, etc. The function allows you to monitor the current lifetime state on the LED monitor and judge whether those parts are approaching the end of their service life. The life prediction function can also issue early warning signals if the lifetime alarm command "LIFE" is assigned to any of the digital output terminals by any of E20 to E21 and E27. By assigning warnings with H81, LiF appears on the keypad, and warning "L-ALM" is output to notify the user.

The predicted values should be used only as a guide since the actual service life is influenced by the surrounding temperature and other usage environments.

Object of life prediction	Prediction method	End-of-life criteria	Prediction timing	On the LED monitor
DC link bus capacitor	<u>Calculating the capacitance of DC link bus capacitor</u> Measures the discharging time of the DC link bus capacitor when the main power is shut down and calculates the capacitance.	85% or lower than initial capacitance at time of shipping (Refer to "Measuring the capacitance of DC link bus capacitor in comparison with initial value at time of shipment")	At periodic inspection H98 bit3 = 0	5_05 (Rated capacity)
		85% or lower of the reference capacitance under ordinary operating conditions at the user site (Refer to "Measuring the capacitance of DC link bus capacitor under ordinary operating conditions at power shutdown")	During ordinary operation H98 bit3 = 1	5_05 (Rated capacity)
	<u>ON-time counting of DC link bus capacitor</u> The time elapsed when the voltage is applied to the DC link bus capacitor (main circuit ON time) is counted. Furthermore, the time is corrected based on the capacity measurement.	When 87,600 hours (10 years) of operation has been exceeded (Note 1: Lifetime is based on the Standard replacement interval listed in Table 7.4-1)	During ordinary operation	5_26 (Elapsed time) 5_27 (Remaining hours)
Electrolytic capacitors on PCBs	The time elapsed when the voltage is applied to the capacitors is counted. Furthermore, the elapsed time based on the ambient temperature is corrected.	When 87,600 hours (10 years) of operation has been exceeded	During ordinary operation	5_06 (Operation time)
Cooling fans	Counts the run time of the cooling fans.	When 87,600 hours (10 years) of operation has been exceeded	During ordinary operation	5_07 (Operation time)

■ **Capacitance of DC link bus capacitor (H42)**

Calculating the capacitance of DC link bus capacitor

- The discharging time of the DC link bus capacitor depends largely on the inverter's internal load conditions, e.g. options attached or ON/OFF of digital I/O signals. If actual load conditions are so different from the ones at which the initial/reference capacitance is measured that the measurement result falls out of the accuracy level required, then the inverter does not perform measuring.
- The capacitance measuring conditions at shipment are extremely restricted, e.g., all input terminals being OFF, in order to stabilize the load and measure the capacitance accurately. Those conditions are, therefore, different from the actual operating conditions in almost all cases. If the actual operating conditions are the same as those at shipment, shutting down the inverter power automatically measures the discharging time; however, if they are different, no automatic measurement is performed. To perform it, put those conditions back to the factory default ones and shut down the inverter. Refer to the steps in "[1] Measuring the capacitance of DC link bus capacitor in comparison with initial value at time of shipment."

Note When the inverter uses an auxiliary control power input (including the "external 24 V power supply input" for the E3N type), the load conditions widely differ so that the discharging time cannot be accurately measured. In this case, measuring of the discharging time can be disabled with the function code H98 (Bit 4 = 0) for preventing unintended measuring. (For details, refer to H98.)

- To measure the capacitance of the DC link bus capacitor under ordinary operating conditions when the power is turned OFF, it is necessary to set up the load conditions for ordinary operation and measure the reference capacitance (initial setting) when the inverter is introduced. Refer to the steps in "[2] Measuring the capacitance of DC link bus capacitor under ordinary operating conditions at power shutdown."

  Setting bit 3 of H98 data to 0 restores the inverter to the measurement in comparison with the initial capacitance measured at shipment.

ON-time counting of DC link bus capacitor

- In a machine system where the inverter main power is rarely shut down, the inverter does not measure the discharging time. For such an inverter, the ON-time counting is provided. If the capacitance measurement is made, the inverter corrects the ON-time according to the capacitance measured. The ON-time counting result can be represented as "elapsed time" and "remaining time" before the end of life.

[1] Measuring the capacitance of DC link bus capacitor in comparison with initial value at time of shipment

When bit 3 of H98 data is 0, the measuring procedure given below measures the capacitance of DC link bus capacitor in comparison with initial one at shipment when the power is turned OFF. The measuring result can be displayed on the keypad as a ratio (%) to the initial capacitance.

---Capacitance measuring procedure---

Note For the Ethernet built-in type (E3N), please replace all parts marked by (*) in the following explanation with the content in the table below. (This is because the conditions for measurement of discharging time of the DC link bus capacitor differ from other types.)

Differences in measurement conditions	Basic type / EMC filter built-in type (E3S/E3E)	Ethernet built-in type (E3N)
Control circuit terminal input/output	[FWD], [REV], [X1 to [X5] / [Y1], [Y2]	[FWD], [REV], [X1] to [X3] / [Y1]
Auxiliary control power input terminals	[R0], [T0] (only for capacities of 18.5 kW or above)	[P24], [N24] (all capacities) [R0], [T0] (only for capacities of 18.5 kW or above)
Keypad	Keypad (TP-M3)	Installation not required (no keypad)
Option cards	Remove before measuring	Removal not required (not installed)
LED display during measurement	Displays 4 dots [....]	Displays 2 dots [..]

1) To ensure validity in the comparative measurement, return the inverter back to the state at time of factory shipment.

- Remove the option card (if using) from the inverter.
- In case another inverter is connected via the DC link bus to the [P(+)] and [N(-)] terminals of the main circuit, disconnect the wires. It is not required to disconnect the DC reactor (optional), if any.
- Disconnect power wires for the auxiliary input to the control circuit ([R0], [T0]). (*)
- Disconnect the USB cable.
- Install the keypad (TP-M3). (*)
  If the keypad has been replaced with the remote keypad (TP-E2) and multi-function keypad (TP-A2SW) (option) after purchasing the inverter, return it to the TP-M3.
- Turn OFF all the digital input signals fed to terminals [FWD], [REV], and [X1] to [X5] of the control circuit and for Ethernet built-in type terminals [FWD], [REV], and [X1] to [X3] (*).
- If a potentiometer is connected to terminal [13], disconnect it.
- If an external apparatus is attached to terminal [PLC], disconnect it.
- Ensure that transistor output terminals [Y1] to [Y2] (*) and relay output terminals [30 A/B/C] do not turn ON.
- Disable the RS-485 and built-in CAN communications links.

Note If negative logic is specified for the transistor output and relay output signals, they are considered ON when the inverter is not running. Change the settings.

- Keep the surrounding temperature within 25°C ±10°C (77°F ±18°F).

2) Turn ON the main circuit power.

3) Confirm that the cooling fan is rotating and the inverter is in stopped state.

4) Turn OFF the main circuit power.

5) The inverter automatically starts the measurement of the capacitance of the DC link bus capacitor. Make sure that " . . . . " appears on the LED monitor.

Note If " . . . . " (*) does not appear on the LED monitor, the measurement has not started. Check the conditions listed in 1).

6) After " . . . . " (*) has disappeared from the LED monitor, turn ON the main circuit power again.

7) Select Menu number 5 "Maintenance Information" in Programming mode and note the reading (relative capacitance (%) of the DC link bus capacitor). (For the Ethernet built-in type (E3N), check function code W75 via Ethernet communication.)

----

[2] Measuring the capacitance of DC link bus capacitor under ordinary operating conditions at power shutdown

When bit 3 of H98 data is 1, the inverter automatically measures the capacitance of the DC link bus capacitor under ordinary operating conditions when the power is turned OFF. This measurement requires measuring the reference capacitance using the setup procedure given below.

Function code	Name	Content
H42	Capacitance of DC link bus capacitor	• Capacitance of DC link bus capacitor (measured value) • Start of initial capacitance measuring mode under ordinary operating conditions (0) • Measurement failure (1)
H47	Initial capacitance of DC link bus capacitor	• Initial capacitance of DC link bus capacitor (measured value) • Start of initial capacitance measuring mode under ordinary operating conditions (0) • Measurement failure (1)

When replacing parts, clear or modify the H42 and H47 data. For details, refer to the maintenance related documents.

--------------------------------------Reference capacitance setup procedure--------------------------------------

Note For the Ethernet built-in type (E3N), please replace all parts marked by (*) in the following explanation with the content in the table below. (This is because the conditions for measurement of discharging time of the DC link bus capacitor differ from other types.)

Differences in measurement conditions	Basic type / EMC filter built-in type (E3S/E3E)	Ethernet built-in type (E3N)
LED display during measurement	Displays 4 dots [....]	Displays 2 dots [..]

1) Set function code H98 (Protection/maintenance functions) to enable the user to specify the judgment criteria for the service life of the DC link bus capacitor (Bit 3 = 1) (refer to function code H98).

2) Stop all inverter operations.

3) Make the inverter ready to be turned OFF under ordinary operating conditions.

4) Set both function codes H42 (Capacitance of DC link bus capacitor) and H47 (Initial capacitance of DC link bus capacitor) to “0.”

5) Turn OFF the inverter, and the following operations are automatically performed.

   The inverter measures the discharging time of the DC link bus capacitor and saves the result in function code H47 (Initial capacitance of DC link bus capacitor).

   The conditions under which the measurement has been conducted will be automatically collected and saved.

   During the measurement, “. . . . ” (*) will appear on the LED monitor.

6) Turn ON the inverter again.

   Confirm that H42 (Capacitance of DC link bus capacitor) and H47 (Initial capacitance of DC link bus capacitor) hold right values. Shift to Menu #5 “Maintenance Information” and confirm that the relative capacitance (ratio to full capacitance) is 100%.

Note If the measurement has failed, “1” is entered into both H42 and H47. Remove the cause of the failure and conduct the measurement again.

Hereafter, each time the inverter is turned OFF, it automatically measures the discharging time of the DC link bus capacitor if the above conditions are met. Periodically check the relative capacitance of the DC link bus capacitor (%) with Menu number 5 “Maintenance Information” in Programming mode.

Note The condition given above tends to produce a rather large measurement error. If this mode gives you a lifetime alarm, set H98 (Protection/maintenance functions) back to the default setting (Bit 3 (DC link bus capacitor life judgment selection) = 0) and conduct the measurement under the conditions at the time of factory shipment. (For the Ethernet built-in type (E3N), check function code W75 via Ethernet communication.)

■ Cumulative run time of capacitors on PCBs (H48)

Function codes	Name	Content
H48	Electrolytic capacitors on PCBs Cumulative run time	Displays the cumulative run time for the capacitor on the PCBs. • Data setting range: 0 to 9999 (10 hour increments)

When replacing capacitors on printed circuit boards, clearing or modifying H48 data is required. For details, refer to the maintenance related documents.

■ Cumulative run time of the cooling fan (H43)

Function codes	Name	Content
H43	Cumulative run time of the cooling fan	Displays the cumulative run time for the cooling fan. • Data setting range: 0 to 9999 (10 hour increments)

When replacing the cooling fan, clearing or modifying H43 data is required. For details, refer to the maintenance related documents.

H44	Startup count 1 Reference function code: H81 Warning selection 1

Counts the number of inverter startups and displays it up to 65535 startups in hexadecimal. Check the displayed number on the maintenance screen of the keypad, and use it as a guide for maintenance timing for parts such as belts. To start the counting over again, e.g. after a belt replacement, set the H44 data to "0." By assigning warnings with H81 so that the count becomes zero, Cnt appears on the keypad, and warning "L-ALM" is output to notify the user.

H45	Simulated failure Related function code: H97 Clear alarm data

H45 causes the inverter to generate a mock alarm in order to check whether external sequences function correctly at the time of machine setup. Setting the H45 data to "1" displays mock alarm Err on the LED monitor. It also issues alarm output (for any alarm) "ALM" (if assigned to a digital output terminal by any of E20, E21, and E27).

Accessing the H45 data requires simultaneous keying of the "STOP key + ▲ key." After that, the H45 data automatically reverts to "0," allowing you to reset the alarm.

As with other alarms that could occur when running the inverter, the inverter saves simulated failure data, enabling you to confirm the simulated failure status.

As with other alarms that could occur when running the inverter, to clear the simulated failure alarm data after setup, use H97. (Accessing the H97 data requires simultaneous keying of the "STOP key + ▲ key.") H97 data automatically returns to "0" after clearing the alarm data.

Tip A simulated failure alarm can also be issued (only while the inverter is stopped) by simultaneous keying of the "STOP key + FUNC/DATA key" on the keypad for 5 seconds or more.

H46	Startup characteristics (Auto search time 2) (Refer to H09)

Refer to the function code H09 section for details on the starting characteristics (auto search mode).

H47, H48	Initial capacitance of DC link bus capacitor, Cumulative run time of capacitors on PCBs (Refer to H42)

For details on initial capacitance of DC link bus capacitor, cumulative run time of capacitors on printed circuit boards, refer to the description of H42.

H49	Startup characteristics (Auto search time 1) (Refer to H09)

For details on the starting characteristics (auto search wait time 1), refer to the description of H09.

H50, H51 H52, H53	Non-linear V/f 1 (Frequency and Voltage) Non-linear V/f 2 (Frequency and Voltage)	(Refer to F04)

The non-linear V/f pattern setting is described in detail in the function code F04 section.

H54, H55 H56 H57 to H60	Acceleration/Deceleration time (Jogging operation) Deceleration time for forced stop 1S-/2S-curve acceleration/deceleration range	(Refer to F07)

For details, refer to the description of F07.

H61	UP/DOWN control initial value selection	(Refer to F01)

For details, refer to the description of F01.

H62	UP/DOWN control (extension function selection)	(Refer to F01)

The UP/DOWN control extension function is described in detail in the function code F01 item.
The extension function selection is the same as that for function code E61. (However, 5, 19, 30, 33, 42, 45, and 48 cannot be selected.)

H63	Lower limit limiter (Operation selection)	(Refer to F15)

For details, refer to the description of F15.

H64	Lower limit limiter (Minimum frequency when performing limiting operation)

H64 specifies the lower limit of frequency to be applied when the current limiter, torque limiter, or overload prevention control is activated. Basically, there is no need to modify the default setting.

- Data setting range: 0.0: F16 (based on frequency limiter (lower limit) setting value)
  0.1 to 599.0 (Hz)
- When performing sensorless vector control for PMSMs, the internal operation for H64 will be 10% of F04 if H64 is set to less than 10% of F04 (base frequency).

H65, H66	Non-linear V/f 3 (Frequency and Voltage)	(Refer to F04)

The non-linear V/f pattern setting is described in detail in the function code F04 section.

H67	Auto energy-saving operation (Mode selection)	(Refer to F37)

The auto energy-saving operation (mode selection) setting is described in detail in the function code F37 section.

H68	Slip compensation 1 (Operation condition selection)	(Refer to F42)

For details, refer to the description of F42.

H69 H114	**Anti-regenerative control (Operation selection)** **Anti-regenerative control (Operation level)** **Related function code: H76 Torque limiter (Braking, Increasing frequency limiter)**

Enable the automatic deceleration (anti-regenerative control) with this function code. If the inverter is not equipped with a PWM converter or braking unit, when the regenerative energy returned exceeds the inverter's braking capability, an overvoltage trip occurs. Turning digital input "AR-CCL" ON cancels anti-regenerative control.

If anti-regenerative control is selected, the output frequency is controlled to suppress the regenerative energy for avoiding an overvoltage trip.

H69 Data	Function		AR-CCL
	Inverter drive control	Forced stop after three times the deceleration time has passed	
0	Disable anti-regenerative control	-	OFF
2	Torque limiter	Enable	OFF
3	DC link bus constant control	Enable	OFF
4	Torque limiter	Disable	OFF
5	DC link bus constant control	Disable	OFF
Either	Disable anti-regenerative control	-	ON

FRENIC-Ace is equipped with two control modes: torque limiter and DC link bus constant control. Understand the features of the respective modes and select the appropriate one.

Inverter drive control	Control operation	Operation mode	Characteristics
Torque limiter (H69 = 2, 4)	Controls the output frequency so that the braking torque is approximately 0.	Enabled during acceleration, constant speed operation and deceleration.	Features high response and makes less prone to overvoltage trips under impact load. The frequency operation amount can be adjusted with H114.
DC link bus constant control (H69 = 3, 5)	Controls the output frequency so that the DC link bus voltage is decreased when it exceeds the limit level.	Enabled only during deceleration Disabled during constant speed operation	The regenerative capability of the inverter can be effectively utilized to shorten the deceleration time.

■ **Anti-regenerative control "AR-CCL" (Function codes E01 to E05, data = 82)**

Anti-regenerative control can be canceled with "AR-CCL." When "AR-CCL" is ON, the H69 setting is ignored, and anti-regenerative control is disabled.

■ **Torque limiter (Increasing frequency limiter) (H76)**

• Data setting range: 0.0 to 599.0 (Hz)

With the torque limiter, the inverter increases the output frequency to limit the output torque. Excessive increase of the output frequency may cause danger, and therefore the increasing frequency limiter (H76) is provided. This prevents the output frequency from increasing to exceed the "reference frequency + H76." If the limit is reached, however, anti-regenerative control is restricted and an overvoltage trip may occur. Increasing the frequency increment limit for braking improves the anti-regenerative capability.

This function is disabled under vector control. Under vector control, torque commands are restricted. The output frequency is determined by the speed on the load side.

If a run command is turned OFF, the anti-regenerative control causes the frequency to increase, and operation may not stop depending on the load conditions. For safety, a function is provided in which the anti-regenerative control is forced to be disabled if the actual deceleration time becomes three times the deceleration time currently selected forcing the operation to stop. The function can be enabled/disabled by the setting of H69.

■ Anti-regenerative control (Operation level) (H114)

Allows the adjustment of the operation level when anti-regenerative control by torque limiter is performed with H69 = 2, 4. Basically, there is no need to modify the setting.

H114 data	Function
0.0 to 50.0%	Adjusted operation level Increasing the value increases the frequency operation.
999	Standard operation level

Note

- The deceleration time may be automatically increased by anti-regenerative control.
- Disable the anti-regenerative control when a braking unit is connected. Otherwise, the anti-regenerative control may be activated at the same time as the operation of the braking unit, resulting in a deceleration time not in accordance with the setting.
- An excessively short deceleration time causes the DC link bus voltage of the inverter to rise too fast for the anti-regenerative control to function. In that case, specify a longer deceleration time.

H70	Overload prevention control

Specifies the rate of decrease of the output frequency of overload prevention control. Before the inverter generates a heat sink overheat or overload trip (alarm OH1 or OLU), the output frequency of the inverter is decreased to avoid a trip. This is applied when operation is required to continue in a system in which the load decreases as the output frequency decreases, such as a pump.

H70 data	Function
0.00	Uses the deceleration time currently selected (F08, E11, E13, E15, etc.)
0.01 to 100.0	Decelerates at a deceleration rate of 0.01 to 100.0 (Hz/s).
999	Cancels overload prevention control

■ Performing overload prevention controlling "OLP" (Function code E20 to E21, E27, data = 36)

Outputs "OLP," which is a signal that turns ON during overload prevention control, in order to inform that the overload prevention control has been activated and the output frequency has changed.

Note

No effect can be expected in a system in which the load does not decrease even if the output frequency decreases. Do not use this function.

H71 d90	Deceleration characteristics (forced brake) Magnetic flux level during deceleration (rate of voltage increase)

When the motor is decelerating, if regenerative energy which exceeds that which the inverter is capable of processing is generated, intermediate DC voltage will rise, and an overvoltage trip will occur. By setting this function code to 1 or 2, a higher output voltage than the command value is output when decelerating, motor loss is increased, and regenerative energy is consumed by the motor, allowing deceleration torque to be increased.

If H71 = 1, the rate of voltage increase can be adjusted with d90. If H71 = 2, output voltage is set proportional to the intermediate DC voltage (F05 = 0: same as disabling AVR) only when decelerating.

H71 data	Function
0	Disable
1	Forced brake operation (rate of voltage increase is adjusted with d90)
2	Forced brake operation (output voltage proportional to intermediate DC voltage: AVR disabled)

■ **Magnetic flux level during deceleration (rate of voltage increase) (d90)**

- Data setting range: 100 to 300 (%)

If too large a value is set for d90, excessive current will flow, and the motor protection electronic thermal overload relay may be triggered.

Note This function is enabled only when the motor is decelerating, and has no effect if a braking load is applied when the motor is accelerating, or running at constant speed. When anti-regenerative control of the torque limiter is enabled (H69 = 2, 4), the deceleration characteristics are disabled.
By enabling H71, motor loss increases, and the electronic thermal overload relay function may be triggered, causing the inverter to trip if it decelerates frequently. If this happens, connect a braking resistor.

H72	Main power supply cutoff detection (Operation selection)

This function monitors the AC input power supply of the inverter to see if the AC input power supply (main power supply) is established and prevents inverter operation when the main power supply is not established.

H72 data	Function
0	Disables main power supply cutoff detection
1	Enables main power supply cutoff detection

With power supply via a PWM converter or DC link bus, there is no AC input. When the data for H72 is “1,” the inverter cannot operate. Change the data for H72 to “0.”

Note For single-phase power supply, consult your Fuji Electric representative.

H73 H74 H75	Torque limiter (Operating condition selection) Torque limiter (Control target) Torque limiter (Target quadrant)

Refer to F40, F41.

H76	Torque limiter (Braking) (Increasing frequency limiter) (Refer to H69)

The Torque limiter (Braking) (Increasing frequency limiter) setting is described in detail in the function code H69 section.

H77	Life of DC link bus capacitor (Remaining time) Reference function code: H81 Warning selection 1

Indicates the time remaining before the end of service life of the DC link bus capacitor.

Transfer the DC link bus capacitor life data when replacing the PCB.

- Data setting range: 0 to 8760 (set in 10 hour increments)

H78 H94	Maintenance interval (M1) Cumulative motor run time 1 Reference function code: H81 Warning selection 1

Specify the maintenance interval in hours with the maintenance interval (M1) (H78).

- Data setting range: 1 to 9999 (set in 10 hour increments)

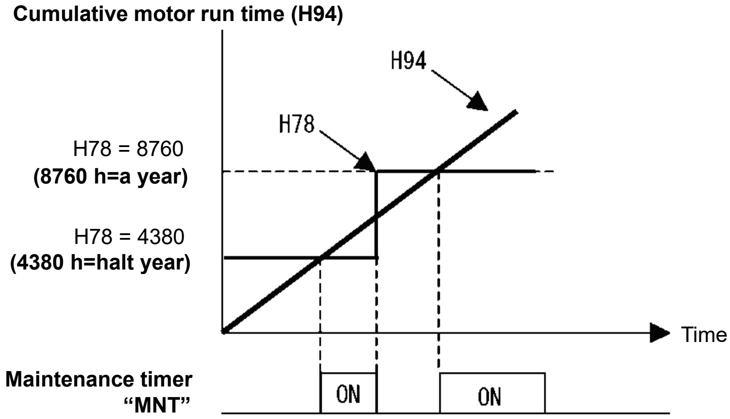
■ **Maintenance timer “MNT” (Function code E20 to E21, E27, data = 84)**

When the cumulative motor run time 1 (H94) reaches the value specified by the maintenance interval (H78), the inverter outputs the maintenance timer signal “MNT”. Furthermore, by assigning warnings with H81, rTE appears on the keypad when the set time is reached, and warning “L-ALM” is output to notify the user.

■ **Cumulative motor run time 1 (H94)**

The cumulative run time of the motor can be indicated by keypad operation. It can be used for management of the machinery or maintenance. Specifying an arbitrary time for the cumulative motor run time 1 (H94) allows an arbitrary value to be specified for the cumulative motor run time. It can be replaced with the initial data to use as a guide for the replacement of machine parts or inverter. Setting “0” allows the cumulative motor run time to be reset.

<For half yearly maintenance>



Note If the maintenance interval is reached, set a new value in H78 and press the FUNC/DATA key to reset the output signal and restart measurement.

This function is exclusively applied to the 1st motor.

■ **Count the run time of commercial power-driven (Motor 1, 2) “CRUN-M1, M2” (Function code E01 to E05, data = 72, 73)**

Even when a motor is driven by commercial power, not by the inverter, it is possible to count the cumulative motor run time 1, 2 (H94, A51) by detecting the ON/OFF state of the auxiliary contact of the magnetic contactor for switching to the commercial power line.

Note Check the cumulative motor run time with 5_23 on keypad Menu number 5 “Maintenance Information.”

H79	**Preset startup count for maintenance (M1) Related function code: H44 Startup count 1** **Reference function code: H81 Warning selection 1**

H79 specifies the number of inverter startup times to determine the next maintenance timing, e.g., for replacement of a belt.

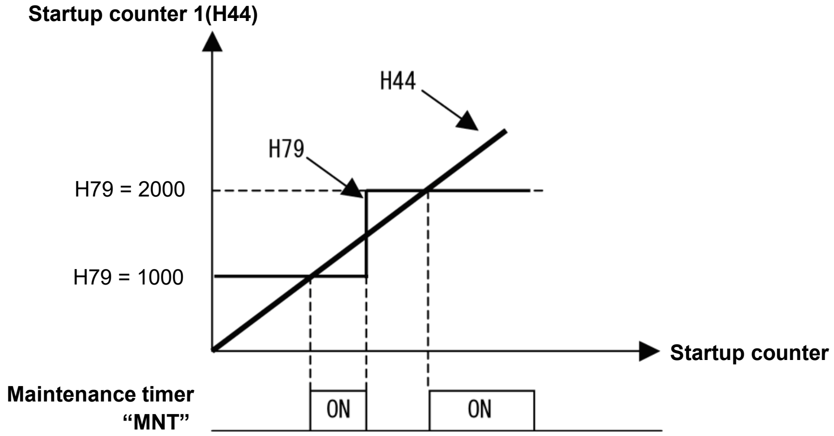
A maximum of 65,535 startups can be set in hexadecimal.

- Data setting range: 0000 (Disable), 0001 to FFFF (hexadecimal format)

■ **Maintenance timer “MNT” (Function code E20 to E21, E27, data = 84)**

When the startup counter for motor 1 (H44) reaches the number specified by H79 (Preset startup count for maintenance (M1)), the inverter outputs the maintenance timer signal “MNT” (if assigned to any digital terminal with any to E20 to E24 and E27) to inform the user of the need of the maintenance of the machinery. Furthermore, by assigning warnings with H81, Cnf appears on the keypad when the set number of times is reached, and warning “L-ALM” is output to notify the user.

< Maintenance every 1,000 times of startups >



Note If the startup counter reaches the specified value, set a new value for the next maintenance in H79 and press the FUNC/DATA key to reset the output signal and restart counting.

This function is exclusively applied to the 1st motor.

H80, A41	Current fluctuation damping gain for motor 1 to 2

The inverter output current driving the motor may fluctuate due to the motor characteristics and/or backlash in the machinery (load). Modifying the H80 data adjusts the controls in order to suppress such fluctuation. However, as incorrect setting of this gain may cause larger current fluctuation, do not modify the default setting unless it is necessary.

- Data setting range: 0.00 to 1.00

H81, H82, H83	Warning selection 1 to 3

If the inverter detects a minor abnormality when detecting an error, the display alternates between the warning code* and operating status monitor (frequency display, etc.), and operation can be continued without tripping the inverter. Function codes H81, H82, and H83 specify which alarms should be categorized as a "warning."

Note Continuing operation while a warning is occurring may cause damage to devices, and therefore the inverter should be stopped promptly from an external source.

* The alarm causes subject to selection and the display when a warning occurs are shown in the following table.

Alarm code	Name	Overview
OH1	Cooling fin overheat	Cooling fin temperature increased to the trip level.
OH2	External alarm	An error that has occurred in peripheral equipment turned the external alarm signal THR ON.
OH3	Inverter internal overheat	The temperature inside the inverter abnormally has increased.
OH6	Charging resistor overheat	The charging resistor temperature rises abnormally due to frequent power ON/OFF.
dbH	Breaking resistor overheat	Estimated temperature of the coil in the braking resistor exceeded the allowable level.
OL1 to OL2	Overload of motor 1 to 2	Motor temperature calculated with the inverter output current reached the trip level.
Er4	Option communication error	Communications error between the inverter and an option.
Er5	Option error	An option judged that an error occurred.
Er8 ErP	RS-485 communication error (COM port 1, 2)	RS-485 communications error in COM ports 1 or 2.
ErE	Speed inconsistency (excessive speed deviation)	The status outside the range (d21) for which the speed regulator deviation (between speed command and estimated speed value/detected speed) is set continued for equal to or longer than the set time (d22).
dO	Excessive positioning deviation	The position deviation during position control was excessive.
Ero	Positioning control error	The deviation overflow value (10 times function code d78) for which the position deviation was set was exceeded when performing synchronous control and position control.
CoF	Current input terminals [C1], [C2] signal line break	Current input terminals [C1], [C2] (option) signal line break
OL	Motor overload early warning	Early warning before a motor overload
OH	Cooling fin overheat early warning	Early warning before a heat sink overheat trip
LiF	Lifetime early warning	It is judged that the service life of any one of the capacitors (DC link bus capacitors or electrolytic capacitors on the printed circuit boards) or cooling fan has expired.
rEF	Reference loss	Analog setting frequency wire break
Pid	PID alarm output	PID control warning (absolute value warning, deviation warning)
UTL	Low torque detection	Output torque drops below the low torque detection level for the specified period.
PTC	PTC thermistor activate	The motor PTC thermistor on the motor detected overheating.
rTE	Machine life (Cumulative motor run time)	The motor cumulative run time reached the specified level.
CnT	Machine life (Number of startups)	Number of startups reached the specified level.
Lob	Low battery warning	Low battery warning for multi-function Keypad (TP-A2SW)
CA1 to CA5	User-defined alarm	Application alarm caused by customizable logic program
iGb	IGBT lifetime early warning	IGBT element temperature power cycle lifetime early warning

Set data for selecting warnings in hexadecimal. For details on how to select the codes, refer to the following pages.

- Data setting range: h.0000 to h.FFFF (hexadecimal format)

■ Selecting warning factors

To set and display the applicable selection in hexadecimal format, the selectable factor is assigned to bits 0 to 15 in the bit assignment tables for H81 to H83 below. Set the bit that corresponds to the cause to be selected to "1."

The selection status for warnings can be expressed in binary or hexadecimal notation as shown in the selection factor display example.

Warning selection 1 (H81), bit assignment of selectable factors

Bit	Symbol	Content	Bit	Symbol	Content
15	OH6	Charging resistor overheat	7	-	-
14	-	-	6	OL2	Motor 2 overload
13	ErP	RS-485 communication error (COM port 2)	5	OL1	Motor 1 overload
12	Er8	RS-485 communication error (COM port 1)	4	dbH	Breaking resistor overheat
11	Er5	Option error	3	-	-
10	Er4	Option communication error	2	OH3	Inverter internal overheat
9	-	-	1	OH2	External alarm
8	-	-	0	OH1	Cooling fin overheat

Warning selection 2 (H82), bit assignment of selectable factors

Bit	Symbol	Content	Bit	Symbol	Content
15	Lob	Low battery warning	7	LiF	Lifetime alarm
14	-	-	6	OH	Cooling fin overheat early warning
13	CnT	Machine life (Number of startups)	5	OL	Motor overload early warning
12	rTE	Machine life (Cumulative motor run time)	4	-	-
11	PTC	PTC thermistor activate	3	CoF	Current input terminals [C1], [C2] signal line break
10	UTL	Low torque detection	2	Ero	Positioning control error
9	PId	PID alarm output	1	dO	Excessive positioning deviation
8	rEF	Reference loss	0	ErE	Speed inconsistency (excessive speed deviation)

Warning selection 3 (H83), bit assignment of selectable factors

Bit	Symbol	Content	Bit	Symbol	Content
15	—	—	7	—	—
14	—	—	6	—	—
13	iGb	IGBT lifetime early warning	5	—	—
12	—	—	4	CA5	User-defined alarm 5
11	—	—	3	CA4	User-defined alarm 4
10	—	—	2	CA3	User-defined alarm 3
9	—	—	1	CA2	User-defined alarm 2
8	—	—	0	CA1	User-defined alarm 1

Display of warning factors

(Example) Warning factors “RS-485 communication error (COM port 2),” “RS-485 communication error (COM port 1),” “Option communications error,” “Overload of motor 1” and “Cooling fin overheat” are selected by H81.

LED No.		LED4				LED3				LED2				LED1			
Bit		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Symbol		–	–	ErP	Er8	Er5	Er4	–	–	–	OL2	OL1	dbH	–	OH3	OH2	OH1
Example	Binary	0	0	1	1	0	1	0	0	0	0	1	0	0	0	0	1
	Hexadecimal *See “Hexadecimal expression” below	3				4				2				1			
	Hexadecimal LED Monitor	LED4 LED3 LED2 LED1 3 4 2 1															

■ Hexadecimal expression

A 4-bit binary number can be expressed in hexadecimal (1 hexadecimal digit). The table below shows the correspondence between the two notations.

Binary and hexadecimal conversion

Binary				Hexadecimal	Binary				Hexadecimal
0	0	0	0	0	1	0	0	0	8
0	0	0	1	1	1	0	0	1	9
0	0	1	0	2	1	0	1	0	A
0	0	1	1	3	1	0	1	1	b
0	1	0	0	4	1	1	0	0	C
0	1	0	1	5	1	1	0	1	d
0	1	1	0	6	1	1	1	0	E
0	1	1	1	7	1	1	1	1	F

Note If H26 (Thermistor operation selection) data is set to “1” (PTC: OH4 trip and stop the inverter), the inverter is stopped without a warning occurring, regardless of the H82 (warning selection 2) bit 11 (PTC thermistor operation) setting.

■ Warning “L-ALM” assignment (Function code E20 to E21, E27, data = 98)

This output signal “L-ALM” comes ON when a warning occurs.

H84, H85	Pre-excitation (Level, Time)

A motor generates torque with magnetic flux and torque current. Lag elements of the rising edge of magnetic flux causes a phenomenon in which enough torque is not generated at the moment of the motor start. To obtain enough torque even at the moment of motor start, enable the pre-excitation with H84 and H85 so that magnetic flux is established before a motor start.

■ Pre-excitation (Level) (H84)

H84 specifies the forcing function for the pre-excitation. It is used to shorten the pre-excitation time.

Basically, there is no need to modify the default setting.

- Data setting range: 100 to 400 (%)

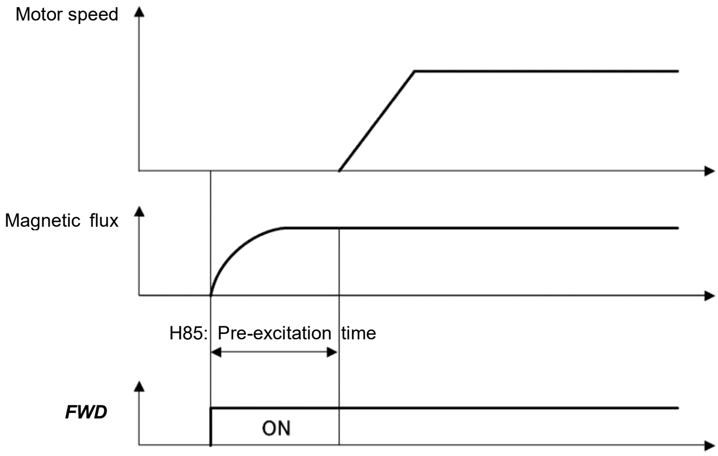
■ Pre-excitation (Time) (H85)

H85 specifies the pre-excitation time before starting operation.

- Data setting range: 0.00 (Disable), 0.01 to 30.00 (s)

When a run command is input, the pre-excitation starts.

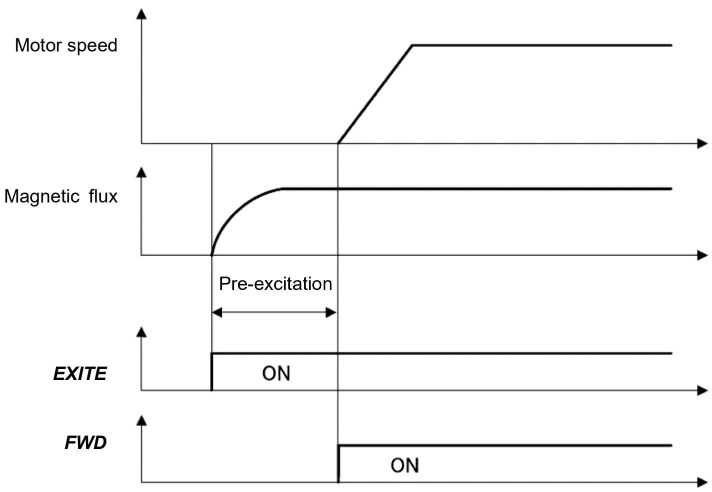
After the pre-excitation time specified by H85 has elapsed, the inverter judges magnetic flux to have been established and starts acceleration. Specify H85 data so that enough time is secured for establishing magnetic flux. The appropriate value for H85 data depends on the motor capacity. Use the default setting value of H13 data as a guide.



■ Pre-excitation “EXITE” assignment (E01 to E05, data = 32)

Turning “EXITE” input signal ON starts pre-excitation. After the delay time for establishing magnetic flux has elapsed, a run command is input. Inputting the run command terminates pre-excitation and starts acceleration.

Use an external sequence to control the time for establishing magnetic flux.



FUNCTION CODES
Chap 5
FUNCTION
F Codes
E Codes
C Codes
P Codes
H Codes
A Codes
b Codes
r Codes
J Codes
d Codes
U Codes
y Codes
o Codes
K Codes

Note Under V/f control (including auto torque boost and torque vector), pre-excitation is disabled, so use DC braking or hold the starting frequency instead.

Note A transient phenomenon, which may occur when the losses of the machinery (load) are small, may make the motor rotate during pre-excitation. If the motor rotation during pre-excitation is not allowed in your system, install a mechanical brake or other mechanism to stop the motor.

WARNING

Even if the motor stops due to pre-excitation, voltage is output to inverter's output terminals U, V, and W.

Failure to observe this could result in electric shock.

H86, H90 — For adjustment by manufacturer

These function codes are for adjustment by the manufacturer. Do not access these function codes.

H89 — Electronic thermal 1 to 2 (Motor protection) (Data retention)

It is possible to select whether to also retain the cumulative time for electronic thermal overload relays 1 to 2 (for motor protection) while the power is OFF.

H89 data	Function
0	The integrated value for electronic thermal overload relays 1 to 2 is cleared when the power is turned OFF and ON again.
1	Retains the integrated value for electronic thermal overload relays 1 to 4 even when the power is OFF.

H91 — Current input wire break detection

Terminal [C1] (C1 function) (current input) wire break can be detected and processed as an alarm (CoF alarm).
If using an analog interface card (OPC-AIO), a wire break can be detected for both terminal [C2] and terminal [C1] in the same way and processed as an alarm (CoF alarm).
If a current input wire break is detected, Y terminal function "C1OFF" is output based on the o88: C1OFF signal operation selection setting.
Function code H91 specifies whether the wire break detection is enabled, and the duration of detection.
A wire break is detected if the terminal [C1] and [C2] current input is less than 2 mA.
The CoF alarm can also be assigned as a warning with H82. If a wire break is detected, coF appears on the keypad, and warning "L-ALM" is output to notify the user.

This is only effective if used with C40 = 0 or 10 (4 to 20 mA).

- Data setting range: 0.0 (Disable wire break detection)
  0.1 to 60.0 s (Detect wire break and issue of alarm CoF within the time)

H92, H93 — Continued operation (P, I) (Refer to F14)

The Continued operation (P, I) setting is described in detail in the function code F14 section.

H94 — Cumulative motor run time 1 (Refer to H78)

The Cumulative motor run time 1 setting is described in detail in the function code H78 section.

H95 — DC braking (Select motor characteristics) (Refer to F20 to F22)

The DC braking setting is described in detail in the function code F20 to F22 section.

H96	STOP key priority/Start check function

H96 specifies a functional combination of "STOP key priority" and "Start check function" as listed below.

H96 data	STOP key priority	Start check function
0	Disable	Disable
1	Enable	Disable
2	Disable	Enable
3	Enable	Enable

■ STOP key priority

Even when run commands are entered from the digital input terminals or via the RS-485 communications link (link operation), pressing the keypad STOP key forces the inverter to decelerate and stop the motor. After that, Er6 appears on the LED monitor.

■ Start check function

For safety, this function checks whether any run command has been turned ON or not in each of the following situations. If one has been turned ON, the inverter does not start up but displays alarm code Er6 on the LED monitor.

- When the power to the inverter is turned ON.
- When the PRG/RESET key is pressed to release an alarm status or when the digital input terminal command "RST" ("Reset alarm") is turned ON.
- When the run command source is switched by a digital input terminal command such as "LE" ("Select link operation (RS-485, BUS option)") or "LOC" ("Local (keypad) command selection").

⚠CAUTION

- The inverter starts up again automatically when the power is turned OFF, or the power is restored following a power failure during inverter operation.
  Due caution is advised when using this function.
- Confirm that this function can be used safely when combined with other applications.
- Users are responsible for enabling this function. Fuji Electric accepts no responsibility.
  Failure to observe this could result in an accident.

H97	Clear alarm data	Related function code: H45 Simulated failure

Clears information (alarm history, relevant information when alarm occurs) for alarms that occur when performing machine adjustment, and returns the converter to the state before the alarm occurred.
To clear alarm data, simultaneous keying of "STOP key + ▲ key" is required.

H97 data	Function
0	Disable
1	Clear (Setting "1" clears alarm data and then returns to "0.")

H98	Protection/Maintenance functions (Operation selection)

H98 specifies whether to enable or disable automatic lowering of carrier frequency, input phase loss protection, output phase loss protection, judgment threshold on the life of DC link bus capacitor, judgment on the life of DC link bus capacitor, DC fan lock detection and braking transistor error detection by setting a bit combination.

Lower the carrier frequency automatically (Bit 0)

This function should be used for critical machinery that requires keeping the inverter running. Even if a heat sink overheat or overload occurs due to excessive load, abnormal ambient temperature, or cooling system failure, enabling this function lowers the carrier frequency to avoid tripping (OH1 OH3 OLU). Note that enabling this function results in increased motor noise.

Note Under sensorless vector control (PMSMs), the automatic carrier frequency reduction function does not work.

Input phase loss protection (Lin) (Bit 1)

This function detects the voltage unbalance between the phases and phase loss of 3-phase power supply. An alarm displays Lin to stop the inverter when it detects this.

Note In configurations where only a light load is driven or a DC reactor is connected, phase loss or line-to-line voltage unbalance may not be detected because of the relatively small stress on the apparatus connected to the main circuit.

Output phase loss protection (OPL : Output Phase Loss) (Bit 2)

Upon detection of output phase loss while the inverter is running, this feature stops the inverter and displays an alarm OPL .

Note Where a magnetic contactor is installed in the inverter output circuit, if the magnetic contactor goes OFF during operation, all the phases will be lost. In such a case, this protection function does not work.

DC link bus capacitor life judgment selection (Bit 3)

Bit 3 is used to select the threshold for judging the life of the DC link bus capacitor between the factory default setting and a user-defined setting.

Note Before specifying a user-defined threshold, measure and confirm the reference level in advance.
(📖 Function code H42)

DC link bus capacitor life judgment (Bit 4)

Whether the DC link bus capacitor has reached the end of its life is judged by measuring the discharging time after power OFF. The discharging time is determined by the capacitance of the DC link bus capacitor and the load inside the inverter. Therefore, if the load inside the inverter fluctuates significantly, the discharging time cannot be accurately measured. As a result, depending on the conditions, it may be mistakenly determined that the DC link bus capacitor has reached the end of its life. To avoid such an error, you can disable the judgment based on the discharging time. (Even if it is disabled, the judgment based on the “ON-time counting” is still performed.)

For details, refer to function code H42.

Since load may fluctuate significantly in the cases described below, disable the life judgment during operation. During periodical maintenance, either conduct the measurement with the life judgment enabled under appropriate conditions, or conduct the measurement under the operating conditions matching the actual ones.

- Auxiliary input for control power is used.
- An option card is used.
- Another inverter or equipment such as a PWM converter is connected to terminals of the DC link bus.

Charging resistance overheat detection protection (OH6) (Bit 5)

An alarm OH6 is displayed when charging resistance overheat is detected in FRN0020E3□-2G or below/FRN0012E3□-4G or below/FRN0012E3□-7G or below. (Subcode 8)

Set this parameter to "1" if you do not want to generate an alarm because frequent power ON/OFF may cause false detection.

Braking transistor error detection (dbA) (Bit 6)

Upon detection of a built-in braking transistor error, this feature stops the inverter and displays an alarm dbA. Set data of this bit to “0” when the inverter does not use a braking transistor and there is no need of entering an alarm state.

To set data of function code H98, assign the setting of each function to each bit and then convert the 8-bit binary to the decimal number. Refer to the assignment of each function to each bit below.

Bit	Function	Data = 0	Data = 1	Factory default
Bit 0	Lower the carrier frequency automatically	Disable	Enable	1: Enable
Bit 1	Input phase loss protection	Continue to run	Enter alarm processing	1: Enter alarm processing
Bit 2	Output phase loss protection	Continue to run	Enter alarm processing	0: Continue to run
Bit 3	DC link bus capacitor life judgment selection	Factory default	User-defined setting	0: Factory default
Bit 4	DC link bus capacitor life judgment	Disable	Enable	1: Enable
Bit 5	Charging resistance overheat detection protection	Enable	Disable	0: Enable
Bit 6	Braking transistor error detection	Continue to run	Enter alarm processing	1: Enter alarm processing

H99, **H197,** **H198** **H199**	**Password 2 setting/comparison** **User password 1 (Protective operation selection, Setting/comparison)** **User password protection active**

The password function is the function to hide the function code entirely/partially which is set for the inverter. When this function is used, perform correct settings after familiarizing yourself with the following details. If incorrect settings are made, the function code cannot be changed or checked. An alarm may also occur and the inverter may stop. Perform the operation carefully.

Tip F99 and H198 data can be changed using the "STOP key + ▲ key" or "STOP key + ▼ key" double operations. Furthermore, H199 cannot transition to the data change screen when H198 has not been set.

Tip By calling up the Programming mode 1. Data Setting, 2. Data Checking, or 0. Favorites menu while password protection is running, a decimal point "." is displayed at the end of the digits displayed on the keypad LED monitor.

Tip If the objective is to prevent inadvertent rewriting of the setting value from the keypad, it is recommended to use the data protective function with function code F00 rather than the password function. For details of the data protection, refer to the items in F00.

Note If a password is set carelessly, the setting values cannot be changed from the keypad, multi-function keypad, or external device using the link function. Be careful when setting.

Note If an incorrect password setting value is entered and you failed to decode the password, the password protection state cannot be released. In addition, failure to decode the password consecutively 5 times results in a warning.

Note To prevent the password decoding by an unintended third party, failure to decode the password for the specified number of times results in LoK alarm, which disables the inverter operation. Therefore, it is recommended to decode the password when the system is stopped. If it is necessary to decode the password during operation, perform decoding carefully.

Note We are not able to know the passwords set by customers. If you have forgotten the password setting value, the only way to decode the password is initialization of the function code. Set and control the password carefully.

Note Password H198 and H99 cannot be accessed through communication.

■ **Password 1 (Rewrite disable protection)**

Function code setting values excluding some codes can be protected as rewrite disable.

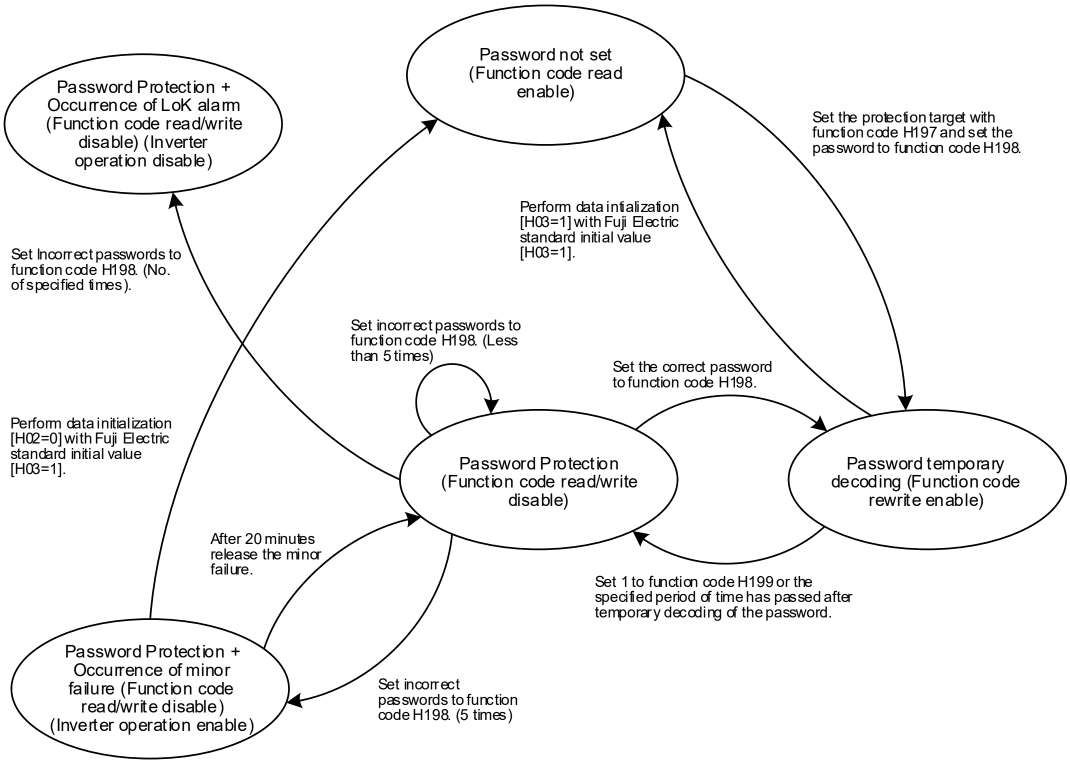
Select the target function code which is protected by H197 and set the password (hexadecimal 4 digits) with function code H198. When function code H199 is set to 1, password 1 protective status (rewrite disable protection) is active.

No.	Name	Function, setting range
H197	Protective operation selection	0: All function codes are disclosed, but changes are not allowed. 1: Only the function code registered in "Favorites" can be disclosed/changed. 2: Only the function codes for customize logic settings are not disclosed/not changed.
H198	Setting/comparison	0000 to FFFF
H199	Protection active	0: Disabled 1: Protection

■ **Temporary disabling of password 1 (Rewrite disable protection)**

When password 1 protective status is shown and the same value as the password set for function code H198 is entered in H198, password 1 protective status is temporarily released and the function code setting value can be rewritten.

If password 2 is set at the same time, it is necessary to decode password 2 with H99 in advance.



Relation chart of password 1 protection status

■ Password 2 (Read/write disable protection)

Setting values of all function codes not by selecting function code H197 can be protected as read disable and rewrite disable. (As an exception, partial function codes are not protected.)

Set the password with function code H99 and set function code H199 to 1. Password 2 protective status (read/write disable protection) is active.

The function code of read/write disable does not allow writing of the setting value to the inverter with the keypad, multi-function keypad, or external device using serial communication, or reading of the setting value.

■ Temporary disabling of password 2 (Read/write disable protection)

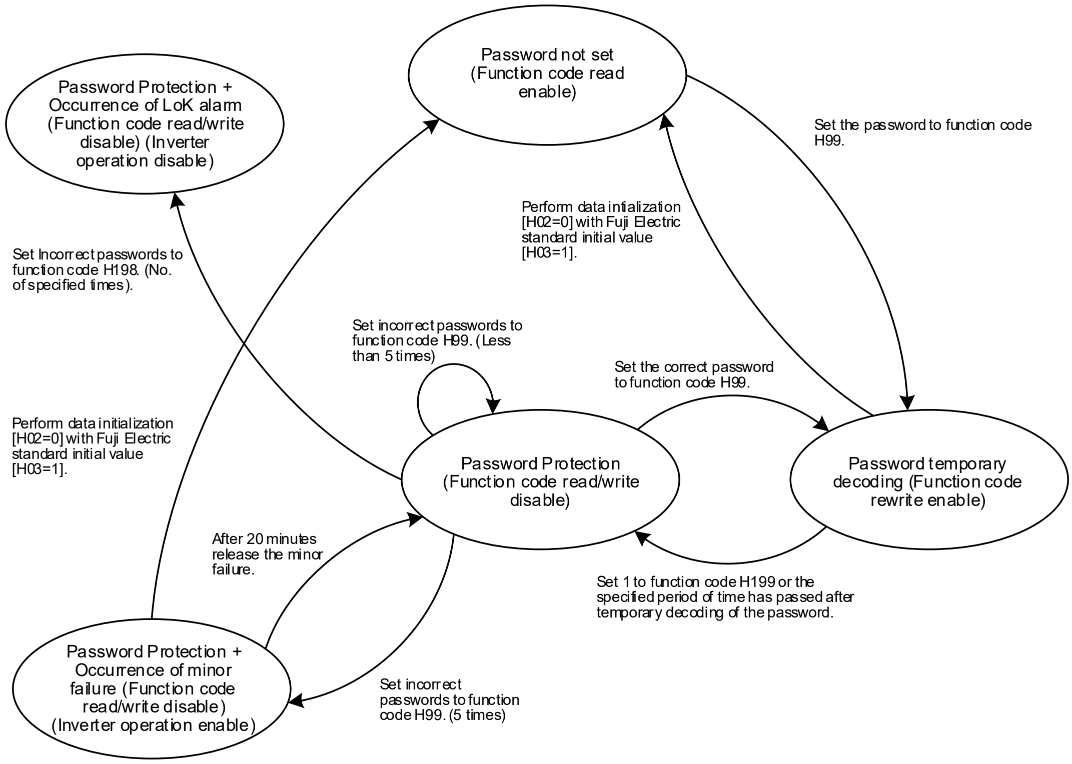
When password 2 protective status is shown and the same value as the password (hexadecimal 4 digits) set for function code H99 is entered in H99, password 2 protective status is temporarily decoded and the function code value can be read and it can be displayed on the keypad.

If password 1 protection (rewrite disable protection) is also set, the function code can be rewritten by temporarily decoding password 1 protective status continuously.

■ Passwords 1, 2 temporary disabling failure

In password 1 protective status or password 2 protective status, if the password value entered in function code H198 or H99 is incorrect when trying to temporarily cancel the protective status, temporary decoding is disabled.

In both function codes H198 and H99, 5 consecutive failures of password input result in a warning.



Relation chart of password 2 protection status

Note: In our factory default status, passwords are not provided, excluding special products. Therefore, if the password set for H198 or H99 is unknown or forgotten, we cannot answer or inform you of the password or its decoding method from protective status.

For this reason, set and control the password at your own risk. If a password is set at the delivery of the product and its decoding is required, please contact the dealer you purchased or the unit manufacturer. (We are not able to know the passwords set by customers.)

■ Setting and temporary disabling of password 1, 2 using multi-function keypad

Setting or temporary decoding of passwords 1 and 2 using the multi-function keypad is performed by the special menu on the multi-function keypad. Therefore, function codes H99, H198 and H199 are not displayed on the function code list of the function code setting menu or function code check menu on the multi-function keypad (H197 is displayed).

For the special password menu of the multi-function keypad, refer to the instruction manual of the multi-function keypad.

5.3.6 H1 codes (High-performance Functions)

H101	Destination

Refer to Chapter 4 "4.4 Destination Setting."

H111	UPS operation level

Specifies the voltage level at which the inverter can operate the motor by UPS operation. For details, refer to "■ UPS operation" in the description of function code E01.

• Data setting range 200 V series: 120 to 220 Vdc, 400 V series: 240 to 440 Vdc

H114	Anti-regenerative control (Operation level)	Related function code: H69

This function code is described in detail in the H69 section.

H116	Forced operation (Fire Mode)	(Operation selection)
H117		(Confirmation time)
H118		(Reference frequency)
H119		(Rotation direction)
H120		(Startup method)
H121		(Waiting time)

Set when wishing to enable forced operation (Fire Mode). With forced operation, the motor can be forcibly run at the specified speed. Even if an alarm occurs during forced operation, operation can be continued. If an alarm occurs due to a protective function such as OC (instantaneous overcurrent protection), operation is resumed with automatic reset. The time until operation is resumed can be set. If switching to forced operation, "Fod" is recorded in the alarm history for the purpose of retaining a record. If continuing operation with forced operation, alarms that are automatically reset are not recorded in the alarm history.

By assigning "FMS" to a digital input terminal and turning "FMS" ON, forced operation (Fire Mode) is enabled. (Function code E01 to E05, data = 134)

By assigning "FMRUN" to a digital output terminal, it turns ON during forced operation. (Function code E20 to E21, E27, data = 95)

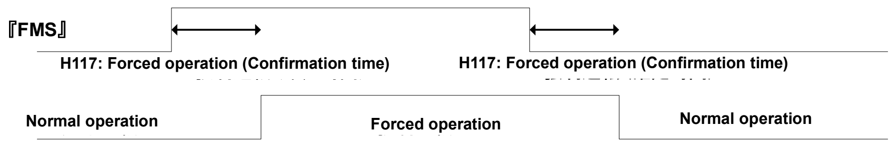
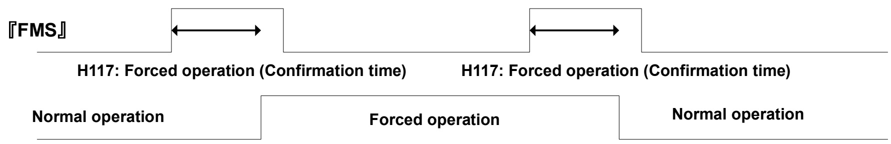
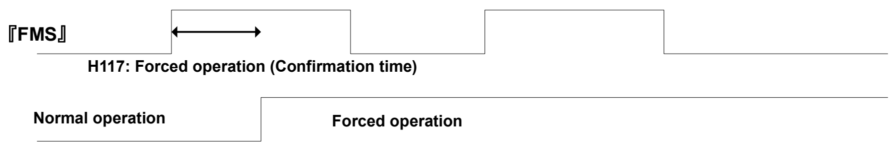
Note By selecting automatic reset with forced operation, the inverter will continue to run with no protective functions, resulting in a risk of inverter damage or fire, etc.

FUNCTION
F Codes
E Codes
C Codes
P Codes
H Codes
A Codes
b Codes
r Codes
J Codes
d Codes
U Codes
y Codes
o Codes
K Codes

■ Forced operation (Fire Mode) (Operation selection) (H116)

- Data setting range: 0, 1, 2, 10, 11, 12, 20, 21, 22

By setting H116, it is possible to select from a total of nine operation modes by combining the three types of forced operation end timing (ON, toggle, latch) and three types of alarm subject to an automatic reset (FMS-1, 2, 3).

<table>
<tr><th>H116 data</th><th>Forced operation</th></tr>
<tr><td>0 : ON-1
10 : ON-2
20 : ON-3</td><td>Forced operation starts when “FMS” turns ON, and normal operation is performed when “FMS” turns OFF.

</td></tr>
<tr><td>1: Toggle-1
11: Toggle-2
21: Toggle-3</td><td>Forced operation starts when “FMS” turns ON or OFF, and normal operation is performed when “FMS” next turns ON or OFF.

</td></tr>
<tr><td>2: Latch-1
12: Latch-2
22: Latch-3</td><td>Forced operation starts when “FMS” turns ON (selection maintained until power turned OFF).

</td></tr>
</table>

Alarm Code	Protective Function	FMS-1	FMS-2	FMS-3
		0: ON-1 1: Toggle method-1 2: Latch method-1	10: ON-2 11: Toggle method-2 12: Latch method-2	20: ON-3 21: Toggle method-3 22: Latch method-3
OC1, OC2, OC3	Overcurrent protection	Automatic reset	Alarm occurrence	Alarm occurrence
OU1, OU2, OU3	Overvoltage protection		Automatic reset	
LU	Undervoltage			
EF	Ground fault protection			
Other alarms		Continue to run or automatic reset		

■ Forced operation (Fire Mode) (Confirmation time) (H117)

- Data setting range: 0.0 to 10.0 (s)

Sets the time at which “FMS” signal ON/OFF is established. This is ignored if “FMS” is turned ON or OFF in a time shorter than this. Turn the “FMS” signal ON for a time longer than the H117 confirmation time.

■ Forced operation (Fire Mode) (Reference frequency) (H118)

Sets the reference speed (reference frequency) when forced operation (Fire Mode) is enabled.

H118 data	Function
0.0	This is based on the reference frequency selected with Frequency setting 1 (F01) and Frequency setting 2 (C30). Under PID control, PID output (reference frequency) is maintained when switching to forced operation.
0.1 to 599.0 Hz	The desired reference frequency can be set in 0.1 Hz increments.

■ Forced operation (Fire Mode) (Rotation direction) (H119)

Sets the run command and rotation direction when forced operation (Fire Mode) is enabled.

H119 data	Function
0	Run/stop with run command (run command selected with F02) when performing normal operation * The motor does not run if the run command is OFF, but alarms are automatically reset.
2	Operation in forward direction (FWD) * The motor is forcibly rotated in the forward direction regardless of whether a run command has been specified.
3	Operation in reverse direction (REV) * The motor is forcibly rotated in the reverse direction regardless of whether a run command has been specified.

■ Forced operation (Fire Mode) (Startup method) (H120)

Sets the startup method when forced operation (Fire Mode) is enabled.

H120 data	Function
0	Startup method when performing normal operation (startup method selected with H09, d67)
1	Startup in auto search mode (retracts without stopping motor while idling)

■ Forced operation (Fire Mode) (Waiting time) (H121)

- Data setting range: 0.0 to 20.0 (s)

Sets the waiting time until an automatic reset after inverter tripping while performing forced operation (Fire Mode).

H130 to H131	For special adjustment (Torque limiting)

This function code is used to adjust the torque limiting responsiveness for control methods other than vector control. Normally, it is not necessary to change the data of these function codes.

H133 to H134	For special adjustment (Anti-regenerative control)

This function code is used to adjust the anti-regenerative control responsiveness. Normally, it is not necessary to change the data of these function codes.

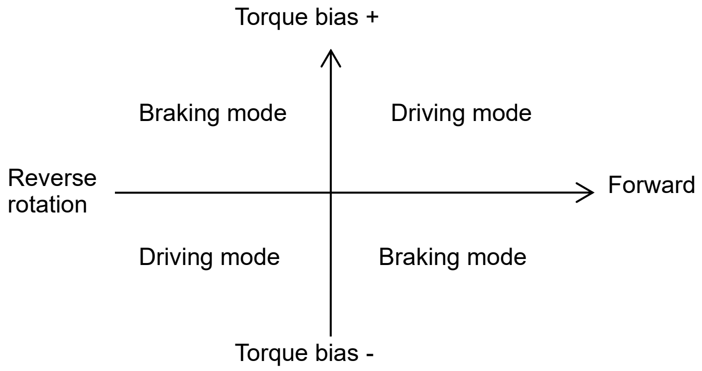
H147	Speed control (JOG) (Feed forward gain)

Refer to the description of d01 to d08.

H154 **H155 to H157** **H158** **H159** **H161** **H162**	**Torque bias**	**(Function selection)** **(Level 1 to 3)** **(Mechanical loss compensation)** **(Startup timer)** **(Shutdown timer)** **(Limiter)**

Torque bias value is added to the torque command output by the speed controller for vector control with sensor. As a result of this, a significant amount of torque can be output with no speed deviation when starting. The torque bias level can be selected from the analog input value or the three fixed values which are specified with function codes and switched by the digital input signals "TB1" and "TB2." Refer to Chapter 8, "Figure 8.2-11 (for E3S/E3E)" or "Figure 8.3-10 (for E3N)" for block diagrams.

The direction of run command and the polarity of the torque bias determine the mode of drive operation (driving/braking). Refer to the figure below.



■ **Torque bias (Function selection) (H154)**

This function allows to select the method of torque bias input.

H154 data	Function
0	Disable torque bias
1	H155 to H157: Enable levels 1, 2 and 3 selected by digital inputs "TB1", "TB2".
2	Enable analog input value.
3	RS-485 communications link (port 1)
4	RS-485 communications link (port 2)
5	Field bus communication

■ **Set level 1, 2 and 3 (H155 to H157); Select torque bias 1, 2 -- "TB1", "TB2" (E01 to E05 data = 61, 62)**

The torque bias level is selected with terminal "TB1" and "TB2". This is valid only when H154 = 1.

Input signal		Torque-bias to be selected
"TB2"	"TB1"	
OFF	OFF	Disable torque-bias
OFF	ON	H155: Torque bias level 1
ON	OFF	H156: Torque bias level 2
ON	ON	H157: Torque bias level 3

Data setting range: -300 to +300 (%) (motor rated torque reference)

■ **Torque bias (Mechanical loss compensation) (H158)**

Use this function to compensate the amount of the mechanical loss of a load.

Data setting range: 0 to 300.00 (%) of a motor rated torque

■ **Hold torque bias command "H-TB" (E01 to E05, data = 62)**

Turning this terminal command ON enables a torque-bias hold command. Hold is canceled by turning this terminal command OFF.

■ **Torque bias (Startup timer) (H159)**

By simply adding the torque bias, the shock may be large. By setting the timer with this function code, the motor can be started with minimal shock. H159 is the time to increase the bias torque from 0 to 100% of the motor rated torque. If this function code is set to "0.00," the torque bias is activated immediately.

Data setting range: 0.00 to 1.00 (s)

■ **Torque bias (Shutdown timer) (H161)**

By setting the shutdown timer, torque bias can be eliminated gradually in the same way as the startup timer. H161 sets the time to subtract 100% of the torque. If this function code is set to "0," the entire torque bias value is subtracted immediately.

Data setting range: 0.00 to 1.00 (s)

■ **Torque bias (Limiter) (H162)**

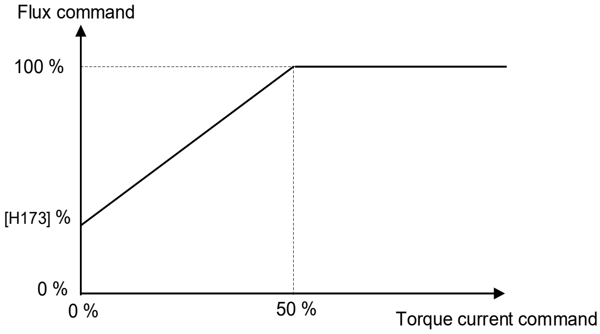
Analog torque bias normally uses a load sensor, but if the sensor is faulty, there is a risk of an excessive torque bias being set. By setting the torque bias limiter, the torque bias value maximum value can be limited.

Data setting range: 0 to 300 (%)

H173	Magnetic flux level at light load

This function decreases the motor magnetic flux at light load and can reduce the motor noise. This can only be used under vector control with sensor. The motor magnetic flux command is controlled in proportion to torque current command that is less than 50%. H173 specifies the minimum value of the flux command. Refer to the figure below.

Data setting range: 10 to 100 (%)



H180	Brake control signal (Check-time for brake operation) Related function codes: J68 to J72

Refer to the description of J68.

H193, H194	User-set initial value (Save, Protection) Related function code: H03

Refer to the descriptions of H02, H03.

H195	DC braking (Braking time at startup) Related function code: F21

DC braking can be activated at startup. For details, refer to the description of F21.

H196	For adjustment by manufacturer

This function code is for adjustment by the manufacturer. Do not access this function code.

H197, H198 H199	User password 1 (Protective operation selection, Setting/comparison) User password protection active Related function code: H99

Refer to the description of H99.

5.3.7 A codes (Motor 2 parameters)

FRENIC-Ace allows you to switch between 2 motors and perform operation using the same inverter. (📖 Function codes E01 to E05, data = 12)

Function codes	Motor to drive	Remarks
F/E/P codes, etc.	Motor 1	Including function codes commonly applied to motors 1 to 2.
A codes	Motor 2	

The switching operation with "M2" is made in order of priority from motor 1 to 2 using the following combinations. By switching the motor, the respective function codes will change, and the motor will be controlled based on the new function codes. "SWM1" and "SWM2" can be output as digital signals used to indicate the selected motor.
(📖 Function codes E20, E21, and E27, data = 48, 49)

Digital input signal	Selected motor	Output signal	
"M2"		"SWM1"	"SWM2"
OFF	Motor 1	ON	OFF
ON	Motor 2 (A codes)	OFF	ON

Note This manual describes function codes applied to motor 1 only. For ones applied to motor 2, refer to the corresponding function codes for motor 1 in Table 5.3.2 Switching function codes list."

Note PMSM control is possible only for motor 1. If changes are not made to the inverter output wiring when switching to induction motor control for motors 2, PMSMs will be driven by induction motors, possibly leading to motor damage, and therefore caution is advised.

Note It is necessary to confirm "M2" 1 ms before the run command is confirmed.

If motor switching is set, the function codes in the following Table 5.3.2 are switched. The function codes listed in the following Table 5.3-3 are for motor 1, and function codes for motor 2 are disregarded, but some functions can be enabled with A98.

Table 5.3.2 Switching function codes list

Name	Function codes	
	Motor 1	Motor 2
Maximum output frequency	F03	A01
Base frequency	F04	A02
Voltage at base frequency	F05	A03
Maximum output voltage	F06	A04
Torque boost	F09	A05
Electronic thermal (Motor protection) (Select motor characteristics)	F10	A06
(Operation level)	F11	A07
(Thermal time constant)	F12	A08
DC braking (Braking starting frequency)	F20	A09
(Operation level)	F21	A10
(Braking time)	F22	A11
Starting frequency	F23	A12
Load selection/Auto torque boost/Auto energy-saving operation	F37	A13
Control method selection	F42	A14
Motor (Poles)	P01	A15
(Rated capacity)	P02	A16
(Rated current)	P03	A17
(Auto tuning)	P04	A18
(Online tuning)	P05	A19
(No-load current)	P06	A20
(%R1)	P07	A21
(%X)	P08	A22
(Slip compensation gain for driving)	P09	A23

FUNCTION CODES
Chap 5
FUNCTION
F Codes
E Codes
C Codes
P Codes
H Codes
A Codes
b Codes
r Codes
J Codes
d Codes
U Codes
y Codes
o Codes
K Codes

Name		Function codes	
		Motor 1	Motor 2
	(Slip compensation response time)	P10	A24
	(Slip compensation gain for braking)	P11	A25
	(Rated slip frequency)	P12	A26
Motor	(Iron loss coefficient 1)	P13	A27
	(%X correction coefficient 1)	P53	A53
Motor selection		P99	A39
Slip compensation	(Operating condition selection)	H68	A40
Current fluctuation damping gain for motor		H80	A41
Cumulative run time of motor		H94	A51
Startup count		H44	A52
(For adjustment by manufacturer)		d51	d52

Table 5.3-3 Function codes that are disregarded for motor 2

Content	Function code	Motor 2 driving
Non-linear V/f	H50 to H53, H65, H66	Disable
Starting frequency (Holding time)	F24	Disable
Stop frequency (Holding time)	F39	Disable
Motor overload early warning	E34, E35	Disable
Droop control	H28	Disable
UP/DOWN control	H61	Fixed at the initial setting 0 Hz
PID control	J01 to J06, J08 to J13, J15 to J19 J57 to J62, J105 to J138, H91	Disable
Brake control signal	J68 to J72, J95, J96	Disable
Current limiter	F43, F44	Disable
Rotational direction limitation	H08	Disable
Maintenance Interval/ Preset startup count for maintenance	H78, H79	Disable
DC braking (Braking time at startup)	H195	Disable

A98 Motor 2 (Function selection)

Setting range: 0 to 255 (decimal setting)

Of the functions disabled for motor 2 onward shown in Table 5.3-3 Function codes that are disregarded for motor 2," the following functions can be enabled.

Bit	Function	Data = 0	Data = 1	Factory default
Bit 0	Current limiter (F43, F44)	Disable	Enable	0: Disable
Bit 1	Rotation direction limiter (H08)	Disable	Enable	0: Disable
Bit 2	Non-linear V/f (H50 to H53, H65, H66)	Disable	Enable	0: Disable
Bit 3 Note	PID control (J01 to J62, H91)	Disable	Enable	0: Disable
Bit 4	Braking signal	Disable	Enable	0: Disable
Bit 5	DC braking (braking timer at startup) (H195)	Disable	Enable	0: Disable
Bit 6, 7	No function assigned	-	-	0

Note) This bit setting does not affect function codes relating to PID control 1 or 2.

5.3.8 b, r codes (Speed control 3 and 4)

FRENIC-Ace has four sets of speed control parameters. They can be selected by “MPRM1” and “MPRM2” signals. The selection made with speed control selection signals “MPRM1” and “MPRM2” takes priority over the selection made with “M2.”

For the description of speed control parameters, refer to function code d01.

Name		Speed control parameter set			
		Set 1	Set 2	Set 3	Set 4
Speed control	(Speed command filter)	d01	A43	b43	r43
	(Speed detection filter)	d02	A44	b44	r44
	(P gain)	d03	A45	b45	r45
	(Integral time)	d04	A46	b46	r46
	(Feed forward gain)	d05	A47	b47	r47
	(Output filter)	d06	A48	b48	r48
	(Notch filter resonance frequency)	d07	A49	b49	r49
	(Notch filter attenuation level)	d08	A50	b50	r50
	(Notch filter width)	d29	A58	b58	r58

■ **Select speed control parameter 1, 2 -- “MPRM1,” “MPRM2” (E01 to E05 data = 78, 79)**

The combination of the ON/OFF states of digital input signals “MPRM1” and “MPRM2” selects one among 4 different speed control parameter sets. d01 to d08, d29 and A43 to A50, A58 can be changed even when switching the motor with “M2.”

Input signal		Selected speed control parameter set
“MPRM2”	“MPRM1”	
OFF	OFF	d01 to d08, d29: Speed control constant 1
OFF	ON	A43 to A50, A58: Speed control constant 2
ON	OFF	b43 to b50, b58: Speed control constant 3
ON	ON	r43 to r50, r58: Speed control constant 4

5.3.9 J codes (Application Functions)

J01	PID control (Operation selection)

Under PID control, the inverter detects the state of a control target object with a sensor or similar device and compares it with the commanded value (e.g., temperature control command). If there is any deviation between them, PID control operates so as to minimize it. That is, it is a closed loop feedback system that matches a controlled variable (feedback amount).

PID control expands the application area of the inverter to process control (e.g., flow control, pressure control, and temperature control) and speed control (e.g., dancer control).

If PID control is enabled (J01 = 1, 2 or 3), the frequency control of the inverter is switched from the drive frequency command generator block to the PID command generator block.

The table below shows the list of PID control setting items.

Table 5.3-4 PID control setting item list

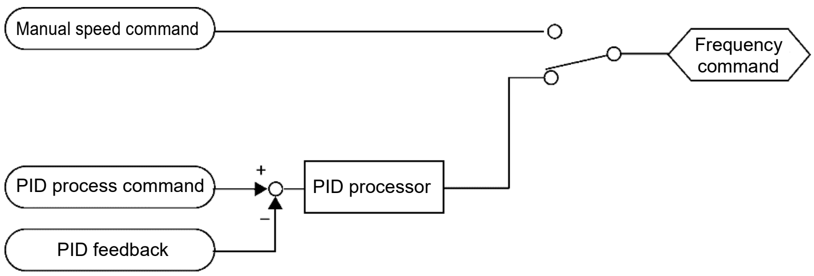
Function code name	PID control
Operation selection	J01
Remote command	J02
Display unit	J105
Maximum scale / Minimum scale	J106, J107
P (Gain)	J03
I (Integral time)	J04
D (Differential time)	J05
Feedback filter	J06
Anti-reset wind-up	J10
Upper limit / Lower limit of PID output	J18, J19
Alarm output	J11, J12, J13
Dancer position control	J57 to J62
PID multistep command	J136 to J138
Low liquid level stop	J08, J09, J15, J16, J17, J23, J24

■ **Operation selection (J01)**

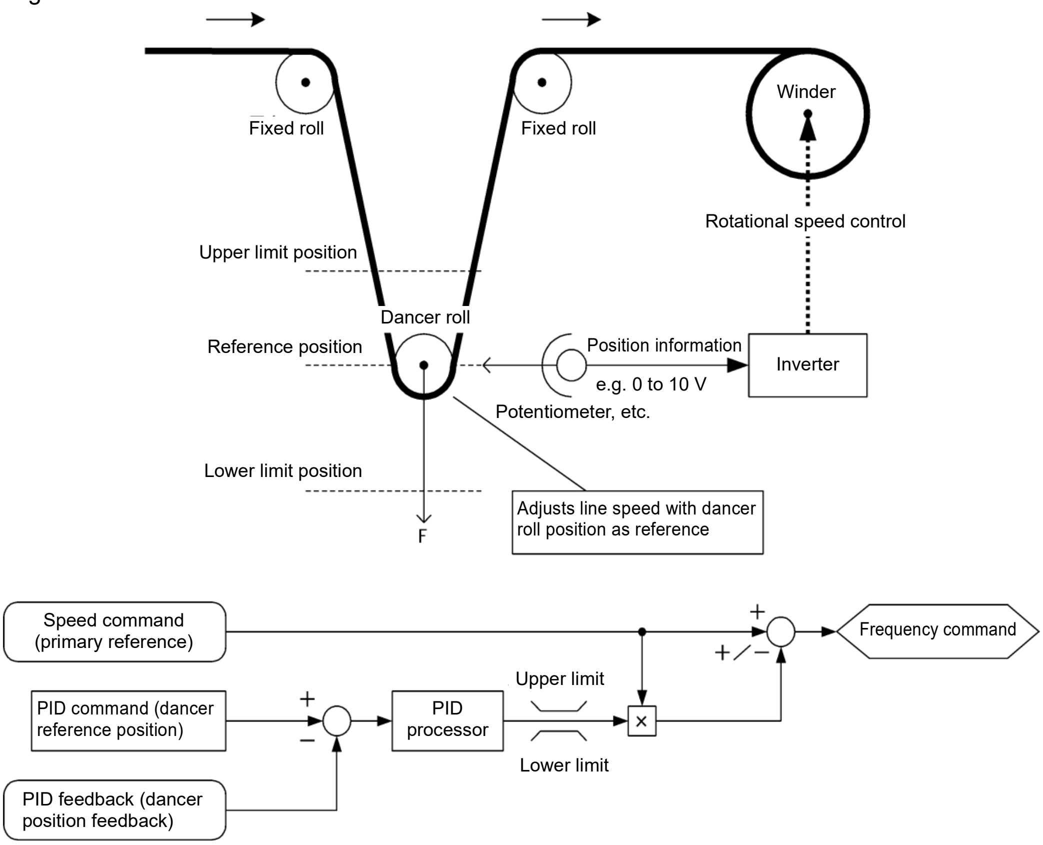
J01 selects the PID control operation and control block.

J01 data	Function
0	Disable
1	Process control (forward operation)
2	Process control (reverse operation)
3	Speed control (dancer)

<Block diagram of PID process control>



<Block diagram of PID dancer control>



- Using J01 allows switching between normal and inverse operations for the PID control output, so you can specify an increase/decrease of the motor rotating speed depending on the difference (error component) between the commanded (input) and feedback amounts, making it possible to apply the inverter to air conditioners. The terminal command "IVS" can also switch operation between normal and inverse.

For details about the switching of normal/inverse operation, refer to the description of "Switch normal/inverse operation "IVS" assignment" (E01 to E05 data = 21).

FUNCTION CODES
Chap 5
FUNCTION
F Codes
E Codes
C Codes
P Codes
H Codes
A Codes
b Codes
r Codes
J Codes
d Codes
U Codes
y Codes
O Codes
K Codes

J02	**PID control (Remote command)** **Related function codes J105: PID control (Display unit)** **J106: PID control (Maximum scale)** **J107: PID control (Minimum scale)** **J136 to J138: PID control (Multistep commands 1 to 3)**

Select the method used to set PID control command values.

J02	Function
0	PID command by keypad PID command with keypad ▲/▼ keys
1	PID command (analog input terminals [12], [C1] (C1 function), [C1] (V2 function)) Terminal [12] input voltage value: 0 to ±10 VDC, PID100% command/±10 VDC Current input to terminal [C1] (C1 function) (4 to 20 mA/0 to 20 mA DC, 100% PID command/20 mA DC) Voltage input to terminal [C1] (V2 function) (0 to ±10 VDC, 100% PID command/±10 VDC)
3	Terminal command UP/DOWN Using the “UP” or “DOWN” command in conjunction with PID minimum scale to maximum scale (specified by J106 and J107) with which the command value is converted into a physical quantity, etc., you can specify 0 to 100% of the PID command (± 100% for PID dancer control).
4	Command via communications link Function code for communication (S13): Transmission data 20000d/100% PID command

[1] PID command by keypad J02 (J02＝0)

Using the ▲/▼ keys on the keypad in conjunction with PID minimum / maximum scale (specified by J106 and J107), you can specify 0 to 100% of the PID command (±100% for PID dancer control) in an easy-to-understand, converted command format.

For details of setting procedure, refer to Chapter 3 “3.3.5 Setting up PID commands from the keypad.”

[2] PID command 1 by analog inputs (J02 = 1)

The desired value can be set for the PID command value by analog input by multiplying by the gain and adding the bias. The polarity can be selected, and the filter and offset can be adjusted. In addition to J02 settings, it is also necessary to select PID command 1 for each analog input setting (function codes E61 to E63). For details, refer to the function codes E61 to E63.

Adjustable elements of PID command values

<table>
<tr><th rowspan="2">Input terminal</th><th rowspan="2">Input range</th><th colspan="2">Common bias</th><th colspan="2">Individual bias</th><th colspan="2">Gain</th><th rowspan="2">Polarity</th><th rowspan="2">Filter</th><th rowspan="2">Offset</th></tr>
<tr><th>Bias</th><th>Reference point</th><th>Bias</th><th>Reference point</th><th>Gain</th><th>Reference point</th></tr>
<tr><td>[12]</td><td>0 to +10 V,
-10 to +10 V</td><td rowspan="3">C51</td><td rowspan="3">C52</td><td>C55</td><td>C56</td><td>C32</td><td>C34</td><td>C35</td><td>C33</td><td>C31</td></tr>
<tr><td>[C1]
(C1 function)</td><td>4 to 20 mA,
0 to 20 mA</td><td>C61</td><td>C62</td><td>C37</td><td>C39</td><td>C40</td><td>C38</td><td>C36</td></tr>
<tr><td>[C1]
(V2 function)</td><td>0 to +10 V</td><td>C67</td><td>C68</td><td>C42</td><td>C44</td><td>C45</td><td>C43</td><td>C41</td></tr>
</table>

Both the common bias and individual bias function.

■ Offsets (C31, C36, C41)

C31, C36, C41, and C74 set offsets for analog input voltage and current. The offset from signals sent from the external equipment can also be compensated.

■ Filters (C33, C38, C43)

C33, C38, C43, and C76 provide the filter time constants for analog input voltage and current. The larger the time constant, the slower the response. Specify the proper filter time constant taking into account the response speed of the machine (load). If the input voltage fluctuates due to line noise, increase the time constant.

■ Polarity selection: Terminal [12] (C35)

C35, C45, and C78 configure the polarity, and therefore the input range for analog input voltage.

C35 data	Terminal [12], input specification
0: Bipolar	-10 to +10 V
1: Unipolar	0 to +10 V (Negative value of voltage is regarded as 0 V)

■ Range / polarity selection for terminal [C1] (C1 function) (C40)

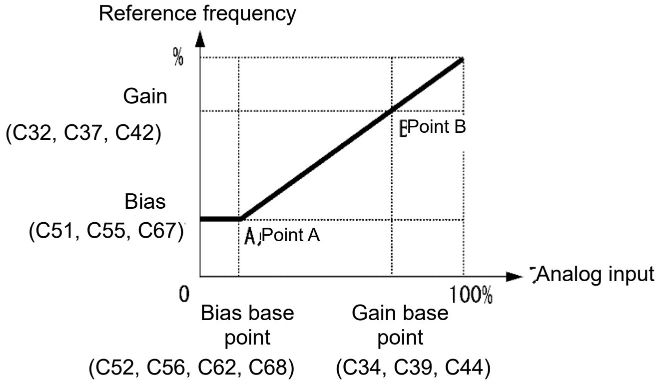
C40 configures the input range for analog input current of terminal [C1] (C1 function).
This allows analog current input to be handled as bipolar data with 12 mA or 10 mA set to 0 by setting to 10 or 11 and compensating with the gain and bias.

<table>
<tr><th>C40 data</th><th>Terminal input range</th><th>Handling when bias value is set to minus</th></tr>
<tr><td>0: Unipolar</td><td>4 to 20 mA</td><td rowspan="2">Limit below 0 point with 0</td></tr>
<tr><td>1: Unipolar</td><td>0 to 20 mA</td></tr>
<tr><td>10: Bipolar</td><td>4 to 20 mA</td><td rowspan="2">Enable below 0 point as minus value.</td></tr>
<tr><td>11: Bipolar</td><td>0 to 20 mA</td></tr>
</table>

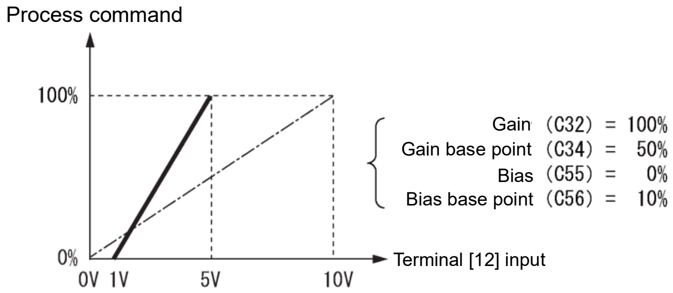
■ Polarity selection for terminal [C1] (V2 function) (C45)

C40 data	C1 (V2 function) terminal input specifications	Handling when bias value is set to minus
0: Bipolar	0 to +10 V	Enable below 0 point as minus value.
1: Unipolar	0 to +10 V	Limit below 0 point with 0

■ **Gain, bias**



(Example) In order to allocate for the range of 0 to 100% to the range of 1 to 5 V at terminal [12], set as follows.



[3] PID command with UP/DOWN control (J02 = 3)

When UP/DOWN control is selected as a PID speed command, turning the terminal command “UP” or “DOWN” ON causes the PID set point value to change within the range from minimum scale to maximum scale.

Settings can be specified in physical system units with display units (J105), maximum scale (J106), and minimum scale (J107).

To select UP/DOWN control as a PID set point value, the “UP” and “DOWN” should be assigned to the digital input terminals. (📖 Function code E01 to E05, data = 17, 18)

“UP”	"DOWN"	Tuning
Data = 17	Data = 18	
OFF	OFF	Retain PID set point value.
ON	OFF	Increase PID set point value at a rate between 0.1%/0.1 s and 1%/0.1 s.
OFF	ON	Decrease PID set point value at a rate between 0.1%/0.1 s and 1%/0.1 s.
ON	ON	Retain PID set point value.

Note The inverter internally holds the PID command value set by UP/DOWN control and applies the held value at the next restart (including powering ON).

[4] PID command via communications link (J02 = 4)

Function code for communication (S13): Transmission data 20000d/100% PID command. For details of the communications format, refer to the RS-485 Communication User’s Manual.

Note
- Other than the remote command selection by J02, the PID multistep commands 1, 2 or 3 (specified by J136, J137 or J138, respectively) selected by the PID multistep commands “PID-SS1” and “PID-SS2” can also be used as preset set point values for the PID command.
- In dancer control (J01 = 3), the setting command from the keypad is in conjunction with the function code J57 (PID control: Dancer position set point), and it is saved as function code data.

Selecting feedback terminals

For feedback control, determine the connection terminal according to the type of the sensor output.

- If the sensor is a current output type, use the current input terminal [C1] (C1 function) of the inverter.
- If the sensor is a voltage output type, use inverter voltage input terminal [12] or [C1] (V2 function).

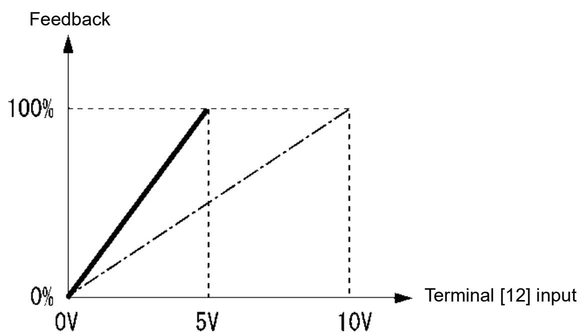
📖 For details, refer to the function codes E61, E62, and E63.

(For air conditioners, fans and pumps)

The operating range for PID process control is internally controlled as 0% through 100%. For the given feedback input, determine the operating range to be controlled by means of gain adjustment.

Example: When the external sensor has an output range of 1 to 5 V:

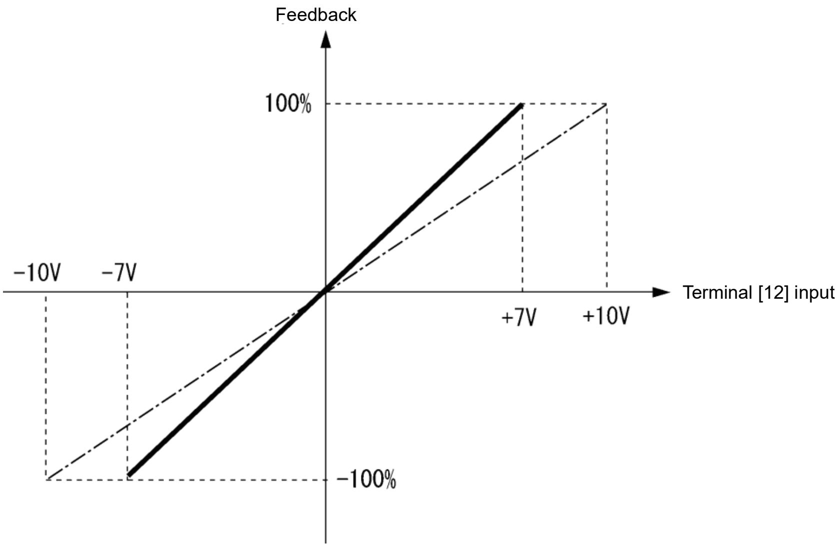
- As this is voltage input, use terminal [12].
- Set the gain (C32 for analog input adjustment) to 200% in order to make 5 V of the maximum output of the external sensor to be 100% of input scale. For the input specification of terminal [12], 0 to 10 V is equivalent to 0 to 100%. The gain therefore must be set 200% (= 10 V/5 V *100). Note also that any bias setting does not apply to feedback control.



(For winders)

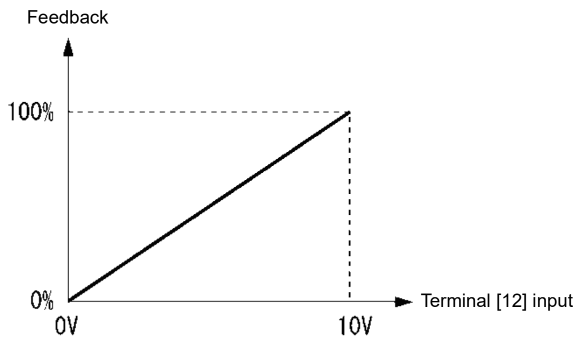
Example 1: When an external sensor has an output range of -7 to +7 VDC:

- As this is voltage input, use terminal [12].
- When the external sensor has ±7 VDC of bipolar output, inside the inverter ±7 VDC should be equivalent to ±100%. To convert ±7 VDC from the output of an external sensor to ±100%, the gain setting (C32) is set in $\frac{10\ \text{V}}{7\ \text{V}} \fallingdotseq 143\%$.



Example 2: When an external sensor has the output range of 0 to 10 VDC:

- As this is voltage input, use terminal [12].
- When the external sensor has unipolar output, inside the inverter it is controlled within the range of 0 to 100%.



In this example, it is recommended that the dancer reference position is set around the 5 V (50%) point.

J03 **J04** **J05** **J06**	**PID control P (Gain)** **PID control I (Integral time)** **PID control D (Differential time)** **PID control Feedback filter** **Related function codes: J59: P (Gain) 2** **J60: I (Integral time) 2** **J61: D (Differential time) 2**

■ **(P gain) (J03)**

These function codes set the PID controller gain.

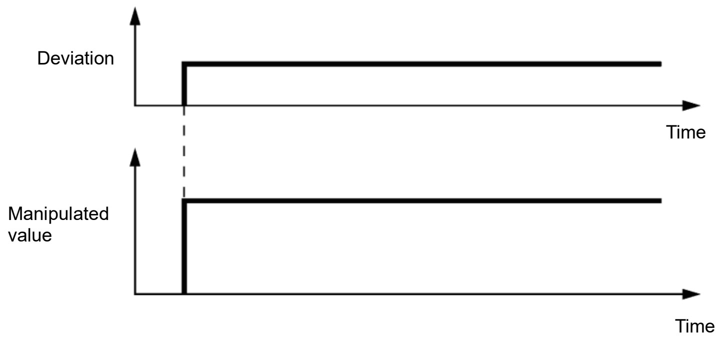
- Data setting range: 0.000 to 30.000 (times)

P (Proportional) action

Actions with a proportional relationship between the operation amount (output frequency) and the deviation are called P actions. However, P action alone cannot eliminate deviation.

Gain is data that determines the system response level against the deviation in P action. An increase in gain speeds up response, but an excessive gain may oscillate the inverter output. A decrease in gain delays response, but it stabilizes the inverter output.

It may be necessary to adjust the P gain when performing dancer control based on differences in machine inertia associated with thick winding and thin winding, or if there is a large deviation from the reference position when the dancer starts.



FUNCTION CODES
Chap 5
FUNCTION
F Codes
E Codes
C Codes
P Codes
H Codes
A Codes
b Codes
r Codes
J Codes
d Codes
U Codes
y Codes
O Codes
K Codes

■ I integral time (J04)

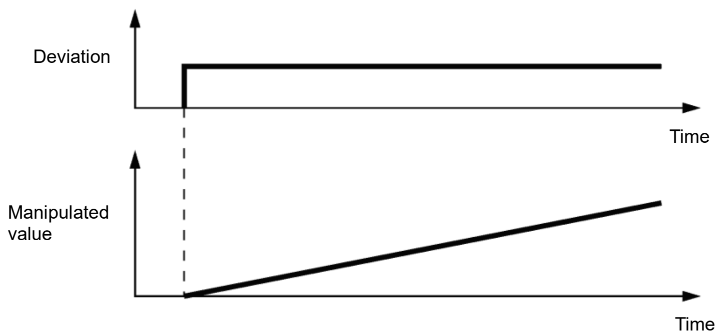
These function codes set the PID controller integral time.

- Data setting range: 0.0 to 3600.0 (s)
  0.0 indicates that the integral component is disabled.

I (Integral) action

An operation in which the change rate of the MV (manipulated value: output frequency) is proportional to the integral value of deviation is called I action, which outputs the MV that integrates the deviation. Therefore, I action is effective in bringing the feedback value close to the commanded value. Therefore, I action is effective in bringing the feedback value close to the commanded value. For the system whose deviation rapidly changes, however, this action cannot make it respond quickly.

The effectiveness of I action is expressed by integral time as parameter, that is J04 data. The longer the integral time, the slower the response. The reaction to the external disturbance also becomes slow. The shorter the integral time, the faster the response. Setting too short integral time, however, makes the inverter output tend to oscillate against the external disturbance.



■ D differential time (J05)

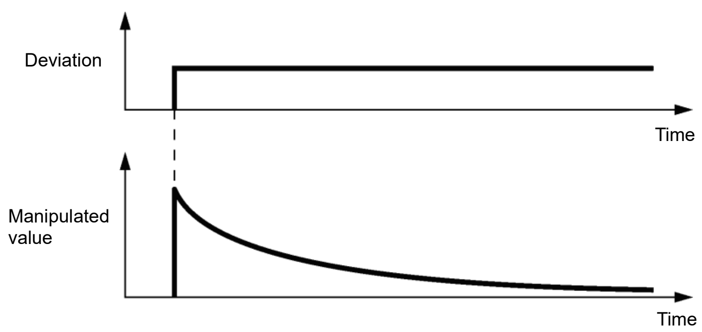
These function codes set the PID controller differential time.

- Data setting range: 0.00 to 600.00 (s)
  0.00 indicates that the differential component is disabled.

D (Differential) action

An operation in which the MV (manipulated value: output frequency) is proportional to the differential value of the deviation is called D action, which outputs the MV that differentiates the deviation. D action makes the inverter quickly respond to a rapid change of deviation.

The effectiveness of D action is expressed by differential time as parameter, that is J05 data. Setting a long differential time will quickly suppress oscillation caused by P action when a deviation occurs. Too long differential time makes the inverter output oscillation more. Setting short differential time will weakens the suppression effect when the deviation occurs.



The combined uses of P, I, and D actions are described below.

(1) PI control

PI control, which is a combination of P and I actions, is generally used to minimize the remaining deviation caused by P action. PI control always acts to minimize the deviation even if a commanded value changes or external disturbance steadily occurs. However, the longer the integral time of I action, the slower the system response to quick-change control. P action can be used alone for loads with very large part of integral components.

(2) PD control

In PD control, the moment that a deviation occurs, the control rapidly generates greater MV (manipulated value: output frequency) than that generated by D action alone, to suppress the deviation increase. When the deviation becomes small, the behavior of P action becomes small. A load including the integral component in the controlled system may oscillate due to the action of the integral component if P action alone is applied. In such a case, use PD control to reduce the oscillation caused by P action, for keeping the system stable. That is, PD control is applied to a system that does not contain any damping actions in its process.

(3) PID control

PID control is implemented by combining P action with the deviation suppression of I action and the oscillation suppression of D action. PID control features minimal control deviation, high precision and high stability. In particular, PID control is effective to a system that has a long response time to the occurrence of deviation.

Follow the procedure below to set data to PID control function codes.

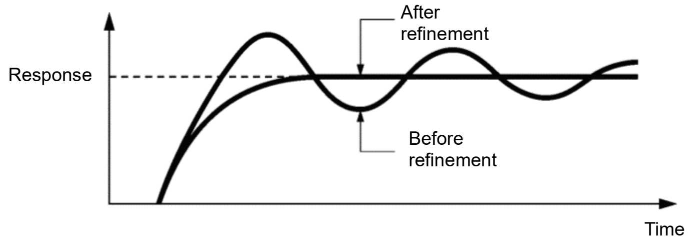
It is highly recommended that you adjust the PID control value while monitoring the system response waveform of the PID feedback with an oscilloscope or equivalent. Repeat the following procedure to determine the optimal solution for each system.

- Increase the PID control (gain) function code data within the range in which feedback signals do not oscillate.
- Increase the PID control (integral time) function code data within the range in which feedback signals do not oscillate.
- Increase the PID control (differential time) function code data within the range in which feedback signals do not oscillate.

The method for refining the system response from the waveforms is shown below.

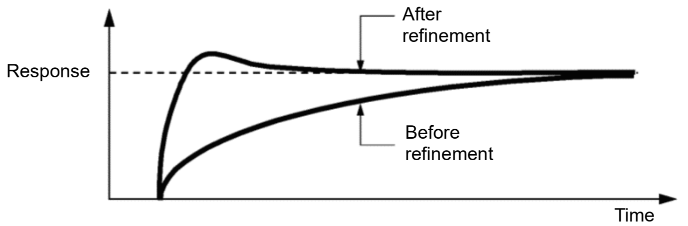
1) Suppressing overshoot

Increase the data of J04 (Integral time) and decrease that of J05 (Differential time).



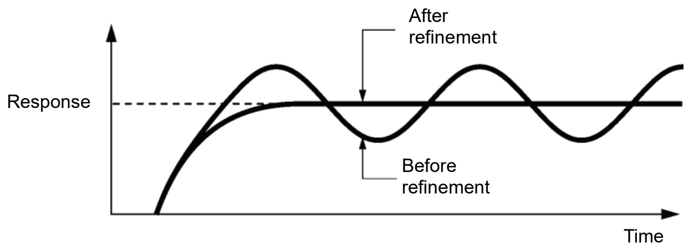
2) Quick stabilizing (Moderate overshoot is allowable.)

Decrease the data of J03 (Gain) and increase that of J05 (Differential time).



3) Suppressing oscillation whose period is longer than the integral time specified by J04

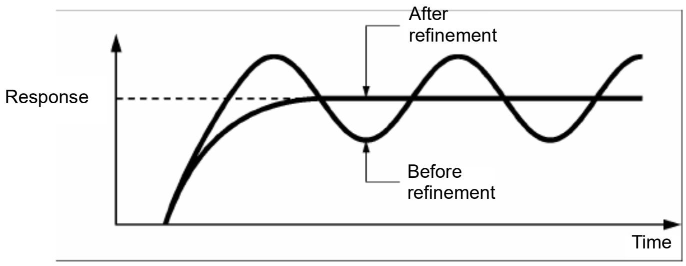
Increase the data of J04 (Integral time).



4) Suppressing oscillation whose period is approximately the same as the time specified by J05 (Differential time)

Decrease the data of the differential time function code.

Decrease the data of the gain function code if the oscillation cannot be suppressed even though the differential time is set to 0 sec.



■ **Feedback filter (J06)**

These function codes set the PID controller feedback filter time.

- Data setting range: 0.0 to 900.0 (s)
- This setting is used to stabilize the PID control loop. Setting too long a time constant makes the system response slow.

Note When speed control (dancer) is selected (J01 ≠ 3 → = 3), the J06 setting value automatically changes to 0.0 s.
To specify the filter time constant in detail, apply an analog input filter (C33, C38 and C43). When speed control (dancer) is not selected (J01 = 3 → ≠ 3), the J06 setting value automatically changes to 0.5 s. Set J06 after setting J01.

J08, J09	**PID control (Pressurization starting frequency, Pressurizing time)** **Related function codes:** **J15 (Low liquid level stop/start frequency level)** **J16 (Low liquid level stop elapsed time)** **J17 (Starting frequency)** **J23 (Low liquid level stop/start feedback deviation)** **J24 (Low liquid level stop/start delay time)**

Low liquid level stop functions (J15 to J17, J23, J24)

Function codes J15 to J17 configure the low liquid level stop function in pump control, a function that stops the inverter when the discharge pressure increases, causing the volume of water to decrease.

When the discharge pressure has increased, decreasing the reference frequency (output of the PID processor) below the Low liquid level stop/start frequency level (J15) for the period specified by the Low liquid level stop elapsed time (J16), the inverter decelerates to stop, while PID control itself continues to operate. When the discharge pressure decreases, increasing the reference frequency (output of the PID processor) above the starting frequency (J17), the inverter resumes operation.

The restarting conditions can be adjusted with J23 and J24.

■ PID control (Low level liquid stop/start frequency level) (J15)

J15 specifies the frequency level which triggers a low liquid level stop of inverter.

■ PID control (Low liquid level stop elapsed time) (J16)

J16 specifies the period from when the PID output drops below the frequency specified by J15 until the inverter starts deceleration to stop.

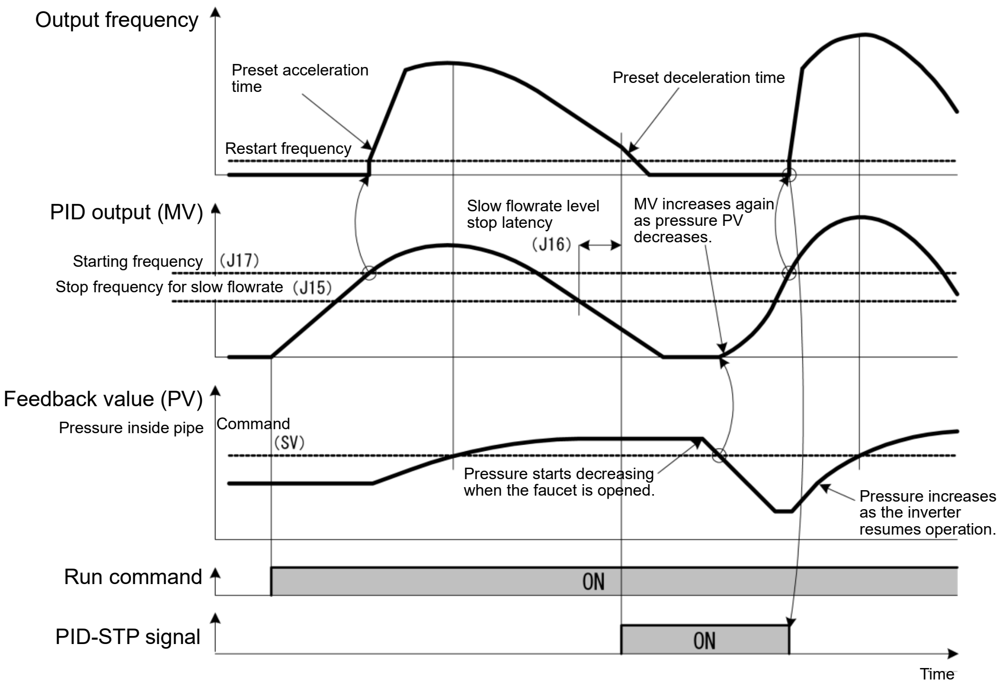
■ PID control (Starting frequency) (J17)

J17 specifies the starting frequency. Set J17 to a frequency higher than the stop/start frequency (J15). If the specified starting frequency is lower than the start/stop frequency, the start/stop frequency is ignored; the low liquid level stop function is triggered when the output of the PID processor drops below the specified starting frequency.

■ Under PID low liquid level stop “PID-STP” assignment (Function code E20~E21 and E27, data = 44)

Under PID low liquid level stop “PID-STP” is ON when the inverter is in a stopped state due to the low liquid level stop function under PID control. “PID-STP” should be assigned if it is necessary to output a signal to indicate that the inverter is stopped.

For the low liquid level stop function, see the chart below.



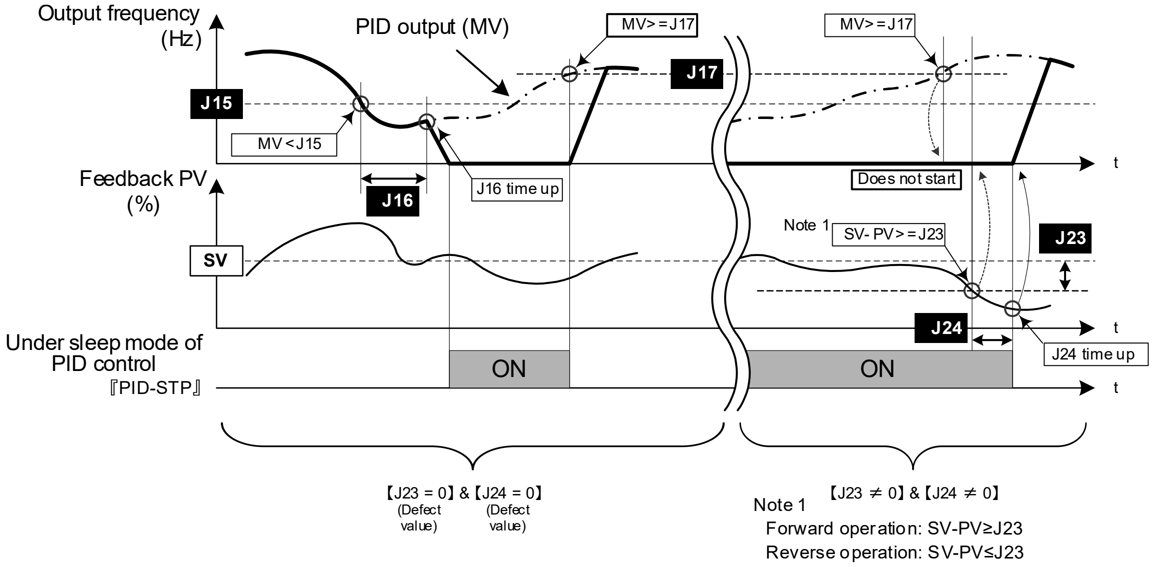
Chap 5 FUNCTION CODES
FUNCTION
F Codes
E Codes
C Codes
P Codes
H Codes
A Codes
b Codes
r Codes
J Codes
d Codes
U Codes
y Codes
O Codes
K Codes

■ **PID control (Low liquid level stop/start feedback deviation) (J23)**

■ **PID control (Low liquid level stop/start delay time) (J24)**

When both of the two conditions below are satisfied (AND condition), the inverter is restarted.

- The discharge pressure has decreased, increasing the frequency command value of the PID controller output to or above the starting frequency (J17), and the delay time (J24) has elapsed.
- The absolute error of the PV (feedback value) against to the SV (command value) is equal to or higher than the Low liquid level stop/start feedback deviation (J23), and the delay time (J24) has elapsed.



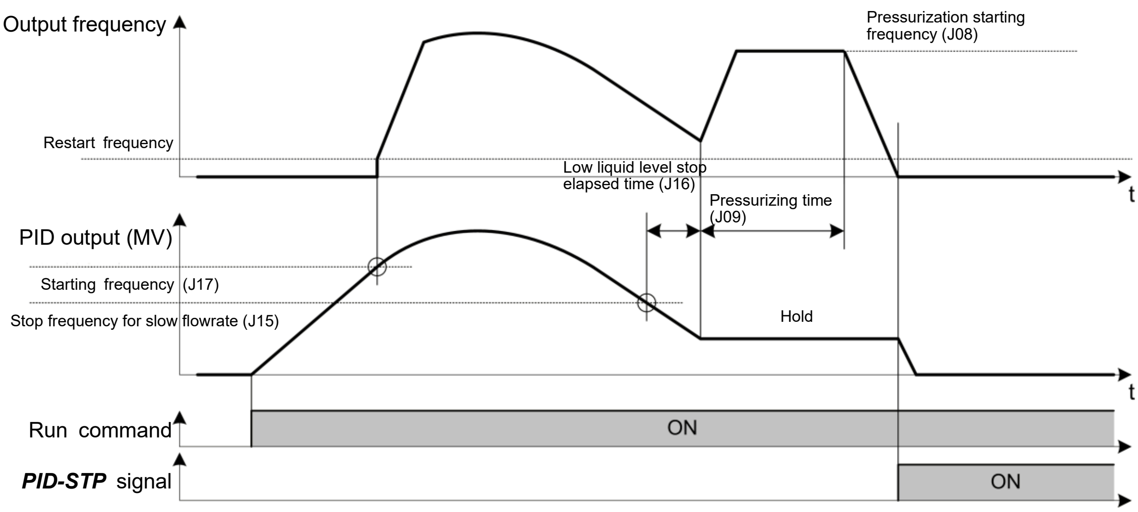
■ **Low liquid level stop pressurization functions (J08, J09)**

By setting the pressurization starting frequency (J08) and pressurizing time (J09), pressurization control is performed after the low liquid level stop elapsed time (J16) at the low liquid level stop/ frequency level (J15) or less. Hold is applied to PID control during pressurization.

On equipment with a bladder tank, by using this function to apply pressure immediately before stopping to raise the pressure, it is possible to increase the stopping time to longer than normal, realizing energy-saving operation.

By being able to adjust the pressurization starting frequency in the parameters, a pressure level appropriate to the equipment status can be set.

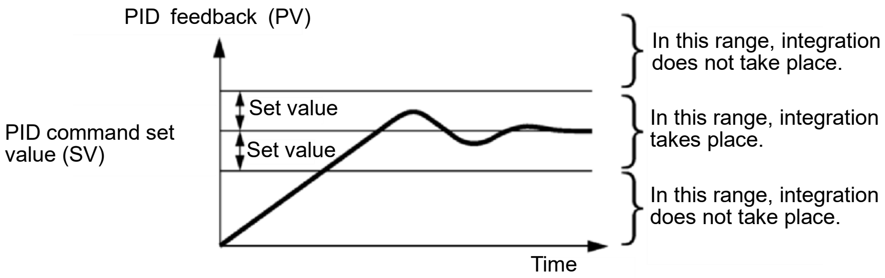
Refer to the following diagram for details on settings and operation.



J10 — PID control (Anti-reset wind-up)

J10 suppresses overshoot in control with the PID processor. As long as the error between the feedback and the PID command is beyond the preset range, the integrator holds its value and does not perform integration operation.

- Data setting range: 0 to 200(%)



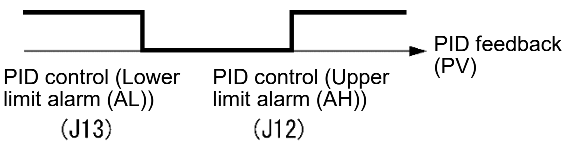
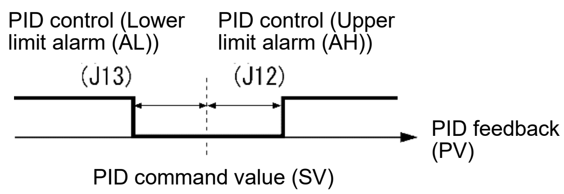
J11 to J13 — PID Control (Alarm output selection, Upper limit alarm (AH) and Lower limit alarm (AL))

The inverter is capable of outputting absolute value warnings or deviation warnings for PID control. It is necessary to set the digital output signal "PID-ALM" in E20 to E24 and E27 (data = 42) as warning outputs.

J11 specifies the warning output types. J12 and J13 each specify the upper and lower limits for warnings.

■ PID Control (Alarm output selection) (J11)

J11 sets the warning type. The following warnings can be selected.

J11 data	Type	Content
0	Absolute value warning	While PV < AL or AH < PV, "PID-ALM" is ON 
1	Absolute value warning (with hold)	Same as above (with Hold)
2	Absolute value warning (with latch)	Same as above (with Latch)
3	Absolute value warning (with hold, latch)	Same as above (with Hold and Latch)
4	Deviation warning	While PV < SV - AL or SV + AH < PV, "PID-ALM" is ON. 
5	Deviation warning (with hold)	Same as above (with hold)
6	Deviation warning (with latch)	Same as above (with latch)
7	Deviation warning (with hold and latch)	Same as above (with hold and latch)

Hold: During the power-on sequence, the alarm output is kept OFF (disabled) even when the monitored quantity is within the alarm range. Once it goes out of the alarm range, and comes into the alarm range again, the alarm is enabled.

Latch: Once the monitored quantity comes into the alarm range and the alarm is turned ON, the alarm will remain ON even if it goes out of the alarm range. To release the latch, perform a reset by pressing the PRG RESET key on keypad, or by turning terminal block "RST" ON. Resetting can be done by the same way as resetting an alarm.

■ **PID Control (Upper limit alarm (AH)) (J12)**

J12 specifies the upper limit alarm (AH) in percentage (%) of the feedback value.

■ **PID Control (Lower limit alarm (AL)) (J13)**

J13 specifies the lower limit alarm (AL) in percentage (%) of the feedback value.

Note The value displayed (%) is the ratio of the upper/lower limit to the full scale (10 V or 20 mA) of the feedback amount (in the case of a gain of 100%).

Upper limit of warning (AH) and lower limit of warning (AL) also apply to the following alarms.

Type	Content	How to handle the warning	
		Alarm output selection (J11)	Data setting
Upper limit (process command)	ON when J12(AH) < PV	Absolute value warning	J13(AL) = 0
Lower limit (process command)	ON when PV < J13(AL)		J12(AH) = 100%
Upper limit (PID error value)	ON when SV + J12(AH) < PV	Deviation warning	J13(AL) = 100%
Lower limit (PID error value)	ON when PV < SV - J13(AL)		J12(AH) = 100%
Upper/lower limit (PID error value)	ON when |SV - PV| > J13(AL)		J13(AL) = J12(AH)
Upper/lower range limit (PID error value)	ON when SV - J13(AL) < PV < SV + J13(AL)	Deviation warning	A negative logic signal should be assigned to “PID-ALM”.
Upper/lower range limit (process command)	ON when J13(AL) < PV < J12(AH)	Absolute value warning	
Upper/lower range limit (PID error value)	ON when SV - J13(AL) < PV < SV + J12(AH)	Deviation warning	

J15 to J17	PID control (Low liquid level stop/start frequency level, Low liquid level stop elapsed time, Starting frequency)

Refer to the J08 section.

J18 J19	PID Control (Upper limit of PID output) PID Control (Lower limit of PID output)

The upper and lower limits can be specified for the PID output, exclusively used for PID control. The settings are ignored when PID cancel “Hz/PID” is enabled and the inverter is operated at the reference frequency previously specified.
(📖 Function code E01 to E05, data = 20)

■ PID Control (Upper limit of PID output) (J18)

J18 specifies the upper limit of the PID processor output limiter in %. If the value of “999” is specified to J18, the setting of the frequency limiter (Upper) (F15) will serve as the upper limit.

■ PID Control (Lower limit of PID output) (J19)

J19 specifies the lower limit of the PID processor output limiter in %. If the value of “999” is specified to J19, the setting of the frequency limiter (Lower) (F16) will serve as the lower limit.

J21	Condensation prevention (Duty)

The motor temperature can be raised while the inverter is stopped to prevent condensation forming by supplying DC current for a fixed period of time.
This function does not work when a PMSM is selected.

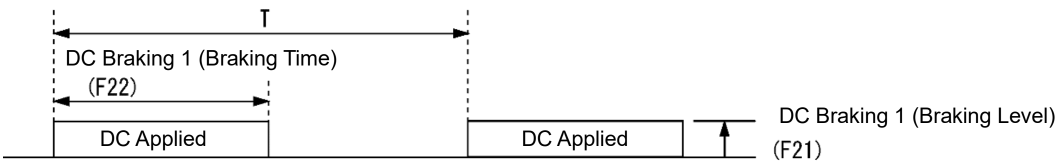
■ Enable conditions

By turning on condensation prevention “DWP” while the inverter is stopped, the condensation prevention function is started.
(Function code E01 to E05, data = 39)

■ Condensation prevention (Duty) (J21)

The current flowing to the motor is based on DC braking 1 (operation level) (F21), and duty control is performed based on the condensation prevention duty (J21) ratio corresponding to DC braking 1 (Braking time) (F22).

$$\text{Dew condensation prevention duty (J21)} = \frac{\text{DC brake (time) (F22)}}{T} \times 100$$



Condensation prevention operation

J23, J24	PID control (Low liquid level stop/start feedback deviation, Low liquid level stop/start delay time)

Refer to the J08 section.

J57	PID Control (Dancer standard position)

J57 specifies the dancer standard position in the range of -100% to +100% for dancer control. If J02 = 0 (keypad) is selected, this function code is applied for the dancer standard position.

It is also possible to modify the set point (PID command) with the ▲/▼ keys on the keypad. If modified, the new set point value is stored as J57 data automatically.

For the setting procedure of the set point (PID command), refer to Chapter 3 "3.3.5 Setting up PID commands from the keypad."

J58 J59 to J61	PID Control (Detection range of dancer standard position error) PID Control (P (Gain) 2, I (Integral time) 2 and D (Differential time) 2)

When the feedback value of dancer roll position comes into the range of "Detection range of dancer standard position error (J58)" the inverter switches PID constants from the combination of J03, J04 and J05 to that of J59, J60 and J61, respectively in its PID processor. Giving a boost to the system response by raising the P gain may improve the system performance in the dancer roll positioning accuracy.

■ **PID Control (Detection range of dancer standard position error) (J58)**

J58 specifies the bandwidth in the range of 1 to 100%. Specifying "0" does not switch PID constants.

■ **PID control P (Gain) 2 (J59)**

■ **PID control I (Integral time) 2 (J60)**

■ **PID control D (Differential time) 2 (J61)**

These are the same as PID control P (Gain), I (Integral time), and D (Differential time) (J03, J04, J05).

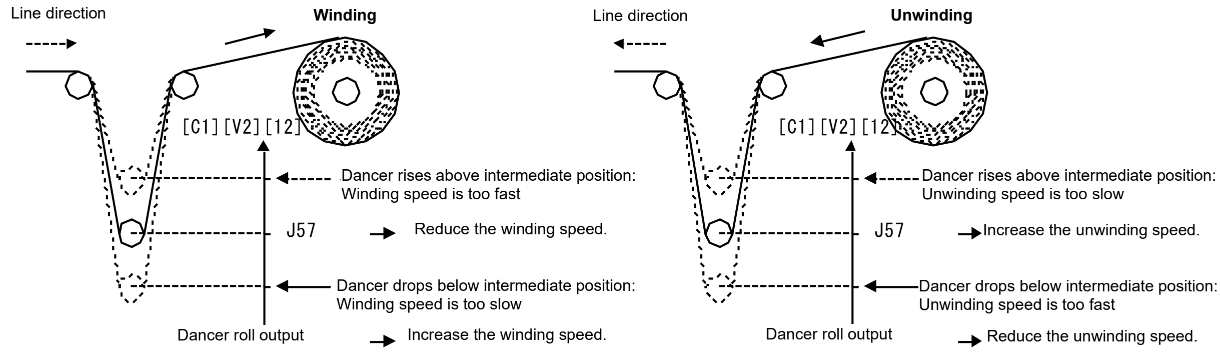
J62	PID control (PID control block selection)

It is possible to select whether to add dancer control PID regulator output to the main settings, or subtract it from the main settings. It is also possible to select whether to compensate the main settings with a ratio, or with an absolute value (Hz) for PID regulator output.

J62 data			Block selection	
Decimal	Bit 1	Bit 0	Control amount	Operation for main settings
0	0	0	Ratio control	Adder
1	0	1	Ratio control	Subtracter
2	1	0	Absolute value control	Adder
3	1	1	Absolute value control	Subtracter

<u>**Winding/unwinding selection**</u>

The frequency compensation direction differs depending on whether winding or unwinding is being performed.
Set J62: bit 0 = 0 for winding, and J62: bit 0 = 1 for unwinding.



[5] Overload stop functions

J63 to J67 J90 to J92	**Overload stop functions (Detection value, Detection level, Operation selection, Operation mode, Timer time)** **Overload stop functions (Torque limiter P (Gain), Torque limiter I (Integral time), Current command level)**

Detects an overload status and if it exceeds the specified detection level (J64) for the specified timer duration (J67), the operation is stopped based on the selected action (J65). It is used to protect the system when an unacceptable overload is applied or to lock the motor shaft by mechanically hitting it to the stopper.

This function is disabled while motor 2 to 4 is selected.

■ Detection value (J63)

Select a target (detected item) to monitor the load status.

J63 data	Detected value	Function overview
0	Torque	To improve the accuracy of calculated torque, perform auto-tuning. Select the driving torque as the target.
1	Current	The no-load current always flows to the motor. Specify J64 (Detection level) correctly considering the no-load current of the applied motor.

■ Detection level (J64)

Set the value for overload detection level in percentage (%) of the motor rated torque or current.

When Contacting the stopper is selected (J65 = 3), detection is performed at motor rated torque of 100%, regardless of the J64 setting.

(See the figure Operation selection J65 = 3)

Note Under sensorless vector control (PMSMs), the function is disabled at a speed of 10% or less of the base frequency.

■ Mode selection (J65)

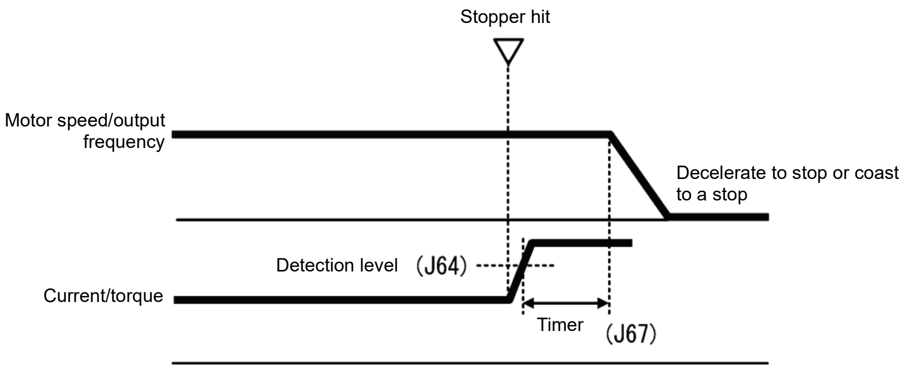
Select an operation when the load exceeds the value specified in J64.

J65 data	Tuning	Function overview
0	Disable	Overload stop function operation cancel
1	Decelerate to stop	Decelerates to stop the motor, as specified in deceleration time.
2	Coast-to-a-stop	Immediately shuts down the inverter, allowing the motor to coast to a stop.
3	Contacting the stopper	The motor decelerates with torque limiting operation, and current control is performed to ensure the holding torque. Current control continues until the run command is turned OFF. Apply the brake before turning OFF the run command. “IOL” and “IOL2” are output during stopper contact control. When stopper contact is selected, perform auto tuning.

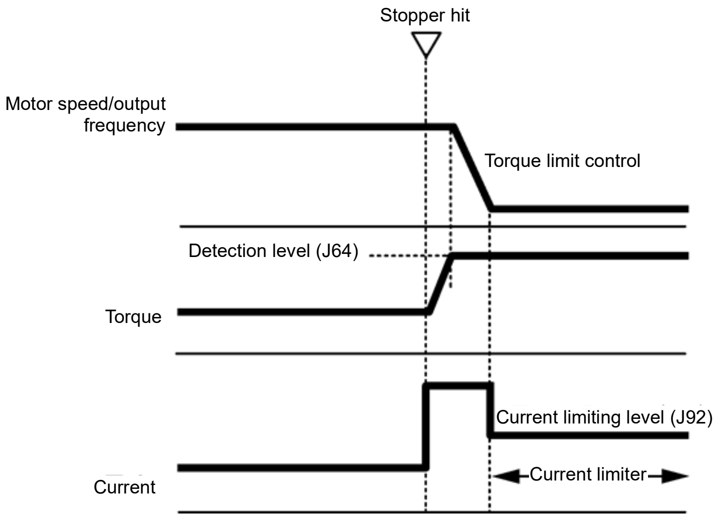
Note

- When overload stop function operation begins, that mode is maintained, preventing re-acceleration. To accelerate, turn OFF the run command, and then turn it back ON again.
- Under vector control with sensor and sensorless vector control, the J65 = 3 Contacting the stopper function is disabled.
- The motor may overheat if stopped for a long period of time with the Contacting the stopper function.
- If using the Contacting the stopper function for lifting applications, be sure to use in combination with the machine brake.
- Even if J65 is set to 3, if normal torque limiting is enabled first during acceleration, etc., the Contacting the stopper function will be disabled. Set the operation mode (J66) and timer time (J67) to ensure that the Contacting the stopper function is enabled after the normal torque limit operation ends.

FUNCTION CODES
Chap 5
FUNCTION
F Codes
E Codes
C Codes
P Codes
H Codes
A Codes
b Codes
r Codes
J Codes
d Codes
U Codes
y Codes
O Codes
K Codes



Operation selection J65 = 1, 2



Operation selection J65 = 3

■ **Operation Mode (J66)**

J66 specifies the inverter's operation condition under which the overload stop function is activated.

Carefully make this setting so as not to activate the overload stop function when it is not necessary.

J66 data	Operation mode
0	Enabled during constant speed and deceleration time.
1	Enabled during constant speed
2	Enabled always

■ **Timer (J67)**

Apply the timer (J67) to prevent the start of the overload stop function due to the instantaneous, unintended load fluctuation. The overload stop function is activated when the operation condition has continued for specified timer J67 (if J65 = 1, 2).

If J65 = 3, the timer time will be the time until the Contacting the stopper function is enabled after switching to J66 operation mode. Set at such times as when waiting time is necessary until the Contacting the stopper function is enabled after the motor reaches a constant speed.

■ **Enable overload stop "OLS" (📖 Function codes E01 to E05, data = 46)**

A digital signal can be used to temporarily enable and disable the overload stop function. If "OLS" is not assigned to any terminal, the overload stop function is always valid. Overload stop is not performed when OFF. By turning OFF the "OLS" signal when the motor is stopped due to an overload stop to disable overload stop, the motor will restart, and therefore caution is advised.

■ **Torque limiting P (Gain) (J90)**

If the torque limiting operation response is slow when the Contacting the stopper function is selected, increase the gain, and if hunting occurs, decrease the gain.

■ **Torque limiter I (Integral time) (J91)**

If the torque limiting operation response is slow when the Contacting the stopper function is selected, decrease the integral time, and if hunting occurs, increase the integral time.

■ **Current command level (J92)**

Compensates the current command during current control with the Contacting the stopper function. By increasing the setting value, the holding torque increases, but an inverter overload alarm (OLU) or motor overload alarm (OL1) may occur, possibly resulting in mechanical system vibration.

[6] Brake control signal

J68 to J72 J95, J96 H180 d120 to d125	**Brake signal (Brake-release current, Brake-release frequency/speed, Brake-release timer, Brake-apply frequency/speed, Brake-apply timer) Brake signal (Brake-release torque, Operation selection) Brake control signal (Check time for brake operation) For brake signal reverse rotation (Brake-release current, Brake-release frequency/speed, Brake-release timer, Brake-release torque, Brake-apply frequency/speed, Brake-apply timer) Related function codes: A98 Motor 2 (Function selection)**

The brake (release/apply) control signal is useful for lift applications such as hoists. This signal is adjustable with these function codes. It is possible to set the release and apply conditions based on these signals (current, frequency) so that a hoisted load does not fall down at the start or stop of the operation, or so that the load applied to the brake is reduced. The inverter is also equipped with dedicated reverse rotation function codes, allowing individual adjustments to be made with forward rotation or reverse rotation if conditions differ when rising and falling.

■ **Brake signal “BRKS” assignment (Function code E20 to E22, E27, data = 57)**

This signal outputs a brake control command that releases or applies the brake.

Releasing the Brake

When the inverter output current and output frequency exceeds the specified level for the brake control signal (J68/J69/J95) for the period specified by J70 (Brake control signal (Brake-release timer)), the inverter judges that required motor torque is generated and turns the signal “BRKS” ON for releasing the brake.

This prevents a hoisted load from falling down due to an insufficient torque when the brake is released.

Function codes	Name	Permissible setting range	Remarks
J68	Brake-release current	0.00 to 300.00%	Set the inverter rated current as 100%.
J69	Brake-release frequency/speed	0.0 to 25.0 Hz	
J70	Brake-release timer	0.000 to 5.000 s	
J95	Brake-release torque	0.00 to 300.00%	Set the motor rated torque as 100%.

Note Resolutions of function codes related to brake signals are different from the FRENIC-Ace(E2).

■ Check brake signal "BRKE" (Function code E20 to E21, data = 65)

If the status of Machine brake signal control "BRKS" fails to agree with the status of Check brake "BRKE" during inverter operation, the inverter enters an alarm stop state with Er6.

This signal is used as a feedback signal for the Machine brake signal control "BRKS." When the mechanical brake does not operate, it causes the inverter to trip to activate the mechanical brake. The response delay time for "BRKS" and "BRKE" can be adjusted with H180: Brake response time.

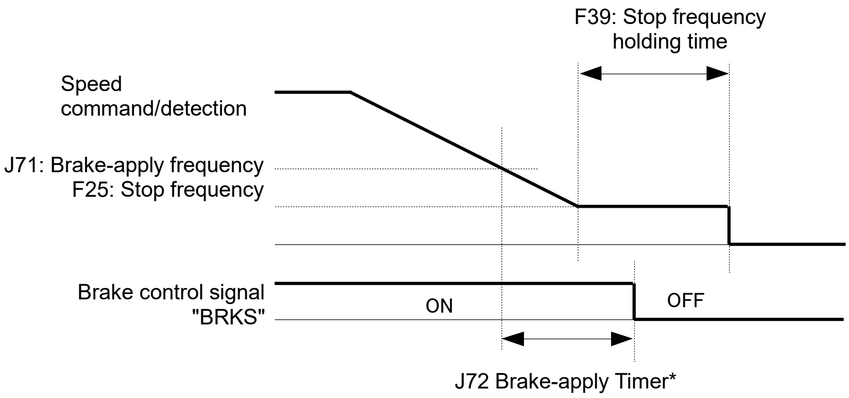
H180: Brake signal operation check time, setting range: 0.00 s to 10.00 s

Applying the brake

When the run command is OFF and the output frequency drops below the level specified by J71 (Brake control signal (Brake-applied frequency/speed)) and stays below the level for the period specified by J72 (Brake control signal (Brake-applied timer)), the inverter judges that the motor rotation is below a certain level and turns the signal "BRKS" OFF for activating (applying) the brake.

This operation reduces the load applied to the brake, extending lifetime of the brake.

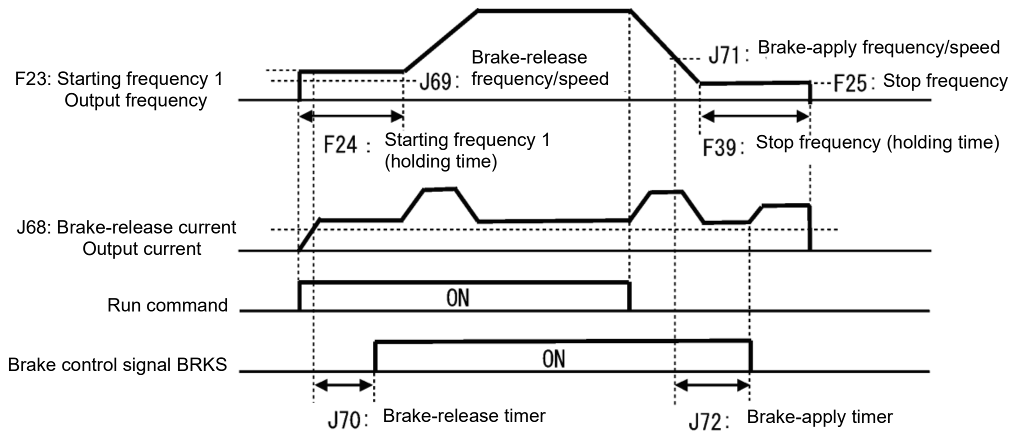
Function codes	Name	Permissible setting range	Remarks
J71	Brake-apply frequency/speed	0.0 to 25.0 Hz	
J72	Brake-apply timer	0.000 to 5.000 s	
J96	Brake signal (Operation selection) (Only available when using vector control with sensor)	0 to 31 (decimal format) Operation speed (bit 0) 0: Detected speed 1: Reference speed	Specifies the criteria of speed to be used for Brake-apply condition.
		Condition of brake-apply control signal (Bit 4) 0: Regardless of run command status (ON or OFF) 1: Only when run command is OFF	Specifies whether to turn off a brake control signal independent of a run command ON/OFF or only when a run command is OFF. When forward and reverse operations are switched, brake-applied conditions may be met in the vicinity of zero speed. For such a case, select "Only when a run command is OFF" (Bit 4 = 1).



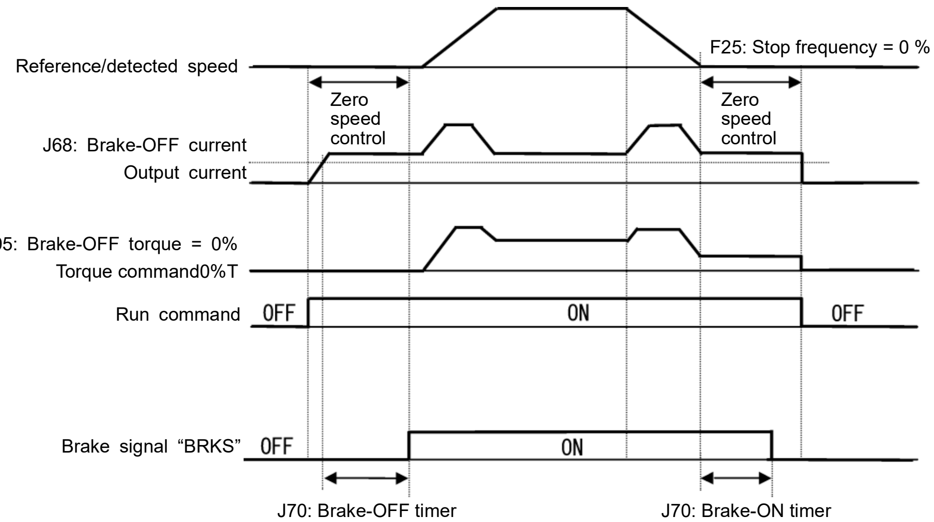
* If inverter output was turned off before the timer counts up, then the brake is applied.

Note

- Brake signals are valid only for motor 1, and when motor 2 is selected by switching the motor, the brake signal turns ON. However, brake signals are also enabled with A98.
- When the inverter is shut down due to an alarm status or coast to stop command, the brake control signal is immediately applied.
- The stop is determined after the output frequency exceeds "F25 stop frequency + E30 frequency arrival hysteresis range", and then the output frequency falls below F25.
  To inch the motor (repeatedly turn ON and OFF the run command in a short time), adjust F25 and E30.



Operation time chart under v/f control



Vector control with sensor

Note

- J71 can be used even under vector control with sensor.
- If using with zero speed control under vector control with sensor, set the J95 brake-release torque to 0%.
- If the brake is released at zero speed, use torque bias.
- If the brake is applied (brake signal OFF) to stop the motor after releasing the brake (brake signal ON) and performing operation, turn the inverter run command OFF and then back ON again in order to release the brake (brake signal ON) to resume operation.
- The brake release signal is not output during auto tuning (stop mode).

■ Dedicated reverse rotation brake signal function codes

If necessary to make individual adjustments with forward rotation or reverse rotation, do so with the following dedicated reverse rotation function codes. If data = 999, operation will be performed with the J code function code setting value.

Function code	Name	Permissible setting range	Remarks
d120	Brake-release current	0.00 to 300.00%, 999: operation based on J68 setting value	100% = inverter rated current
d121	Brake-release frequency/speed	0.0 to 25.0 Hz, 999: operation based on J69 setting value	
d122	Brake-release timer	0.000 to 5.000 s, 999: operation based on J70 setting value	
d123	Brake-release torque	0.00 to 300.00%, 999: operation based on J95 setting value	100% = motor rated torque
d124	Brake-apply/speed	0.0 to 25.0 Hz, 999: operation based on J71 setting value	
d125	Brake-apply timer	0.000 to 5.000 s, 999: operation based on J72 setting value	

[7] Positioning control

J73 to J88 | **Positioning control**

Simplified positioning is possible with the feedback signal from PG.

The feedback signals are counted within the inverter, operation starts from the set start point, and deceleration starts and the system switches to low-speed operation until the set stop position is reached.

The positioning control function can be used at the same time as pulse string input and speed control with PG.

■ Related function codes used for position control

The following table contains a list of related function codes used for position control.

Table 5.3-5 Function code list

Function code	Name	Permissible setting range	Unit	Factory shipment value	Change when running
From E01 to E05, E98, E99	Terminal [X1] to [X5} (Function selection)	42 (1042): Activate the limit switch at start point "LS" 43 (1043): Start/Reset "S/R" 44 (1044) Switch to the serial pulse receiving mode "SPRM" 45 (1045) Enter the return mode "RTN"	-	-	×
E20, E21, E27	Terminal Y1 (Function selection) Terminal Y2 (Function selection) Terminal 30ABC (Function selection)	80 (1080): Stop position override alarm "OT" 81 (1081): Positioning "TO" 82 (1082): Positioning complete "PSET" 83 (1083): Current position pulse overflow "POF"	-	-	×
J73	Positioning control (Start timer)	0.0: Timer disabled 0.1 to 1000.0: Timer value	s	0.0	○
J74	(Start point: upper digit)	-999 to 999	p	0	○
J75	(Start point: lower digit)	[P]: Absolute value, 0 to 9999*1	p	0	○
J76	(Z point: upper digit)	-999 to 999	p	0	○
J77	(Z point: lower digit)	[P]: Absolute value, 0 to 9999*1	p	0	○
J78	(Creep speed switching point: upper digit)	0 to 999	p	0	○
J79	(Creep speed switching point: lower digit)	0 to 9999	p	0	○
J80	(Creep speed)	0 to 400	Hz	0	○
J81	(Stop target point: upper digit)	-999 to 999	p	0	○
J82	(Stop target point: lower digit)	0 to 9999	p	0	○
J83	(Permissible range)	0 to 9999	p	0	○
J84	(End timer)	0.0: Timer disabled 0.1 to 1000.0: Timer value	s	0.0	○
J85	(Coasting compensation)	0 to 9999	p	0	○
J86	(Stop position command method)	0: Sign/pulse 1: Forward/reverse pulse	-	0	○
J87	(Z point compensation direction)	0: Allowed in the forward direction only 1: Allowed in the reverse direction only 2: Allowed in both the forward and reverse directions	-	0	×
J88	*2 (Current position pulse pole)	0: Forward direction 1: Reverse the detection direction sign	-	0	×

*1 You can change the [P] setting by pressing simultaneously the STOP + ▼ keys when the data value "0" is displayed. The data value "0" can be changed from [P] using the STOP + ▲ keys.

*2 If the detection polarity was reversed due to faulty PG wiring, you can reverse the detection polarity with J88 without changing the wiring.

■ **Functional description**

The encoder output pulse is counted within the inverter using the PG option, operation starts from the set start point (S point), deceleration starts and the system switches to low-speed operation until the set stop position (E point) is reached.

The positioning control function starts the positioning operation when both the start/reset signal “S/R” terminal and the run command are ON.

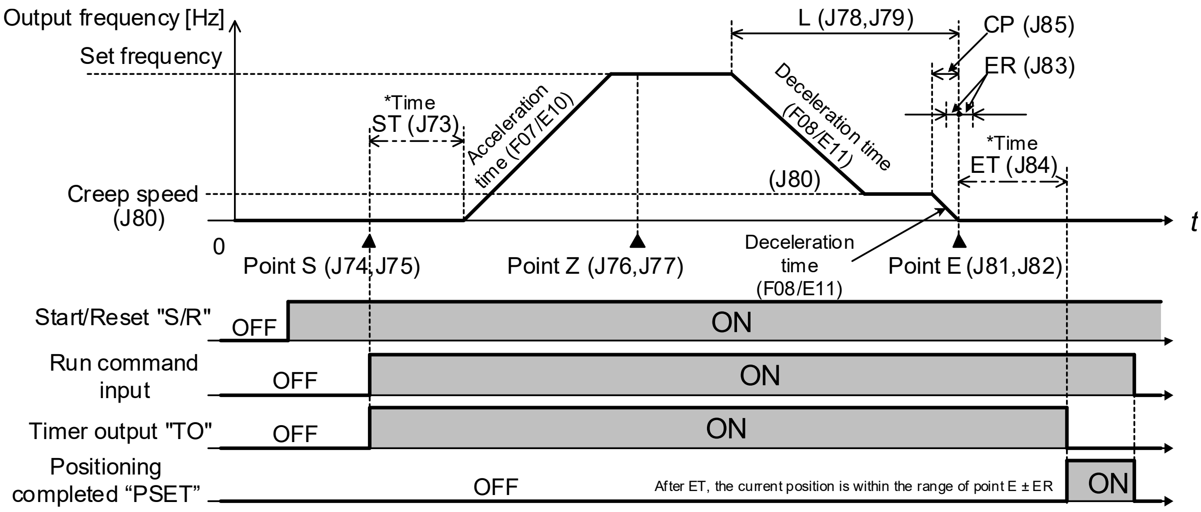


Figure 5.3-1 Positioning control function run pattern

Note

- The positioning control function is available only when motor 1 is selected.
- During the jogging operation (inching), the positioning control function is disabled during PID control (J01 ≠ 0).
- If undervoltage occurs during positioning control, the Ero alarm occurs and the restart after momentary power failure operation (F14) is not performed.
- The retry function (H04, H05) is disabled during positioning control.

Tip The status during positioning control can be monitored with the keypad Menu number 3 “Drive Monitoring” (refer to Chapter 3). (📖: Function code E52)

■ **Symbol list**

The symbols in Figure 5.3-1 are shown in Table 5.3-6.

Table 5.3-6 Symbol list

Symbol	Name	Function codes	Content
S point	Start point	J74, J75	Sets the data of the position where positioning starts. The way the start position data is handled differs when the start point setting is displayed as [P] (absolute position) and when it is displayed as setting values other than [P] (relative position).
			[Absolute position] When the start point setting = [P], the current position is the start position. The positioning starts with the current position pulse count as the start position data. [Example] When the current position pulse is 10,000 pulses, start point setting = [P], and stop position (E point) setting = 20,000 pulses. In this case, the current position 10,000 is handled as the start position data and, when the positioning starts, the position moves to 20,000 with a travel pulse count of 10,000 (20,000 - 10,000).
			[Relative position] When the start point setting = a (≠ [P]), the current position data is replaced. Regardless of the current position, when the positioning starts, the current position is replaced with the “a” pulse of the start point setting and positioning starts with this setting as the start position data. [Example] When the current position pulse is 10,000 pulses, start point setting a = 4,000 pulses, and stop position (E point) setting = 20,000 pulses. In this case, the current position data changes from 10,000 to 4,000 when the positioning starts and the position moves from 4,000 (the start position) to 20,000 with a travel pulse count of 16,000 (20,000 - 4,000).
ST	Start timer	J73	Specifies the waiting time until the motor operation starts when both the “S/R” terminal and the run command are ON (it corresponds to the brake-release delay). The ST count does not start if the output frequency is already ≠0 Hz (during inverter output) when the “S/R” terminal is ON.
Z point	Position preset	J76, J77	The current position is corrected to the position data set as the position preset (Z point) when the first Z signal Low is detected as High after the “LS” terminal changes from OFF to ON. This corresponds to a mechanical position compensation and origin reset. However, Z point compensation is not performed when the position preset setting is [P]. ・Position preset setting = a (≠ [P]) ・Position preset setting = [P] (Z point compensation not performed) It is also possible to limit the rotation direction of Z point compensation via “LS” terminal input using J87.
L	Creep speed switching point	J78, J79	This is the pulse count (set as an absolute value) from the stop position (E point) where the deceleration starts toward the creep speed (J80).
CP	Coasting compensation	J85	Specifies the position where to start deceleration-to-stop in front of the stop position (E point) as a pulse count from the E point. Set this function taking the inertia when performing deceleration-to-stop into consideration.
E point	Stop target point	J81, J82	This is the target stop position.
ER	Stop target point permissible range	J83	This is the permissible range for the difference between the stop position (E point) and the real stop point. At the end of the stop ET after the positioning completion, when │real stop point – E point│≦ ER, the “PSET” signal is output after the positioning completion. when │real stop point – E point│> ER, the stop position override alarm “OT” is output.

ET	End timer	J84	The waiting time until it becomes possible to input the next positioning start signal after the system stops at the stop position. After the system stops at the positioning completion, the positioning complete signal “PSET” or the stop position override alarm “OT” is output after this timer ends or after 0.5 seconds if ET < 0.5 seconds. If the run command OFF is input during the ET count, the ET count stops and neither the “PSET” nor the “OT” signals are output. “PSET” and “OT” are guaranteed to be output for at least 100 ms.

■ Input/output terminal functions

Table 5.3-7 List of I/O terminal functions

Terminal functions	Terminal name	Description
Activate the limit switch at start point	“LS” Limit Switch	Terminal used when replacing the current position with the position preset (Z point) setting value (Z point compensation). The encoder Z signal that is input first after the “LS” terminal is changed from OFF to ON changes from Low to High. After ON↑: With the change of the Z signal from Low to High, the current position is replaced by the position preset (Z point) setting value of J76 and J77. Other than the above: Nothing is performed.
Start/Reset “S/R”	Start/Reset	Terminal used to enable/disable the positioning control function. ON: Positioning control function enabled (operation possible) OFF: Positioning control function disabled (operation not possible)
Switch to serial pulse receiving mode	“SPRM” Serial Pulse Receiving Mode	Depending on the function code setting, when the serial pulse reception input shares the terminal with pulse input for other functions (positioning control function and pulse string input or speed control with PG), the PG input pulse is counted as the stop position while the “SPRM” terminal is ON. ON: Serial pulse receiving mode enabled OFF: Serial pulse receiving mode disabled However, when the serial pulse reception input is assigned exclusively to PG input (only the positioning control function), the pulse count received is the stop position regardless of the ON/OFF state of the “SPRM” terminal. In both cases, the pulse count received (= stop position J81, J82) is cleared to “0” when the “SPRM” terminal is turned from OFF to ON.
Enter the return mode	“RTN” Return Mode	When the positioning starts with the “RTN” terminal to ON, the operation is carried in the reverse direction with the current S point and E point settings. This terminal is used to move from the start point (S point) to the stop point (E point) and then to return to the start point (S point). It is possible to perform back-and-forth movement positioning. ON: Return mode enabled OFF: Return mode disabled When performing the return operation, set the terminal command “RTN” to ON before using the terminal command “S/R” and the run command.

Note The operation to clear the received pulse count (=stop position J81, J82) to “0” by setting the “SPRM” terminal from OFF to ON is always enabled.

Pay attention when you operate the system since the stop position will be cleared to “0” if you set the terminal OFF⇒ ON inadvertently.

Tip When using the positioning control function and speed control with PG or pulse string input at the same time, the [XA], [XB], [XZ], [YA], [YB], and [YZ] inputs differ from what is shown in the table above. Refer to Table 5.3-13.

Table Output terminal functions

Terminal functions	Terminal name	Description
Stop position override alarm	“OT” Over Stop position	**ON condition** ET ends (after 0.5 s. when ET < 0.5 s.) when ｜real stop point - stop position (E point)｜> ER set value **OFF condition** Conditions other than the above
Positioning	"TO" Timer Output	**ON condition** From the start of the start timer (J73) to the end of the end timer set time **OFF condition** Conditions other than the above and when the output frequency is 0 Hz after a cancellation
Positioning complete	"PSET" Position SET	**ON condition** ET ends (after 0.5 s. when ET < 0.5 s.) When ｜real stop point - stop position (E point)｜≦ ER set value **OFF condition** Conditions other than the above
Current position pulse overflow	"POF" Position Overflow	**ON condition** The “POF” signal is output when the current position pulse is outside the -9,999,999 to +9,999,999 range, regardless of the ON/OFF state of the “S/R” terminal input that shows the enabled/disabled state of the positioning control function. **OFF condition** When the value returns within the range after being outside. When the run command is set to ON while “S/R” terminal is ON. When Z point compensation is performed.

■ **Monitor-related items**

With the positioning control function, the status of the function and the pulse count can be monitored using the keypad. The monitor-related items are as follows in the LED monitor and menu number 3 “Drive Monitoring.”

Table 5.3-9 LED monitor (function code E43 setting value)

E43 Data	Monitor items	Unit	Content	Refer to:
21	Current position	p	Displays the current position pulse count.	Table 5.3-11
22	Positioning deviation	p	Displays the deviation between the current position pulse count and the stop position pulse count.	

Table 5.3-10 Keypad menu #3 “Operation monitor”

LED monitor display	Monitor items	Unit	Content	Refer to:
3_17	Stop position	p	Displays the pulse count of the position when positioning is complete. Displays the stop position J81, J82 when the “RTN” terminal is OFF and the start point J74, J75 when the terminal is ON.	Table 5.3-11
3_18	Current position	p	Displays the current position pulse count.	

3. 19	Positioning deviation	p	Displays the deviation between the current position pulse count and the stop position pulse count.	
3.20	Positioning control function status monitor	-	Displays the number of the positioning control function status shown in Fig. 5.3-2	Fig. 5.3-2

■ Displaying system on the LED monitor

The LED monitor and operation monitor display the pulse count in the -9,999,999 pulses to +9,999,999 pulses range. To display it, the 4-digit LED monitor shows alternately the upper and lower four digits for one second and three seconds, respectively. The display repeatedly alternates between higher order digits 1 sec → 4 lower order digits 3 sec → higher order digits 1 sec → 4 lower order digits 3 sec →When the lower order digits are displayed, a dot "." is added after the last digit.

Table 5.3-11 Displaying system for pulse count

Pulse count	LED monitor on remote keypad, multi-function keypad, operation monitor on remote keypad		Remarks
	4 higher order digits	4 lower order digits	
+9,999,999	+999	9999.	Maximum display value
+19,999	+ 1	9999.	Zeros are not suppressed in higher order digits.
+10,000	+ 1	0000.	
+9,999	+ 0	9999.	
+10	+ 0	0010.	
0	0	0000.	
-10	- 0	0010.	
-9,999	- 0	9999.	
-10,000	- 1	0000.	
-19,999	- 1	9999.	
-9,999,999	-999	9999.	Minimum display value

■ Positioning control function status

Control statuses can be monitored with the positioning control function. A status example is shown in Fig. 5.3-2 and explanations are given in Table 5.3-12.

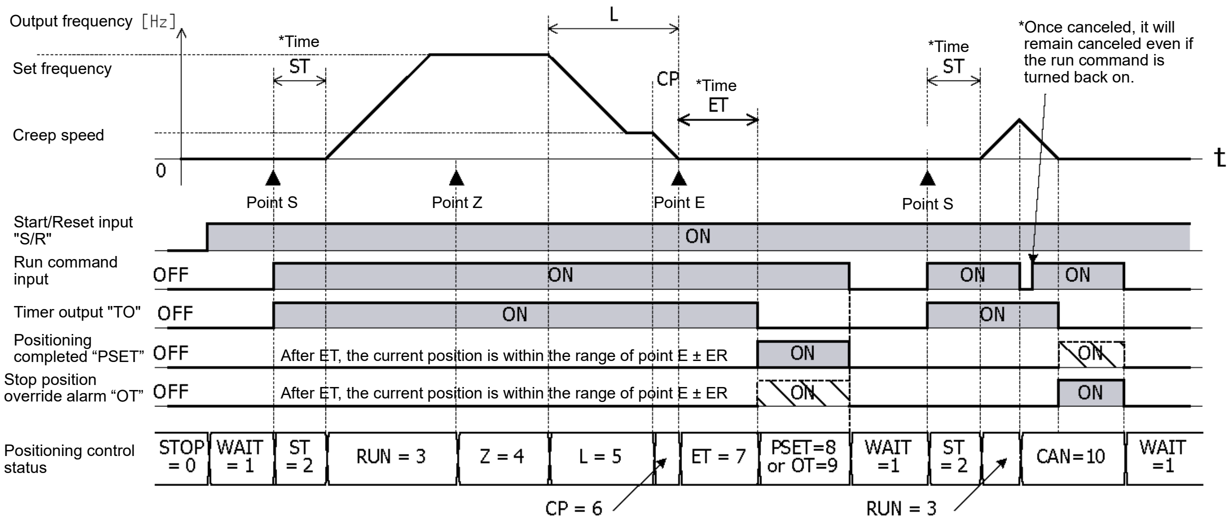


Fig. 5.3-2 Positioning control function status example

Table 5.3-12 Status name/number and description in the positioning control function

Positioning control function status	Status name *1	Status No. *2	Description
Positioning control function stopped	STOP	0	"S/R" is OFF. The status changes to "WAIT = 1" when waiting for the run command with "S/R" ON. However, if the output frequency is other than 0 Hz (with gate output) when "S/R" is ON, ST count is not performed and the status changes to "Running: RUN = 3."
Waiting for run command	WAIT	1	"S/R" is ON and the run command is OFF. The status changes to "ST count: ST = 2" when the run command turns ON in this status. When the set value of the start timer (J73) is 0.0 sec, the status changes from "WAIT = 1" to "RUN = 3."
ST count	ST	2	ST count is being performed with both "S/R" ON and the run command ON. The status changes to "Running: RUN = 3" when the ST count is complete.
Running	RUN	3	The status until the current position ≥ (E point - L position) or until Z point compensation is performed. (During forward rotation) The status until the current position ≦ (E point + L position) or until Z point compensation is performed. (During reverse rotation)
Z point compensation complete	Z	4	The status changes to this status when Z point compensation is performed during "Running: RUN = 3."
Running at creep speed	L	5	Status when deceleration is being performed to reach the creep speed (J80) or when running at creep speed.
Stop operation	CP	6	Deceleration has stopped because the current position ≥ (E point - CP position). Deceleration has stopped because the current position ≤ (E point + CP position).
ET count	ET	7	ET count is being performed.
Positioning complete	PSET	8	Displays the positioning complete status. "PSET" is being output.
Stop position override alarm	OT	9	The stop point error warning status. OT is being output.
Cancel stop	CAN	10	The status changes to "Cancel stop: CAN = 10" when the positioning control function operation has been canceled between "ST = 2" and "ET = 7". After the operation has been stopped, the positioning control function running status "TO" is turned off and the positioning completion signal "PSET" or stop point error warning "OT" is output. Note that the canceled status is maintained and the reference frequency is forcibly maintained at 0 Hz after "Cancel stop: CAN = 10" has occurred and until the run command is turned OFF.

*1 The status name can be referenced in the "Drive Monitoring" menu on the LCD monitor of multi-function keypad.

*2 The status number is displayed on the LCD screen of the operation monitor with the multi-function keypad and in Menu 3_20 with the remote operation keypad.

■ Serial pulse receiving function

When the "S/R" function is assigned to X terminal and the serial pulse receiving setting is enabled, you can set the stop position (E point) with pulse input from the host equipment.

The pulse count that has been calculated is applied to the stop position (J81, J82).

The pulse input type for serial pulse reception is set with J86.

Note When the serial pulse reception input terminal is used in common with other function terminals, the PG input pulse is calculated as the stop position with serial pulse reception only when the "SPRM" terminal is ON.

However, when the serial pulse reception input is assigned to a dedicated terminal, the pulse count received is the stop position regardless of the ON/OFF state of the "SPRM" terminal.

■ PG terminal assignment when used in combination with other functions

When using the positioning control function and speed control with PG or pulse train input at the same time, the [XA], [XB], [XZ], [YA], [YB], and [YZ] inputs are assigned as shown in Table 5.3-13.

The assignment differs when the inputs for the positioning control function are used independently.

Table 5.3-13 PG terminal function assignment

<table>
<tr><th>Pulse string input
F01/C30 = 12</th><th>Speed control with PGF42/A14= 3,4</th><th>Positioning control "S/R" assignment</th><th>Normal</th><th>Serial pulse receiving mode
"SPRM" terminal ON</th></tr>
<tr><td rowspan="8">N/A</td><td rowspan="4">N/A</td><td rowspan="2">N/A</td><td>X: Pulse monitor</td><td rowspan="2"></td></tr>
<tr><td>Y: Pulse monitor</td></tr>
<tr><td rowspan="2">Yes</td><td colspan="2">X: Serial pulse (J86)</td></tr>
<tr><td colspan="2">Y: Positioning control</td></tr>
<tr><td rowspan="4">Yes</td><td rowspan="2">N/A</td><td>X: Pulse monitor</td><td rowspan="2"></td></tr>
<tr><td>Y: Speed control</td></tr>
<tr><td rowspan="2">Yes</td><td>x: Positioning control</td><td>X: Serial pulse (J86)</td></tr>
<tr><td colspan="2">Y: Speed control</td></tr>
<tr><td rowspan="8">Yes</td><td rowspan="4">N/A</td><td rowspan="2">N/A</td><td>X: Pulse train input</td><td rowspan="2"></td></tr>
<tr><td>Y: Pulse monitor</td></tr>
<tr><td rowspan="2">Yes</td><td>X: Pulse train input</td><td>X: Serial pulse (J86)</td></tr>
<tr><td colspan="2">Y: Positioning control</td></tr>
<tr><td rowspan="4">Yes</td><td rowspan="2">N/A</td><td>X: Pulse train input</td><td rowspan="2"></td></tr>
<tr><td>Y: Speed control</td></tr>
<tr><td rowspan="2">Yes</td><td>X: Pulse train input</td><td>X: Serial pulse (J86)</td></tr>
<tr><td colspan="2">Y: Speed control/positioning control</td></tr>
</table>

In the table, the "X" indicates the [XA], [XB], and [XZ] terminals while the "Y" indicates the [YA], [YB], and [YZ] terminals.

The positioning control function cannot be used with vector control with sensor (induction motor) (F42 = 6) and sensorless vector control (PMSM) (F42 = 15).

When switching to the serial pulse receiving mode with the “SPRM” terminal, set the following dead times since the input type changes.

Table 5.3-14 Input specifications when switching modes with “SPRM”

Function switching	When “SPRM” changes from ON to OFF	When “SPRM” changes from OFF to ON	Remarks
Positioning control ⇔Switch to the serial pulse receiving mode	Start the serial pulse reception input at least 100 ms after OFF ⇒ ON.	Do not input within 100 ms before and after ON⇒OFF.	-
Pulse string input ⇔Switch to the serial pulse receiving mode		Stop the serial pulse reception input at least 100 ms before ON ⇒ OFF. Also, resume the pulse string input at least 100 ms after ON ⇒OFF.	The pulse string input value when “SPRM” switches OFF⇒ON is held for the serial pulse receiving mode time (while “SPRM” is ON) +100 ms.

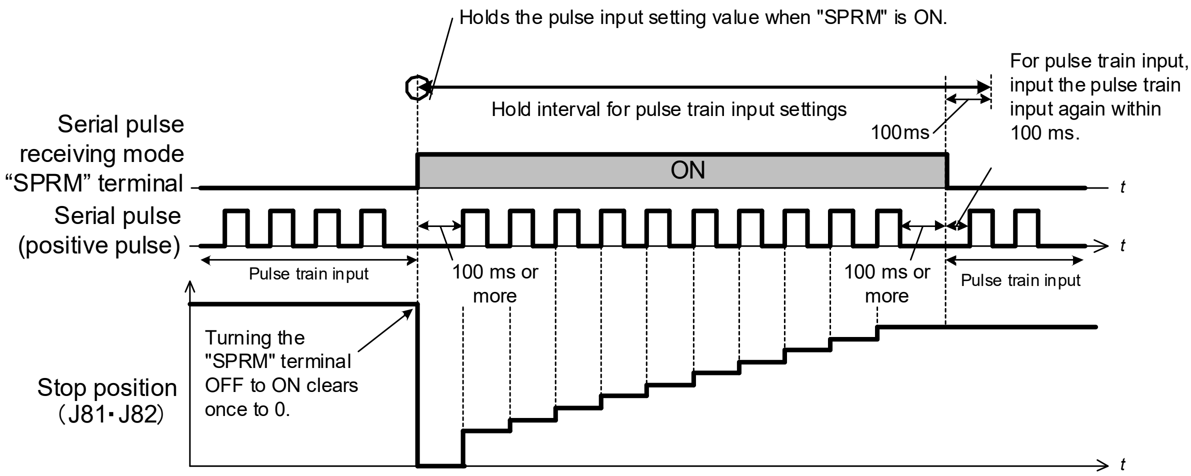


Table 5.3-3 Switching between pulse string input and serial pulse reception

FUNCTION CODES
Chap 5
FUNCTION
F Codes
E Codes
C Codes
P Codes
H Codes
A Codes
b Codes
r Codes
J Codes
d Codes
U Codes
y Codes
O Codes
K Codes

J97 to J99	Servo lock (Gain, Completion timer, Completion range)

■ Servo lock

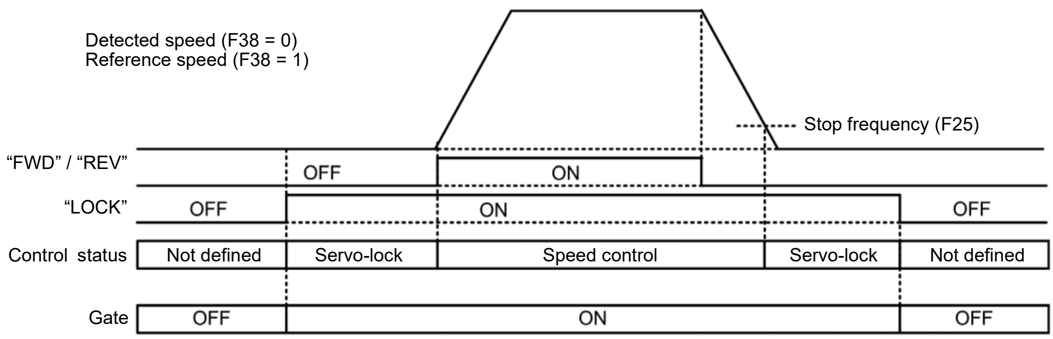
This function holds the motor within the positioning completion range specified by J99 for the period specified by J98 even if an external force applies to the motor. The servo lock function is available only at vector control with speed sensor (F42 = 6, 16). By assigning servo lock command “LOCK” to the digital input terminal and turning it ON, the servo lock function is enabled.

Note The servo lock operates at low speed, and if used with an external force applied for a long period of time, there is a risk of overheat protection being triggered. Inverter output will be at low frequency when the servo lock is applied, and therefore the servo lock should be used in the “current rating 150%/3 s,” “80%/continuous” range to act as inverter thermal limiting. (The carrier frequency is automatically limited to the upper limit of 5 kHz.)

■ Startup conditions of servo lock

	Servo lock control starts when the following conditions are met:	
	F38 = 0 (Use actual speed as a decision criteria)	F38 = 1 (Use reference speed as a decision criteria)
1	Run command OFF, or Reference frequency < Stop frequency (F25)	
2	“LOCK” (“Servo lock command”) ON (Assignment of “LOCK” (E01 to E05 data = 47))	
3	The actual speed is less than the stop frequency (F25).	The reference speed is less than the stop frequency (F25).

■ Operation examples



Typical control sequence of servo lock

⚠WARNING

When the servo lock command is ON, the inverter keeps on outputting voltage on output terminals [U], [V] and [W] even if a run command is OFF and the motor seems to be in stop state.

Failure to observe this could result in electric shock.

■ **Specifying servo lock control**

Positioning complete signal “PSET” assignment (E20 to E21, E27: function code data = 82), servo lock (completion timer) (J98), servo lock (completion range) (J99)

When the servo lock ends, and the motor is held in the range set at servo lock (completion range) (J99) for the length of time set at servo lock (completion timer) (J98), an ON signal is output as the in-position signal.

Data setting range J98: 0.000 to 1.000 (s)

Data setting range J99: 0 to 9999 (pulses)

■ **Servo lock (Gain) (J97)**

J97 specifies the gain of the servo lock positioning to adjust the stop behavior and shaft holding torque against an external force.

J97	Small ⟵⟶ Large
Stop behavior	Response slow, but smooth ↔ Response quick, but hunting might occur.
Shaft holding torque	Small ↔ Large

Data setting range: 0.000 (servo lock disabled), 0.001 to 9.999 (times)

■ **Servo lock precautions**

(1) Positioning control error Ero

If a positioning error exceeds the value equivalent to four rotations of the motor shaft when the inverter is servo locked, the inverter issues a positioning control error signal Ero.

(2) Stop frequency (F25) under servo lock

Since servo lock starts when the output frequency is below the stop frequency (F25), it is necessary to specify such F25 data that does not trigger Ero (that is, specify the value equivalent to less than 4 rotations of the motor shaft).

Stop frequency (F25) < (4 x Gain (J97) x Maximum output frequency (F03/A01))

(Example) When Gain (J97) = 0.01 and Maximum output frequency (F03/A01) = 60 Hz, specify F25 data < 2.4 Hz.

(3) The following functions are ignored in the servo lock mode

- Frequency/speed control specified with the stop frequency
- Rotation direction limitation

5.3.10 J1 codes (Application Functions)

J105	PID control (Display unit)

Units can be displayed when using the multi-function keypad (TP-A2SW).

This function code selects the PID control display unit. When using PID control, data such as PID command values (SV), feedback values (PV), and control input (MV) can be monitored on the keypad. This function code is used to set the respective data display units.

If performing PID control with the same unit and at the same scale as feedback values, there is no need to change the J105 settings.

Set if wishing to perform PID control for feedback values with another unit or scale.

Use with J105 set to “0” if using with the unit selected at feedback.

J105	Display unit	J105	Display unit	J105	Display unit
0	*	26	GPS	49	inHg
1	No unit	27	GPM	50	WC
2	%	28	GPH	51	Ft WG
4	r/min	29	CFS	52	ATM
7	kW	30	CFM	60	K (temperature)
8	HP	31	CFH	61	°C (temperature)
10	mm/s	32	kg/s	62	°F (temperature)
11	mm/m	33	kg/m	65	Nm
12	mm/h	34	kg/h	66	lb Ft
13	m/s	35	lb/s	70	mm
14	m/min	36	lb/m	71	cm
15	m/h	37	lb/h	72	m
16	FPS	38	AF/Y	73	km
17	FPM	40	Pa (pressure)	74	in
18	FPH	41	kPa (pressure)	75	Ft
19	SPM	42	MPa (pressure)	76	Yd
20	m^3/s (flow)	43	mbar (pressure)	77	mi
21	m^3/min (flow)	44	bar (pressure)	80	ppm (concentration)
22	m^3/h (flow)	45	mmHg (pressure)	90	m^3
23	L/s (flow)	46	Psi (pressure)	91	L
24	L/min (flow)	47	mWG (pressure)	92	GAL
25	L/h (flow)	48	inWG (pressure)	93	OZ

* The units and scales for feedback values are used.

PID display coefficient and monitoring

To monitor the PID command and its feedback value, set the scale to convert the values into easy-to-understand physical quantities such as temperature. The display unit cannot be used on the standard keypad. Use with the multi-function keypad (TP-A2SW).

	Display unit	Maximum scale	Minimum scale
Terminal [12]	C58	C59	C60
Terminal [C1] (C1 function)	C64	C65	C66
Terminal [C1] (V2 function)	C70	C71	C72

For details on scales, refer to function codes C59, C60, C65, C66, C71, and C72, or to E43 for details on monitoring.

J106 J107	PID control (Maximum scale) (Minimum scale)

The PID control values can be converted to a physical quantity that is easy to recognize and displayed accordingly. J106 sets the maximum scale "display at 100% of the PID command value", and J107 sets the "display at 0% of the PID command value." The displayed value is determined as follows:

Display value = (PID command value (%)) / 100 * (Max. scale - Min. scale) + Min. scale

- Data setting range: (Max. scale and min. scale) -999.00 to 0.00 to 9990.00

If valid PID feedback signals (E61 to E63 = 5) are assigned to the analog input terminal, and J105 = 0 (factory default), the scale (C59, C60, C65, C66, C71 or C72) for the analog input terminal is applied for the scale.

J136 to J138	PID control (Multistep commands 1 to 3)

PID command values can be given by digital input PID multistep commands. Assign the digital input terminals with "PID-SS1" and "PID-SS2".

PID-SS2	PID-SS1	PID multistep command
OFF	OFF	Not selected
OFF	ON	J136: PID multistep command 1 setting range: -999.0 to -0.00 to -9990.0
ON	OFF	J137: PID multistep command 2 setting range: -999.0 to 0.00 to 9990
ON	ON	J138: PID multistep command 3 setting range: -999.0 to 0.00 to 9990

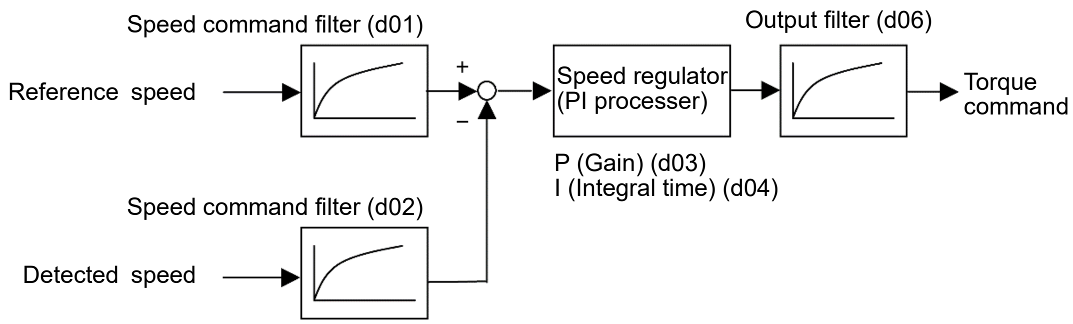
5.3.11 d codes (Application Functions 2)

[1] Speed control

d01, A43, b43, r43 **d02, A44, b44, r44** **d03, A45, b45, r45** **d04, A46, b46, r46** **d05, A47, b47, r47** **d06, A48, b48, r48**	**Speed control 1 to 4 (Speed command filter)** **(Speed detection filter)** **(P gain)** **(I integral time)** **(Feed forward gain)** **(Output filter)** **Reference function code: d25: ASR switching time**

These function codes are used to adjust speed control constants, allowing optimum speed control to be performed under V/f control with sensor, vector control with sensor, or sensorless vector control.

■ **Block diagram of the speed control algorithm**



■ **Selected speed constant switching**

In preparation for situations where it is necessary to change speed control constants due to changes in the load or machine conditions, FRENIC-Ace is equipped with 4 sets of speed control constants, allowing changes to be made with digital input terminal functions “MPRM1” and “MPRM2.”

■ **Speed command filter (d01/A43/b43/r43)**

d01 specifies the time constant determining the first order delay of the speed command filter.

- Data setting range: 0.000 to 5.000 (s)

Modify this data when an excessive overshoot occurs against the change of the reference speed.

Increasing the filter time constant stabilizes the reference speed and reduces overshoot against the change of the reference speed, but it slows the response speed of the inverter.

■ **Speed detection filter (d02/A44/b44/r44)**

d02 specifies the time constant determining the first order delay of the speed detection filter.

- Data setting range: 0.000 to 0.100 (s)

Modify this data when the control target (machinery) is oscillatory due to deflection of a drive belt or other causes so that ripples (oscillatory components) are superimposed on the detected speed, causing hunting (undesirable oscillation of the system) and blocking the PI processor gain from increasing (resulting in a slow response speed of the inverter). In addition, if a low encoder (PG) resolution makes the system oscillatory, try to modify this data.

Increasing the time constant stabilizes the detected speed and allows to raise the PI processor gain even with ripples superimposed on the detected speed. However, speed detection itself is delayed, resulting in a slower speed response, larger overshoot, or hunting.

■ **P (Gain) (d03/A45/b45/r45), I (integral time) (d04/A46/b46/r46)**

d03 and d04 specify the gain and integral time of the speed regulator (ASR), respectively.

By setting d04 = 999, the speed regulator (ASR) configuration can be changed from a PI regulator to a P regulator, allowing the integral term to be disabled.

- Data setting range: (d03) 0.1 to 200.0 (times)
  (d04) 0.001 to 9.999 (s), 999 (Cancel integral term)

P (Gain)

Definition of "P gain = 1.0" is that the torque command is 100% (100% torque output of each inverter capacity) when the speed deviation (reference speed – detected speed) is 100% (equivalent to the maximum speed). If the maximum output frequency (F03/A0) setting is changed, the P gain = 1.0 definition will change, and therefore the setting value should be reviewed.

Determine the P gain according to moment of inertia of machinery loaded to the motor output shaft. Larger moment of inertia needs larger P gain to keep the flat response during whole operation.

Specifying a larger P gain improves the quickness of control response, but may cause a motor speed overshooting or hunting (undesirable oscillation of the system). Moreover, mechanical resonance or vibration sound on the machine or motor could occur due to excessively amplified noise. If it happens, decreasing P gain will reduce the amplitude of the resonance/vibration. A too small P gain results in a slow inverter response and a speed fluctuation in low frequency, which may prolong the time required for stabilizing the motor speed.

I (Integral time)

Specifying a shorter integral time shortens the time needed to compensate the speed deviation, resulting in quick response in speed. Specify a short integral time if quick arrival to the target speed is necessary and a slight overshooting in the control is allowed; specify a long time if any overshooting is not allowed and taking longer time is allowed.

If a mechanical resonance occurs and the sound from the motor or gears is abnormal, setting a longer integral time can transfer the resonance point to the low frequency zone and suppress the resonance in the high frequency zone.

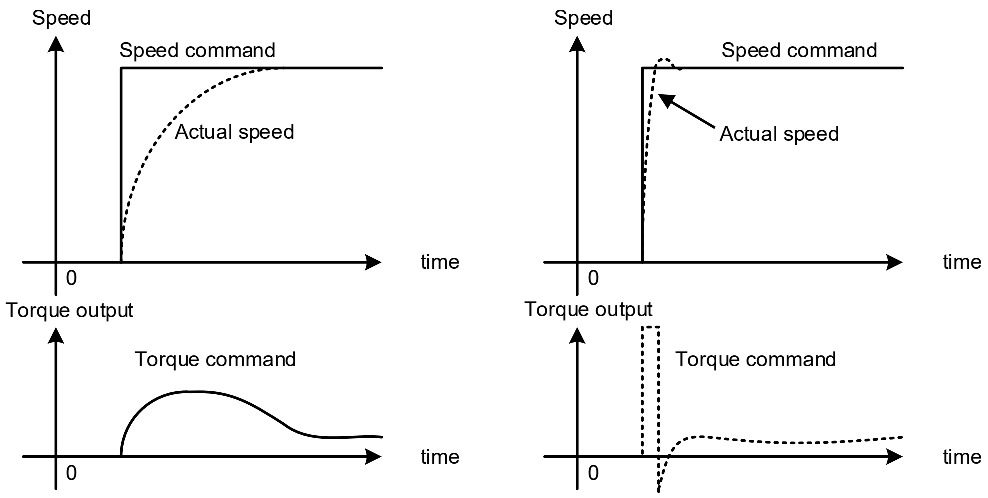
■ Feed forward (FF) gain (d05/A47/b47/r47)

The inverter operates the feed forward (FF) control that adds the acceleration torque calculated from the variation of speed command to torque command directly.

The PI control of ASR is feedback control and it makes the compensation operation against the result (actual speed detection value). Therefore, it can also control against the unpredictable disturbances or the uncertain characteristics of controlled factors also. However, it becomes a follow-up control even if the variation of speed command is already known. Since the operating amount (torque command) can be obtained in advance for known factors, more responsive control can be expected if the amount is added directly to the torque command. This is the function code for such control. Feed forward (FF) control is used to add the torque determined from the speed command change directly to the torque command.

Setting range: 0.00 to 99.99 (s)

This is valid if the load inertia is known beforehand. Conceptually, as it is shown in the following figure, the follow-up speed behavior against the actual speed command is clearly different between feed forward control enabled and disabled. However, to get the maximum effect, it is necessary to adjust this function code setting and the PI control settings value of the ASR.



The above-mentioned effect can be obtained by setting the P gain of ASR higher. However, the response of the system becomes faster in this setting and there is the possibility that it has a negative effect due to generation of vibration.

■ **Output filter (d06/A48/b48/r48)**

This specifies the time constant for the primary delay filter for speed regulator output.

Setting range: 0.000 to 0.100 (s)

This is used when machine resonance such as hunting or vibrations cannot be suppressed by adjusting the P gain or integral time. Generally speaking, the resonance amplitude can be decreased by increasing the output filter time constant, but increasing it too much may cause the system to become unstable.

■ **Select speed control parameters 1, 2 -- "MPRM1", "MPRM2" (E01 to E05 data = 78, 79)**

The combination of the ON/OFF states of digital input terminal functions "**MPRM1**" and "**MPRM2**" selects one of 4 different level speed control parameter sets.
These parameters are valid under vector control with sensor, V/f control with sensor, and sensorless vector control.

Input signal		Speed control constant
"MPRM2"	"MPRM1"	
OFF	OFF	Speed control constant 1: d01 to d06
OFF	ON	Speed control constant 2: A43 to A48
ON	OFF	Speed control constant 3: b43 to b48
ON	ON	Speed control constant 4: r43 to r48

■ **Relationship between motor switching and Select speed control parameters**

If neither speed control constant 1 "MPRM1" nor speed control constant 2 "MPRM2" has been assigned to a digital input terminal, by switching the motor with input terminal "M2," speed control constants 1 and 2 are assigned to motor 1 and motor 2, respectively.

If speed control constant 1 "MPRM1" and speed control constant 2 "MPRM2 has been assigned to a digital input terminal, by switching the motor with input terminal "M2," speed control constants 1 to 4 can be selected by the input terminals "MPRM1" and "MPRM2" for motor 1 and motor 2, respectively.

■ **ASR switching time (d25)**

Speed control parameter switching by "MPRM1" and "MPRM2" signals is possible even while the motor is running. Speed control P (Gain) and I (Integral time) are among the function codes that can be switched. Switching these parameters during operation may cause an abrupt change of torque and result in a mechanical shock, depending on the driving conditions of the load.
To reduce such a mechanical shock, the inverter decreases the abrupt torque change using the ramp function of ASR switching time (d25).

Data setting range: 0.000 to 1.000 (s)

d07, A49, b49, r49 d08, A50, b50, r50 d29, A58, b58, r58	Speed control 1 to 4 (Notch filter resonance frequency) Speed control 1 to 4 (Notch filter attenuation level) Speed control 1 to 4 (Notch filter width) Reference function code: d25: ASR switching time

These function codes specify speed control using notch filters. The notch filters make it possible to decrease the speed loop gain only in the vicinity of the predetermined resonance points, suppressing the mechanical resonance. The notch filters are available only under “vector control with sensor.” Setting the speed loop gain at a high level in order to obtain quicker speed response may cause mechanical resonance. If this happens, the speed loop gain must be decreased to reduce the speed response in the whole operating range and suppress the mechanical resonance. In such a case, using the notch filter makes it possible to decrease the speed loop gain only in the vicinity of the predetermined resonance points and set the speed loop gain at a high level in other operating points, enabling a quicker speed response in the whole operating range.

4 resonance frequencies can be set, allowing the respective attenuation levels and widths to be set.

	Function code	Name	Data setting range	Unit	Remarks
Notch filter 1	d07	Speed control 1 (Notch filter resonance frequency)	1 to 500	Hz	
	d08	Speed control 1 (Notch filter attenuation level)	0 to 40	dB	
	d29	Speed control 1 (Notch filter width)	0 (narrow) to 3 (wide)	-	
Notch filter 2	A49	Speed control 2 (Notch filter resonance frequency)	1 to 500	Hz	
	A50	Speed control 2 (Notch filter attenuation level)	0 to 40	dB	
	A58	Speed control 2 (Notch filter width)	0 (narrow) to 3 (wide)	-	
Notch filter 3	b49	Speed control 3 (Notch filter resonance frequency)	1 to 500	Hz	
	b50	Speed control 3 (Notch filter attenuation level)	0 to 40	dB	
	b58	Speed control 3 (Notch filter width)	0 (narrow) to 3 (wide)	-	
Notch filter 4	r49	Speed control 4 (Notch filter resonance frequency)	1 to 500	Hz	
	r50	Speed control 4 (Notch filter attenuation level)	0 to 40	dB	
	r58	Speed control 4 (Notch filter width)	0 (narrow) to 3 (wide)	-	

Setting the notch filter attenuation level to “0” (dB) disables the corresponding notch filter.

d09 to d13 H147	**Speed control (JOG)** **(Speed command filter, Speed detection filter, P (Gain), I (Integral time), Output filter)** **Speed control (JOG) (FF gain),**

These function codes are used to set up the speed control during jogging operation.

The block diagrams and function codes related to jogging operation are the same as for normal operation.
Since this speed control setting is exclusive to jogging operations, specify these function codes to obtain higher speed response to obtain smooth jogging operation.
For details, refer to the corresponding descriptions (d01 to d06) about the speed control sequence for normal operation.

Jogging operation is enabled when the following run commands turn ON.

- ■ **Jogging operation “JOG” (Function code data = 10)**
- ■ **Forward JOG “FJOG,” Reverse JOG “RJOG” (Function code data = 94, 95)**

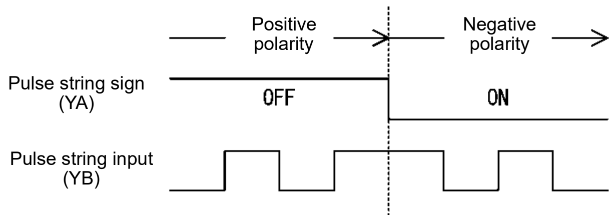
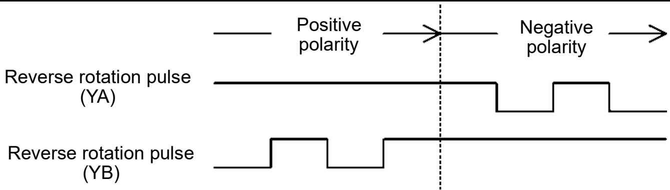
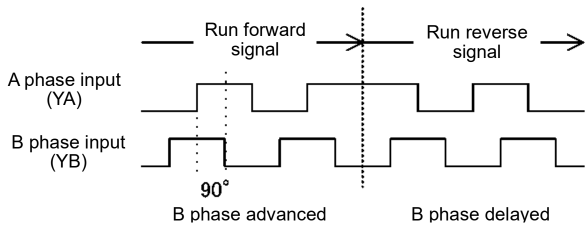
📖 The jogging operation method can be performed from the keypad. For details, refer to Chapter 3 “3.3.6 Performing jogging operations with the keypad”

d14 to d18	**PG option Ch2 (Pulse string input)** **(Pulse input method), (Encoder pulse count), (Pulse scaling factor 1),** **(Pulse scaling factor 2), (Pulse string command filter time constant)**

These function codes apply to PG option card input terminals [YA] and [YB], and they normally function as speed feedback side encoder input. (Sets speed feedback input for vector control with sensor and V/f control with sensor.)
By setting these function codes, operation is also possible as command side encoder input. For details, refer to “■ PG input switching “PG-SEL” assignment” in Chapter 5 “5.3.2 E codes (Extension terminal functions).”

■ **PG option Ch2 (Pulse input format) (d14)**

d14 specifies the speed feedback input format.

d14 data	Pulse input format	Remarks
0	Pulse string sign/pulse string input	
1	Forward and reverse pulse	
2	A, B phase 90° phase difference (B phase lead)	If using a dedicated Fuji motor for vector control, set to “2”. 
3	A, B phase 90° phase difference (A phase lead)	This setting is the inversion of d14 = 2. (A phase lead is forward rotation) In case that YA and YB are reversely connected to the specified terminals, setting “3” to this function code can reverse the polarity of detected speed (position) without changing the connection.

■ PG option Ch2 (Encoder pulse count) (d15)

Set the encoder pulse count for speed feedback input.

- Data setting range: h.0014 to h.EA60 (hexadecimal format)

(20 to 60000 (P/R) when the above range is expressed in decimal format.)

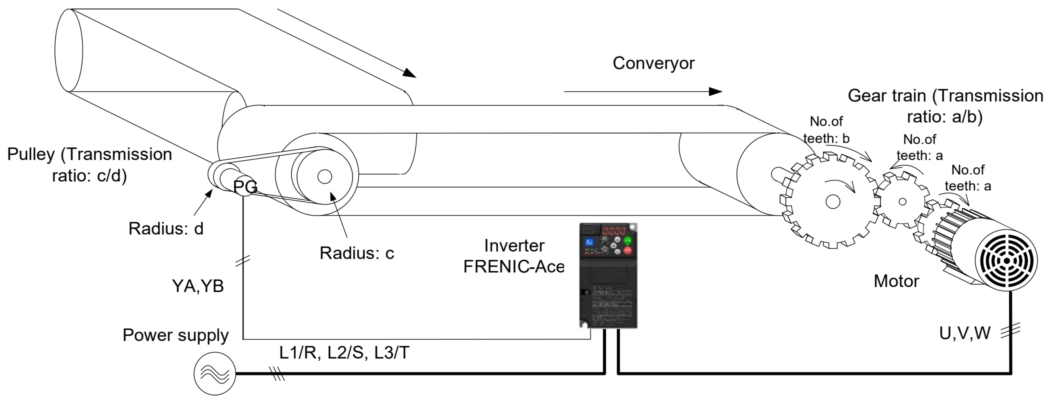
If using a dedicated Fuji motor for vector control, set to “0400 (1024 P/R).”

■ PG option Ch2 (Pulse scaling factor 1) (d16) and (Pulse scaling factor 2) (d17)

d16 and d17 specify the factors to convert the speed feedback input pulse rate into the motor shaft speed (min-1).

- Data setting range: 1 to 32767

Specify the data according to the transmission ratios of the pulley and gear train as shown below.



An example of a closed loop speed control system (conveyor)

Listed below are expressions for conversion between the speed feedback input pulse rate and the motor shaft speed.

$$\text{Motor shaft speed} = \frac{\text{Pulse scaling factor 2 (d17)}}{\text{Pulse scaling factor 1 (d16)}} \text{x Encoder shaft speed}$$

$$\frac{\text{Pulse scaling factor 2 (d17)}}{\text{Pulse scaling factor 1 (d16)}} = \frac{b}{a} \ \text{N} \ \frac{d}{c}$$

$$\text{Pulse scaling factor 1 (d16)} = a \ \text{N} \ c$$

$$\text{Pulse scaling factor 2 (d17)} = b \ \text{N} \ d$$

Note

- Under vector control with sensor, either mount the speed detector pulse encoder directly on the motor shaft, or mount it on a shaft with similar level of rigidity. A backlash, slip or deflection being on the mounting shaft could interfere with normal control. If the reduction ratio of the shaft with encoder is high, or the encoder pulse count is low, it may not be possible to perform control correctly.
- If using a dedicated Fuji motor for vector control, the encoder is mounted directly on the motor shaft, and therefore “1” should be set for both Pulse scaling factor 1 (d16) and Pulse scaling factor 2 (d17).

■ PG option Ch2 (Pulse input filter time constant) (d18)

A filter can be applied to pulse input by setting a time constant.

- Data setting range: 0.000 to 5.000 (s)

d21, d22 d23	Speed agreement / PG error (Detection range, Detection timer) PG error selection

Speed agreement signal “DSAG” (Function code E20 to E21, E27 (data = 71))

■ Speed agreement / PG error (Detection range) (d21), (Detection timer) (d22)

- Data setting range (d21) 0.0 to 50.0 (%), in (%) of the maximum speed
  (d22) 0.00 to 10.00 (s)

When performing vector control with sensor/sensorless vector control, V/f control with sensor, or dynamic torque vector control with sensor, if the speed regulator’s deviation (deviation between speed command and estimated speed value/detected speed) is within the specified range (d21), the signal “DSAG” turns ON. If the deviation is out of the specified range (d21) for the specified period (d22), the signal turns OFF. This signal allows the user to check whether the speed regulator works properly or not.

Speed agreement/PG error detected “PG-ERR” (Function code E20 to E21, E27 (data = 76))

■ Speed agreement/PG error (Detection range (d21), Detection timer (d22), PG error selection (d23)

- Data setting range (d21) 0.0 to 50.0 (%), in (%) of the maximum speed
  (d22) 0.00 to 10.00 (s)
  (d23) 0 to 5

d23 data	Function
0	Continued operation 1
1	Alarm (ErE: Speed inconsistency/excessive speed deviation) stoppage 1
2	Alarm (ErE: Speed inconsistency/excessive speed deviation) stoppage 2
3	Continued operation 2
4	Alarm (ErE: Speed inconsistency/excessive speed deviation) stoppage 3
5	Alarm (ErE: Speed inconsistency/excessive speed deviation) stoppage 4

When performing vector control with sensor/sensorless vector control, V/f control with sensor, or dynamic torque vector control with sensor, If the status outside the range (d21) for which the speed regulator deviation (between speed command and estimated speed value/detected speed) is set continues for equal to or longer than the set time (d22), the inverter judges that a PG error has occurred.
However, the detection conditions (exception conditions), processing after detection, and error detection range will differ depending on the d23 setting.

<table>
<tr><th>d23 Data</th><th>Detection conditions</th><th>Processing after error detection</th><th>Error detection range with speed command > F04</th></tr>
<tr><td>0</td><td rowspan="2">When the inverter cannot follow the reference speed (even after soft-starting) due to a heavy overload or similar, so that the detected speed is less than the reference speed, the inverter does not interpret this situation as a PG error.</td><td>The inverter outputs the PG error detected signal “PG-ERR” and continues to run.</td><td rowspan="3">Detection range = d21 x Maximum output frequency, which is constant, even if the speed command is above the base frequency (F04).</td></tr>
<tr><td>1</td><td rowspan="2">The inverter initiates a motor coast-to-a-stop with the ErE alarm.</td></tr>
<tr><td>2</td><td>No exception.</td></tr>
<tr><td>3</td><td rowspan="2">When the inverter cannot follow the reference speed (even after soft-starting) due to a heavy overload or similar, so that the detected speed is less than the reference speed, the inverter does not interpret this situation as a PG error.</td><td>The inverter outputs the PG error detected signal “PG-ERR” and continues to run.</td><td rowspan="3">If the speed command is below the base frequency (F04), detection range = d21 x Maximum output frequency, which is constant.
If it is above the base frequency, detection range = d21 x Speed command x Maximum output frequency /Base frequency (F04).</td></tr>
<tr><td>4</td><td rowspan="2">The inverter initiates a motor coast-to-a-stop with the ErE alarm.</td></tr>
<tr><td>5</td><td>No exception.</td></tr>
</table>

Note Enabling an operation limiting function such as the torque limit and droop control will increase the deviation caused by a huge gap between the reference speed and detected one. In this case, the inverter may trip, interpreting this situation as a PG error, depending on the running state. To avoid this incident, set the d23 data to “0” (Continue to run) to prevent the inverter from tripping even if any of those limiting functions is activated.

d24	Zero speed control	(Refer to F23)

Refer to the description of F23.

d25	ASR switching time	(Refer to d01)

ASR switching time is explained in detail in the Function code d01 section.

d29	Speed control 1 (Notch filter width)	(Refer to d07)

Speed control 1 (Notch filter width) is described in detail in the Function code d07 section.

d32, d33	Speed limit/Overspeed level 1 and 2	(Refer to H18)

Speed limit/Overspeed level (Level 1 and Level 2) is described in detail in the Function code H18 section.

d35	Overspeed detection level	(Refer to H18)

If an overspeed protection level (%) is set for d35, an overspeed protection alarm occurs under the following conditions.

Overspeed protection level = Maximum output frequency (F03/A01) x d35(%)

Setting d35 data to “999” causes the inverter to issue an overspeed alarm if either of the following conditions are satisfied.

Overspeed detection level

600 Hz
Maximum output frequency (F03/A01) x (d32 for forward rotation) x 120(%)
Maximum output frequency (F03/A01) x (d33 for reverse rotation) x 120(%)
(Maximum output frequency (F03/A01) + Torque limiter (Braking) (Increasing frequency limiter) H76) x 120(%)

Lowest level of the above

d41	Application control selection

d41 selects/deselects line speed control or master-follower operation (start at the same time, start after synchronization).

Line speed control suppresses an increase in line speed resulting from the increasing radius of the take-up roll in a winder system.

Master-follower operation drives two or more shafts of a conveyer while keeping their positions in synchronization.

■ Application control selection (d41)

Sets whether to enable/disable line speed control and master-follower operation (start at the same time, start after synchronization).

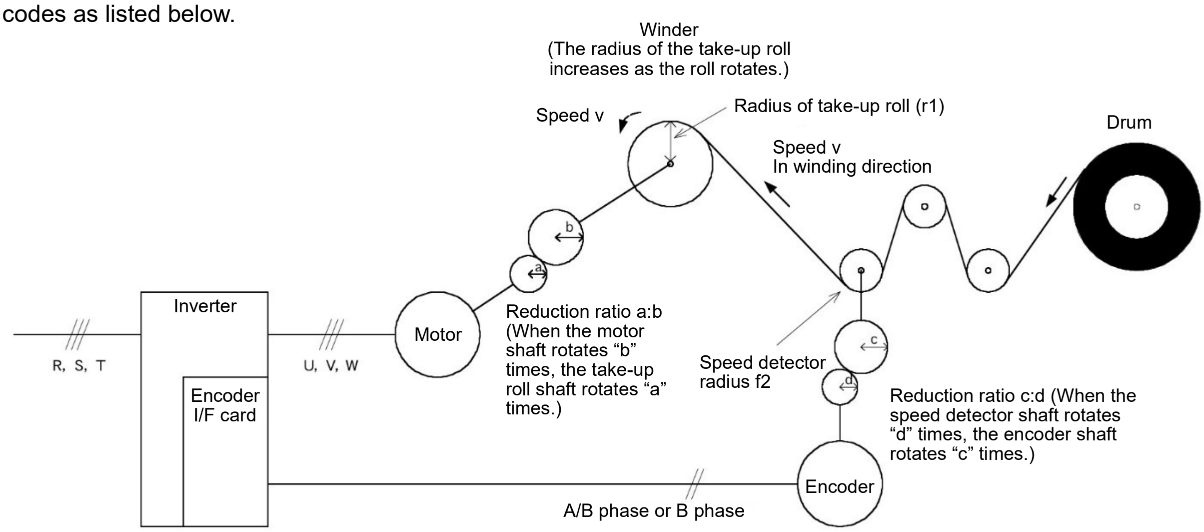
d41 data	Function
0	Disable (normal control)
1	Enable (Line speed control) Caution: This control is valid only when “V/f control with sensor” or “Vector control with sensor (with auto torque boost)” is selected with F42 or A14 (data = 3 or 4).
2	Master-follower operation (Enable synchronous operation (start at the same time, without Z phase)
3	Master-follower operation (start after synchronization)
4	Master-follower operation (Enable synchronous operation (start at the same time, with Z phase)

In a winder system (e.g., roving frames, wiredrawing machines), if the inverter continues to run the motor at a constant shaft speed, the take-up roll gets bigger with materials (roving, wire, etc.) and its radius increases so that the winding speed of the take-up roll increases. To keep the line speed (winding speed) constant, the inverter detects the winding speed using a sensor and controls the motor rotation so that the winding speed stays constant.

[2] Line speed control

Machinery configuration of winder system and function code settings

Shown below is a machinery configuration of a winder system for which it is necessary to configure the function codes as listed below.



- Speed reduction ratio between motor shaft and take-up roll shaft a: b
- Speed reduction ratio between speed detector shaft and encoder shaft c: d
- Radius of take-up roll before winding r_1 [m]
- Radius of speed detector r_2 [m]

Setting the reduction ratio

Function codes	Name	Setting
d15	Encoder pulse count	Encoder pulse count (P/R)
d16	Pulse scaling factor 1	Speed reduction ratio of the whole machinery (load) $\frac{K_2}{K_1}=\frac{r_2}{r_1}\times\frac{b}{a}\times\frac{d}{c}=\frac{d17}{d16}$ d16: Denominator factor for the speed reduction ratio (K1 = r1 (a (c) d17: Numerator factor for the speed reduction ratio (K2 = r2 (b (d)
d17	Pulse scaling factor 2	

■ Line speed command

Under line speed control, speed commands should be given as line speed commands.

Setting with digital inputs

To digitally specify a line speed in m/min, make the following settings.

Function codes	Name	Setting
E48	LED monitor details	5: Feed speed (line speed)
E50 E39	Display coefficient for speed monitor Speed display auxiliary coefficient	$K_s=\frac{240\pi\times a\times r_1}{p\times b}$ K_s: Display coefficient for transport time (E50) / Speed display auxiliary coefficient (E39) p: Number of motor poles a, b: Motor shaft-to-winding shaft speed reduction ratio (Winding shaft a rotates when motor shaft b rotates.) r_1: Radius of take-up roll before winding (initial value) in m

Setting with analog inputs

To specify a line speed using analog inputs, set an analog input (0 to 100%) based on the following equation.

$$\text{Analog input (\%)} = \frac{p \times b \times 100}{240\pi \times r1 \times a \times fmax} \times V$$

V: Line speed in m/min fmax: Maximum output frequency (F03, A01, b01, r01)

■ **Adjustment**

Like usual speed controls, it is necessary to adjust the speed command filter, speed detection filter, P gain, and integral time in the speed control sequence that controls the line speed at a constant level.

Function codes	Name	How to adjust
d01	Speed control (Speed command filter)	If an excessive overshoot occurs for a speed command change, increase the filter constant.
d02	Speed control (Speed detection filter)	If ripples are superimposed on the speed detection signal so that the speed control gain cannot be increased, increase the filter constant to obtain a larger gain.
d03	Speed control P (Gain)	If hunting is caused in the motor speed control, decrease the gain. If the motor response is slow, increase the gain.
d04	Speed control I (Integral time)	If the motor response is slow, decrease the integral time.

■ **Cancel line speed control -- “Hz/LSC” (Function code E01 to E05, data = 70)**

Turning ON “Hz/LSC” cancels line speed control. This disables the frequency compensation of PI operation, resulting in no compensation for a take-up roll getting bigger and an increase in the winding speed. Use this signal to temporarily interrupt the control for repairing a thread break, for example.

“Hz/LSC”	Function
OFF	Enable line speed control (depending on d41 setting)
ON	Cancel line speed control (V/f control, without compensation for a take-up roll getting bigger)

■ **Hold line speed control frequency in the memory -- “LSC-HLD” (Function code E01 to E05, data = 71)**

If “LSC/HLD” is ON under line speed control frequency, stopping the inverter (including an occurrence of an alarm and a coast-to-a-stop command) or turning OFF “Hz/LSC” saves the current frequency command compensating for a take-up roll getting bigger, in the memory. At the time of restart, the saved frequency command is applied and the inverter keeps the line speed constant.

“LSC-HLD”	Function
OFF	Disable (No saving operation)
ON	Enable (Saving the frequency command compensating for a take-up roll getting bigger)

Note Shutting off the inverter power while operation is stopped loses the frequency compensation data saved in the memory. At the time of restart, therefore, the inverter runs at the frequency without compensation so that a large overshoot may occur.

d51 to d57	For adjustment by manufacturer

These function codes are for adjustment by the manufacturer. Do not access these function codes.

d59 to d63	PG option Ch1/Terminal [X] (Pulse string input) (Pulse input format, Encoder pulse count, Filter time constant, Pulse compensation coefficient 1, 2) (Refer to F01)

These function codes apply to pulse string input for PG option card input terminals [XA] and [XB], or inverter control input terminal [X5]. They normally function as speed command side pulse string input.
By setting these function codes, operation is also possible as speed feedback side encoder input. For details, refer to "■ PG input switching "PG-SEL" assignment" in Chapter 5 "5.3.2 E codes (Extension terminal functions)."

For details on pulse rate input, refer to the description of Function code F01.

d67	Starting characteristic (Auto search mode: for sensorless vector control)

For details on starting characteristics, refer to the description of function code H09.

d68 to d69	For adjustment by manufacturer

These function codes are for adjustment by the manufacturer. Do not access these function codes.

d70	Speed control limiter

d70 specifies a limiter for the PI value output calculated in speed control sequence under "V/f control with sensor" or "dynamic torque vector control with sensor."

A PI value output is usually within the "slip frequency x maximum torque (%)" under normal control conditions.

If an abnormal state such as a temporary overload arises, the PI value output greatly fluctuates, and it may take a long time for the PI value output to return to the normal level. Limiting the PI value output with d70 suppresses such abnormal operation.

Data setting range: 0 to 100 (%) (assuming the maximum frequency as 100%)

[3] Master-follower operation

d71 to d78	Master-follower operation

With master-follower operation, the speed and position of the master shaft being run by another inverter is detected with an encoder (PG), and the speed and position of the follower shaft being run by this inverter are synchronized. Depending on the synchronization method, there are 4 methods: “Speed synchronization (tuning) operation” and “Synchronous operation (start at the same time (without Z-phase compensation))” do not require the Z-phase, while “Start after synchronization” and “Synchronous operation (start at the same time (with Z-phase))” have Z-phase compensation.

PG option card OPC-CP-PG or OPC-CP-PG3 is required to allow a 2-system encoder to be connected.

Input the master side motor PG signals to terminals [XA], [XB], and [XZ], and the follower side motor PG signals to terminals [YA], [YB], and [YZ]. However, if “Without Z-phase compensation” is selected, it is not a problem if terminal [XZ] and [YZ] are not connected.

<table>
<tr><th rowspan="2">Master-follower operation method</th><th rowspan="2">Synchronization</th><th rowspan="2">Z-phase signal connection</th><th colspan="4">Master side = follower side (Required/Not required)</th></tr>
<tr><th>Number of motor poles</th><th>Motor reduction ratio</th><th>Encoder pulse count</th><th>Encoder reduction ratio</th></tr>
<tr><td>Speed synchronization (tuning)</td><td>Speed synchronization</td><td>Not required</td><td colspan="4">Not required</td></tr>
<tr><td>Master-follower (with Z-phase compensation)</td><td rowspan="3">Position synchronization (*1)</td><td>Required</td><td colspan="2" rowspan="3">Not required*3</td><td colspan="2">Required*2</td></tr>
<tr><td>Synchronous operation (start at the same time (without Z-phase compensation))</td><td>Not required</td><td colspan="2">Not required*3</td></tr>
<tr><td>Synchronous operation (start at the same time (with Z-phase compensation))</td><td>Required</td><td colspan="2">Required*2</td></tr>
</table>

(*1) When performing position master-follower operation, control is performed so that the machine speed/position is synchronized with the encoder detected speed/position, and therefore the relationship between the machine speed/position and encoder detected speed/position should be master side = follower side. If this relationship is not observed, it will not be possible to perform position master-follower operation.

(*2) When performing position master-follower operation, configure so that master side = follower side for the encoder pulse count and encoder reduction ratio.

(*3) It is recommended that master side = follower side for the number of motor poles and motor reduction ratio, but if the configuration is such that the master side machine speed/position and follower side machine speed/position relationship is equal, the master side does not have to be equal to the follower side. By applying a scaling factor to pulse detection from the master side encoder, it is also possible to synchronously control the machine speed/position ratio for the master side and follower side.

■ **Application control selection (d41)**

d41 data	Function
0	Speed synchronization (tuning) operation
2	Synchronous operation (start at the same time (without Z phase)
3	Synchronous operation (Start after synchronization (with Z-phase))
4	Synchronous operation (start at the same time (with Z phase))

Specifications of master-follower operation

	Item	Specifications	Remarks
Control	Speed control range under V/f control with sensor	1:100	4P motor, When using 1024P/R encoder Speed reduction ratio = 1:1 During running at constant speed
	Speed control range under vector control with sensor	1:1500	
	Position control accuracy	±2°	
Electrical specifications	Input pulse rate	10 p/s to 100 kp/s *1	Maximum wiring length: 100 m (328 ft) *1 When using an AB phase encoder

*1 For PGs with an open collector output, the input pulse rate is 30 kp/s or below and the maximum wiring length is 20 m (66 ft).

Related function code list

The following table shows a list of function codes used for master-follower operation.

Function code list

Function code	Name	Permissible setting range * Lists only those which are related	Unit	Remarks
F01, C30	Frequency setting 1, 2	0 to 12 12: Pulse string input	-	
F31 F61	Terminal [FM1] (Function selection) Terminal [FMP] (Function selection)	17: Master-follower angle deviation -100 to 0 to 100%: -180 to 0 to +180 deg	-	
F42	Control method selection	3, 4, 6 (speed control with sensor)	-	
E01 to E05, E98, E99	Terminal [X1] to [X5]*1 [FWD] [REV] (Function selection)	11(1011): “Hz2/Hz1” Frequency setting 2, 1	-	
E20 to E21, E27	Terminal [Y1] to [Y2], [30ABC] (Function selection)	29(1029): “SY” Master-follower synchronization complete	-	
d01, A43, b43, r43	Speed control (Speed command filter)	0.000 to 5.000	s	
d02, A44, b44, r44	(Speed detection filter)	0.000 to 0.100	s	
d03, A45, b45, r45	P (Gain)	0.01 to 200.0	Times	
d04, A46, b46, r46	I (Integral time)	0.000 to 5.000	s	
d70	(Limiter)	0.00 to 100.00	%	
d14	PG option Ch2 (Pulse input format)	0: Pulse train sign/pulse train input 1: Forward/reverse pulse 2: A, B phase 90° phase difference (B phase lead) 3: A, B phase 90° phase difference (A phase lead) 4: A, B phase 90° phase difference (B phase lead) UVW signal	-	
d15	(Encoder pulse count) *2	0014 to EA60 (hexadecimal format) (20 to 60000 (decimal format))	P/R	
d16	(Pulse scaling factor 1)	1 to 32767	-	
d17	(Pulse scaling factor 2)	1 to 32767	-	
d18	(Pulse string command filter time constant)	0.000 to 5.000	s	
d59	PG option Ch1/Terminal X (Pulse input format)	0: Pulse train sign/pulse train input 1: Forward/reverse pulse 2: A, B phase 90° phase difference (B phase lead) 3: A, B phase 90° phase difference (A phase lead)	-	
d60	(Encoder pulse count) *2	0014 to EA60 (hexadecimal format) (20 to 60000 (decimal format))	P/R	
d61	(Pulse string command filter time constant)	0.000 to 5.000	s	
d62	(Pulse compensation coefficient 1)	1 to 32767	-	
d63	(Pulse compensation coefficient 2)	1 to 32767	-	
d41	Application control selection (mode selection)	0: Disable 2: Synchronous operation (start at the same time (without Z phase)) 3: Synchronous operation (start after synchronization) 4: Synchronous operation (start at the same time (with Z phase))	-	

d71	Master follower operation (Main speed regulator gain)	0.00 to 1.50	Times	
d72	(APR P gain)	0.00 to 200.00	Times	
d73	(APR output + side limiter)	20 to 200, 999: No limiter	%	
d74	(APR output - side limiter)	20 to 200, 999: No limiter	%	
d75	(Z phase alignment gain)	0.00 to 10.00	-	
d76	(Offset angle between master and follower)	0 to 359	deg	
d77	(Synchronous completion detection angle)	0 to 100	deg	
d78	(Excessive deviation detection level)	0 to 65535 (1 = 10 pulses)	-	

*1 Pulse string input for terminal [X5] is disabled when the PG interface card is installed.
*2 When performing master-follower operation (d41 = 2, 3, 4), use a PG with same pulse count of 20 to 3000 P/R for both the master side and follower side.

■ Data setting for master-follower operation

F01	Frequency setting 1
C30	Frequency setting 2

Select the pulse string input (F01/C30 = 12) as a reference command source.

Switching between master-follower operation and individual operation is possible using the “Hz2/Hz1” terminal command. A switching example is given below.

(Example) Turning terminal [X1] ON for individual operation during which a digital frequency command drives the inverter. Set F01 and C30 data to “12” and “0,” respectively. And set E01 data to “11” to assign the “Hz2/Hz1” command to terminal [X1].

<u>It is recommended to perform switching between master-follower operation and individual operation when the inverter is stopped.</u> Switching when the inverter is running may activate the protective function. To avoid it, decrease the difference between the output frequency and the reference frequency to apply after switching.

F07, E10, E12, E14	Acceleration time
F08, E11, E13, E15	Deceleration time

Also in master-follower operation, the inverter controls the output frequency according to the acceleration /deceleration time as usual. Set the acceleration/deceleration time as short as possible. Be aware that setting the acceleration/deceleration time longer than that of the reference inverter reduces the ability of the follower motor to follow.

Tip Selecting “Vector control with sensor” (F42 = 6) ignores the acceleration /deceleration times specified by the function codes, running the motor with the acceleration/deceleration time 0.0 s.

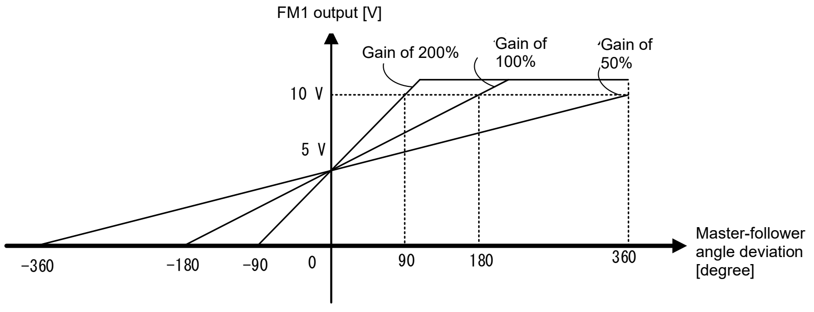
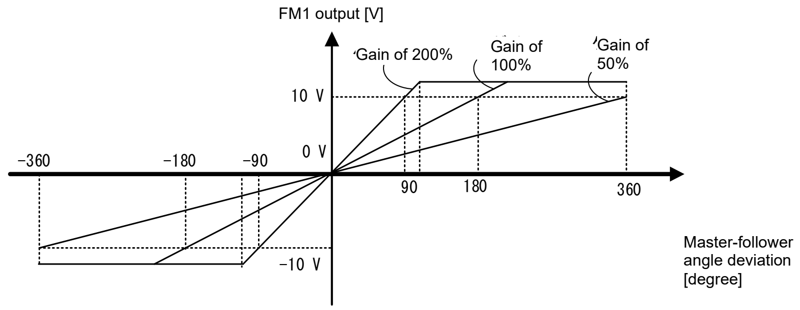
F23, F24	Starting frequency, Starting frequency (Holding time)
F25, F39	Stop frequency, Stop frequency (Holding Time)

Set the starting frequency and stop frequency as low as possible to the extent that the motor can generate enough torque. During master-follower operation, basically set the holding times for the starting frequency and stop frequency at 0.0 s. Running at a frequency lower than the stop frequency or starting frequency cannot be followed. Be aware that specifying the holding time deteriorates the ability of the follower motor to follow at the time of startup or stop.

Tip Selecting “Vector control with sensor” (F42 = 6) ignores the starting/stop frequencies (holding time) specified by the function codes, running the motor with the holding time 0.0 s.

F31, F61 Terminal [FM1], [FM2] (Function selection)

By setting “17: Master-follower angle deviation” for F31 and F61, the master-follower angle deviation is output to analog output. An example when voltage output is set is shown in the following diagram.

F29, 32 Terminal [FM1], [FM2] (Operation selection)	Voltage output
0: Voltage output (0 to +10 VDC)	
4: Voltage output (0 to ±10 VDC)	

Master-follower angle deviation monitoring with analog output voltage

F42 Control method selection

To perform master-follower operation, select a control mode with sensor (F42 = 3, 4 or 6). Usually, you can select “V/f control with sensor” (F42 = 3).

d01 to d05 Speed Control (Speed command filter, Speed detection filter, P (Gain), I (Integral time), FF(Gain))

For speed control-related function codes, refer to d01.

d14 to d17 PG option Ch2 (Feedback input)
(Pulse input format, Encoder pulse count, Pulse scaling factor 1, Pulse scaling factor 2)

For settings related to feedback input, feedback input, refer to d14 to d17.

d18 PG option Ch2 (Feedback input) (Filter time constant)

Sets the filter time constant for feedback input. The larger the time constant, the slower the response. Specify the proper filter time constant taking into account the response speed of the machine (load). If the pulse is lower and frequency command fluctuates, set larger time constant.

d59, d60 **d62, d63**	PG option Ch1/Terminal X (Pulse string input) (Pulse input format, Encoder pulse count, Pulse compensation coefficient 1, Pulse compensation coefficient 2)

For settings related to command pulse input, refer to F01.

d61	PG option Ch1/Terminal X (Pulse string input) (Filter time constant)

Set filter time constant for pulse string input. The larger the time constant, the slower the response. Specify the proper filter time constant taking into account the response speed of the machine (load). If the pulse is lower and frequency command fluctuates, set larger time constant.

d71	Master follower operation (Main speed regulator gain)

d71 adjusts the main speed regulator gain to control the response and the steady-state deviation. Usually, it is not necessary to change the factory default. Only selecting Enable synchronous operation (start at the same time (without Z phase)) (d41 = 2) enables the setting made with d71.

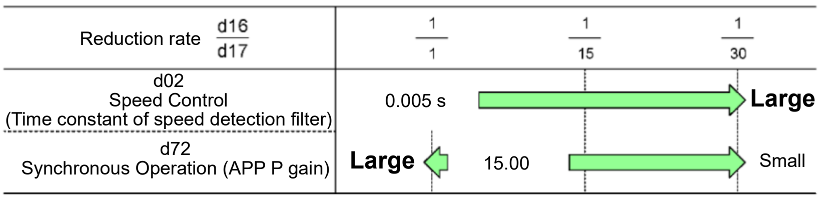
d72	Master-follower operation APR P gain

d72 determines the response of the automatic position regulator (APR).

If the APR output comes to be a single rotation of the encoder shaft per second when the phase angle error (position deviation) between the master and follower PGs becomes equal to a single rotation of the encoder shaft, that gain is assumed to be 1.0.

Setting an overly large value to the gain data easily causes hunting, and setting an overly small value results in a large steady-state deviation. Adjust the gain referring to the d72 setting guide below. If the d72 setting is adjusted, it is recommended that d02 also be adjusted.

(For detailed block diagrams, refer to "Synchronous operation (without Z phase) control block diagram (d41=2)" and "Synchronous operation (with Z phase) control block diagram (d41=3 or 4)."

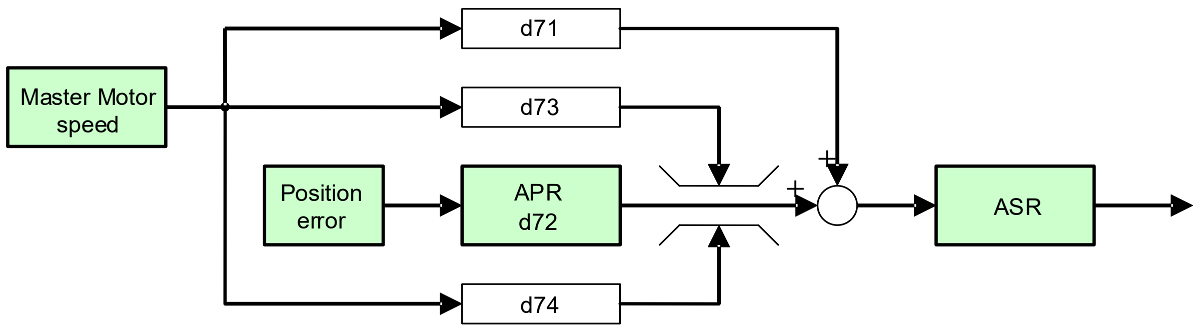


d72 setting guide

d73	Master-follower operation (APR output + side limiter)
d74	Master-follower operation (APR output + side limiter)

These function codes specify the limits of APR output relative to the master motor speed.

Specification of “999” disables the limiter.



Operation of APR output limiters

For detailed block diagrams, refer to "Synchronous operation (without Z phase) control block diagram (d41=2)” and "Synchronous operation (with Z phase) control block diagram (d41=3 or 4).”

d75	Master-follower operation (Z phase alignment gain)

If the APR output reaches the maximum frequency when the phase angle error between the master and follower PGs (position deviation) becomes 10% of the pulse rate at the maximum frequency, that gain is assumed to be 1.0.

Usually, it is not necessary to change the factory default.

If the reduction ratio is small and the encoder pulse count is low, it is necessary to decrease the Z phase alignment gain relative to the factory default.

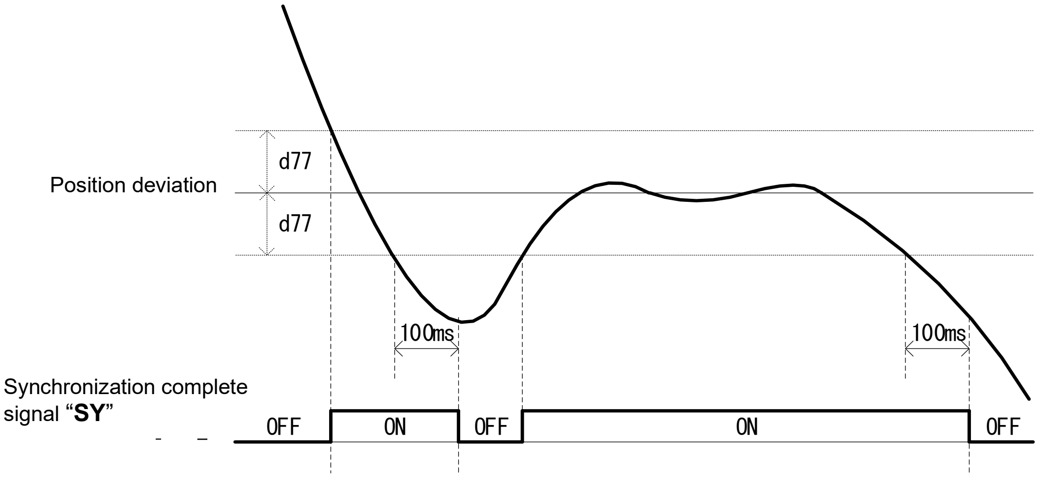
d76	Master-follower operation (Offset angle between master and follower)

In start after synchronization mode, the follower inverter delays starting to synchronize the Z phase with that of the master motor by the offset angle specified by this function code.

d77	Master-follower operation (Synchronization completion detection angle)

d77 specifies the synchronization completion detection angle. If the absolute value of the phase angle deviation (position deviation) between the master and follower PGs becomes equal to or below the synchronization completion detection angle specified by d77, the inverter issues a synchronization completed signal "SY," provided that the E20 to E21 data (Terminal function) is set to "29" (Synchronization complete).

Once turned ON, the synchronization completed signal "SY" is kept ON for 100 ms.

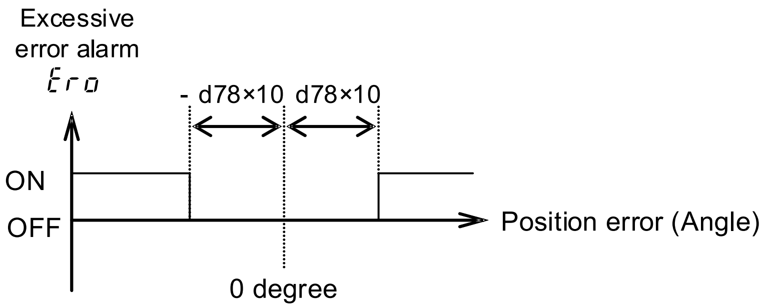


Synchronization complete detection signal "**SY**"

d78	Master-follower operation (Excessive deviation error detection range)

d78 specifies the detection level for the positioning control alarm (Ero). If the absolute value of the phase angle deviation (position deviation) between the master and follower PGs exceeds 10 times the d78 setting, the inverter issues an alarm Ero and shuts down its output.

During master-follower operation, the inverter always monitors for excessive deviation. The d78 setting should be made taking into account that the deviation temporarily increases immediately after startup.

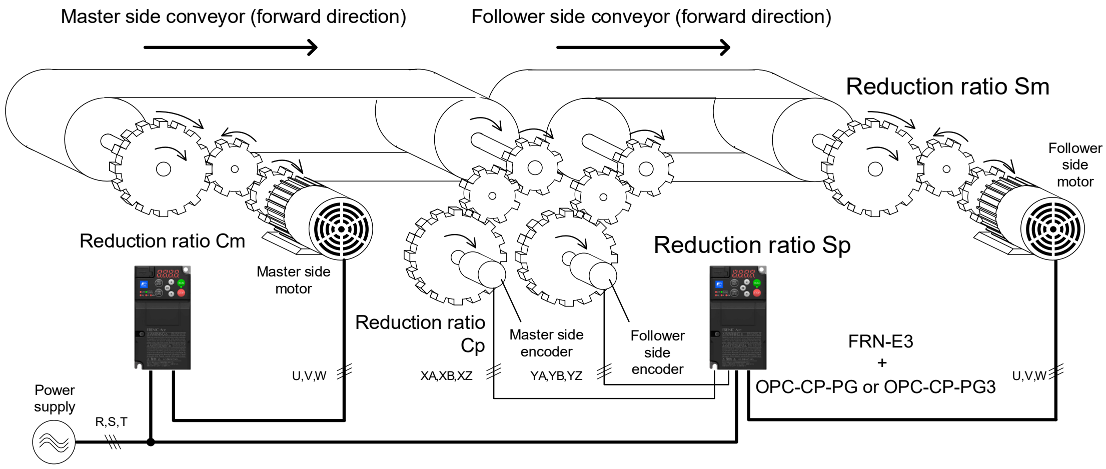


Excessive error alarm Ero

■ **Checking the encoder connection method and rotation direction**

Before beginning master-follower operation, be sure to check the machine system travel direction and run command direction for both the master side and follower side, the motor rotation direction, and the rotation direction with encoder pulses.

If these are not set correctly, it will not be possible to perform operation correctly when performing master-follower operation.

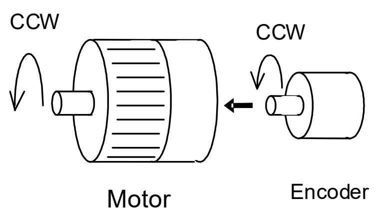


Conveyor synchronization system configuration example

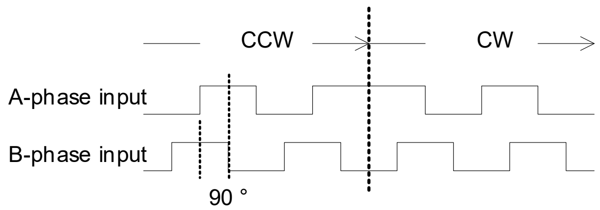
For details on how to install the PG interface card in the inverter, refer to the instruction manual for PG interface card “OPC-CP-PG” or “OPC-CP-PG32.”

Connect the master side motor encoder output to terminals [XA], [XB], and [XZ], and connect the follower side motor encoder output to terminals [YA], [YB], and [YZ].

The motor and encoder forward direction rotates to the left (CCW) as viewed from the shaft. When rotating in the forward direction (CCW), either connect so that encoder output pulses are forward rotation signals (B phase leads A phase by 90°), or switch the A phase and B phase by switching the d14 and d59 setting values ("2” ↔ “3”).



Motor and encoder forward direction



Encoder rotation direction and output signals

Master side inverter

Inverter	Run command	Forward rotation (FWD) when FWD-CM shorted		Reverse rotation (REV) when REV-CM shorted	
	Connection with motor	Connection in UVW phase order	Connection not in UVW phase order	Connection in UVW phase order	Connection not in UVW phase order
Braking resistor overheating	Rotational direction	**CCW**	CW	CW	CCW
		CW	CCW	CCW	CW
Master side conveyor	Operational direction	**Forward direction**	Reverse direction	Reverse direction	Forward direction
Master side encoder	Rotational direction	**CW**	CCW	CCW	CW
	Output signal	**A phase lead**	B phase lead	B phase lead	A phase lead
PG option card (OPC-CP-PG)	When XA-A phase, XB-B phase connected I/O check: “4_15” polarity	**-: Reverse rotation (REV)**	+: Forward rotation (FWD)	+: Forward rotation (FWD)	-: Reverse rotation (REV)
	When XA-B phase, XB-A phase connected I/O check: “4_15” polarity	**+: Forward rotation (FWD)**	-: Reverse rotation (REV)	-: Reverse rotation (REV)	+: Forward rotation (FWD)

CW: Clockwise (right rotation) as viewed from shaft side
CCW: Counterclockwise (left rotation) as viewed from shaft side
indicates the direction of rotation in the "Conveyor synchronization system configuration example" above.

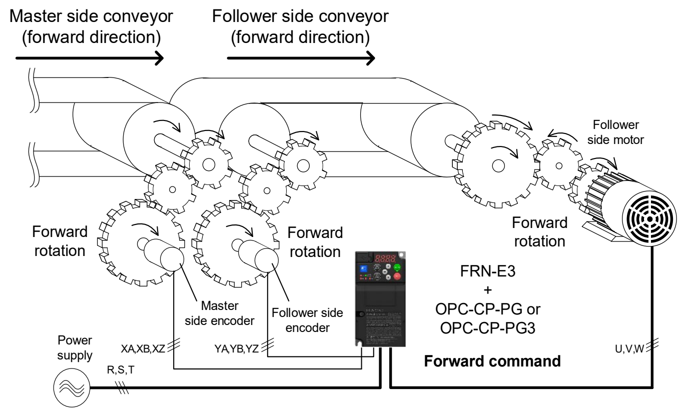
Follower side inverter

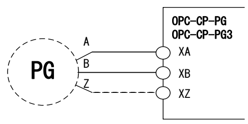
Inverter	Run command	Forward rotation (FWD) when FWD-CM shorted		Reverse rotation (REV) when REV-CM shorted	
	Connection with motor	Connection in UVW phase order	Connection not in UVW phase order	Connection in UVW phase order	Connection not in UVW phase order
Braking resistor overheating	Rotational direction	**CCW**	CW	CW	CCW
		CW	CCW	CCW	CW
Follower side conveyor	Operational direction	**Forward direction**	Reverse direction	Reverse direction	Forward direction
Follower side encoder	Rotational direction	**CCW**	CW	CW	CCW
	Output signal	**B phase lead**	A phase lead	A phase lead	B phase lead
PG option card (OPC-CP-PG)	When YA-A phase, YB-B phase connected I/O check: “4_17” polarity	**+: Forward rotation (FWD)**	-: Reverse rotation (REV)	-: Reverse rotation (REV)	+: Forward rotation (FWD)
	When YA-B phase, YB-A phase connected I/O check: “4_17” polarity	**-: Reverse rotation (REV)**	+: Forward rotation (FWD)	+: Forward rotation (FWD)	-: Reverse rotation (REV)

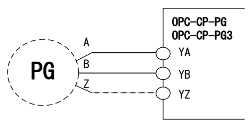
CW: Clockwise (right rotation) as viewed from shaft side
CCW: Counterclockwise (left rotation) as viewed from shaft side
indicates the direction of rotation in the "Conveyor synchronization system configuration example" above.

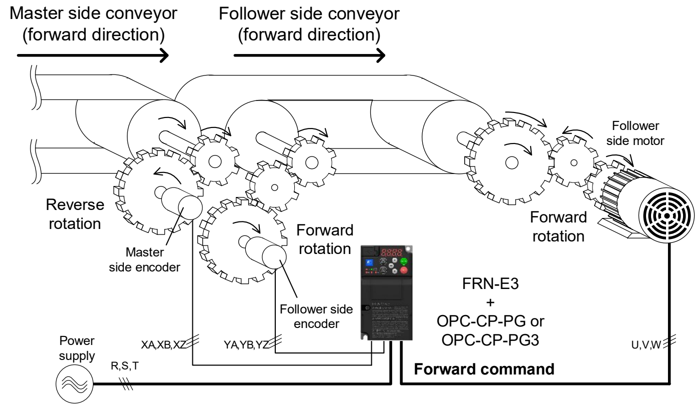
If the master side and follower side encoder detection rotation direction differs from that of the follower side motor rotation direction, re-wire correctly, taking the following wiring example into consideration. When d41 = 0, 2, there is no need for Z-phase wiring.

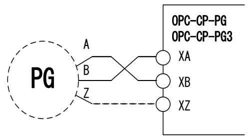
System configuration and encoder wiring method
(if running follower side conveyor in forward direction with d41 = 2, 3, 4 forward command)

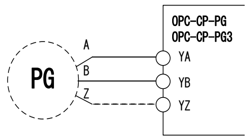
<table>
<tr><th>System configuration example</th><th>Encoder connection terminal</th></tr>
<tr><td rowspan="2">


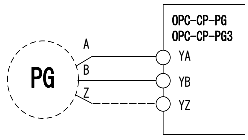
</td><td>Master side encoder wiring
→ XA and XB are connected as is.


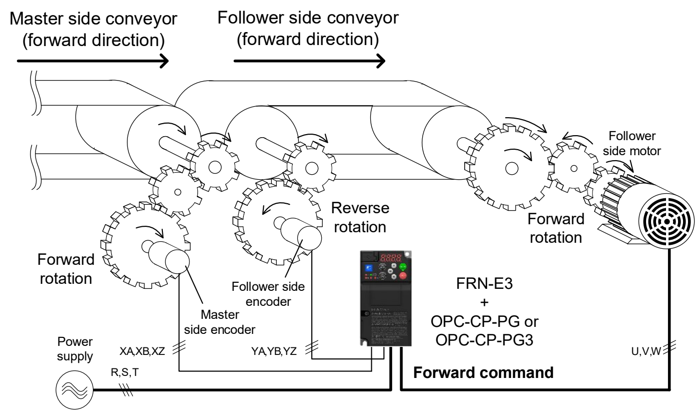
</td></tr>
<tr><td>Follower side encoder wiring
→ YA and YB are connected as is.


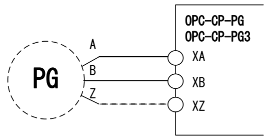
</td></tr>
<tr><td rowspan="2">


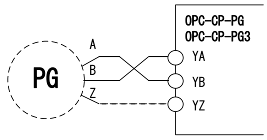
</td><td>Master side encoder wiring
→ The XA and XB connection is reversed.


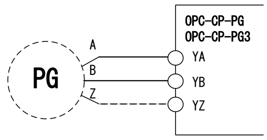
→ Or XA and XB are connected as is.
and d59 is set to 3 (*)


</td></tr>
<tr><td>Follower side encoder wiring
→ YA and YB are connected as is.


</td></tr>
<tr><td rowspan="2">


</td><td>Master side encoder wiring
→ XA and XB are connected as is.


</td></tr>
<tr><td>Follower side encoder wiring
→ The YA and YB connection is reversed.


→ Or YA and YB are connected as is.
and d14 is set to 3


</td></tr>
</table>

(*) With this machine configuration, only if d41 = 2 (Enable synchronous operation (start at the same time (without Z-phase)), master-follower conveyor operation can be performed in forward direction by setting the run command for the follower side to reverse rotation (REV) without “connecting as is.” If d41 = 3, 4 for this machine configuration, and if d41 = 2, 3, or 4 in other machine configuration examples, by setting the follower side run command to forward rotation (FWD), master-follower conveyor operation can be performed in the same direction.

If the run command differs from the conveyor movement direction, it will be necessary to either switch the motor wiring (e.g., U-phase-U-phase, V-phase-V-phase, W-phase-W-phase ↔ U-phase-U-phase, V-phase-W-phase, W-phase-V-phase), or switch the run command (FWD ↔ REV).

If the rotation direction detected by the encoder differs after switching the conveyor movement direction, switch the encoder wiring again (A-phase-A-phase, B-phase-B-phase ↔ A-phase-B-phase, B-phase-A-phase), or switch the d14 and d59 setting values (“2” ↔ “3”).

■ Operational direction

The operational direction in master-follower operation is determined by the run command and the rotation direction detected by the encoder for the master side and follower side. If the position synchronization method is selected, the motor may stop due to a positioning control alarm (Ero).

Follower side run command	Master side independent rotation detection direction “I/O Checking” “4_15” polarity	Follower side independent rotation detection direction “I/O Checking” “4_17” polarity	Follower side operational direction when performing master-follower operation	
			• Speed synchronization • Synchronous operation (start at the same time (without Z-phase))	• Start after synchronization • Synchronous operation (start at the same time (with Z phase))
Forward rotation (FWD) when FWD to CM shorted	+: Forward rotation (FWD)	+: Forward rotation (FWD)	Forward rotation (FWD)	Forward rotation (FWD)
		-: Reverse rotation (REV)	Reverse rotation (REV)	Stop*
	-: Reverse rotation (REV)	+: Forward rotation (FWD)	Reverse rotation (REV)	Stop*
		-: Reverse rotation (REV)	Forward rotation (FWD)	Reverse rotation (REV)
Reverse rotation (REV) when REV-CM shorted	+: Forward rotation (FWD)	+: Forward rotation (FWD)	Forward rotation (FWD)	Forward rotation (FWD)
		-: Reverse rotation (REV)	Reverse rotation (REV)	Stop*
	-: Reverse rotation (REV)	+: Forward rotation (FWD)	Reverse rotation (REV)	Stop*
		-: Reverse rotation (REV)	Forward rotation (FWD)	Reverse rotation (REV)

* If the master side rotates in the direction in which the follower side inverter stops, pulses are counted, and therefore a positioning control alarm (Ero) occurs. If the master side then returns to the follower side inverter rotation direction, synchronization is resumed from the position where the deviation is 0.

■ **Reduction ratio setting**

With master-follower operation, it is necessary to set the reduction ratio appropriately for the motor-machine system and encoder-machine system based on the system configuration.

<table>
<tr><th colspan="3">Synchronization</th><th>Speed synchronization</th><th>Position synchronization</th></tr>
<tr><td rowspan="2">Master side</td><td>Command encoder pulse count</td><td>d60</td><td>• If same as follower side encoder
d60 = d15
• If different from follower side encoder
d60 = Master side encoder pulse count</td><td>Be sure to set the same encoder pulse count as the follower side.
d60 = d15
* If the master side and follower side differ, position synchronization will not be possible.</td></tr>
<tr><td>Command pulse compensation coefficient 1, 2</td><td>d62
d63</td><td>$\frac{d63}{d62}=\frac{1}{S_m \times C_p}$
S_m: Follower side machine system reduction ratio
C_p: Master side encoder reduction ratio</td><td>$\frac{d63}{d62}=\frac{1}{S_m \times C_p}$
S_m: Follower side machine system reduction ratio
C_p: Master side encoder reduction ratio
Master side/follower side reduction ratio (pulse scaling factor)
• If synchronization performed at 1:1 ratio
Same configuration (C_p = S_p)
• If synchronization performed at 1/n master side/follower side ratio
Set the scaling factor only to (C_p = S_p x 1/n) with configuration left unchanged.</td></tr>
<tr><td rowspan="2">Follower side</td><td>Feedback encoder pulse count</td><td>d15</td><td>Set the Follower side encoder pulse count.</td><td>Set the follower side (= master side) encoder pulse count.</td></tr>
<tr><td>Feedback pulse scaling factor 1, 2</td><td>d16
d17</td><td>$\frac{d17}{d16}=\frac{1}{S_m \times S_p}$
S_m: Follower side machine system reduction ratio
S_p: Follower side encoder reduction ratio</td><td>$\frac{d17}{d16}=\frac{1}{S_m \times S_p}$
S_m: Follower side machine system reduction ratio
S_p: Follower side encoder reduction ratio
The same configuration is recommended for the master side/follower side reduction ratio (pulse scaling factor).</td></tr>
<tr><td colspan="2">Number of motor poles</td><td>P01</td><td>Set the number of motor poles on the follower side.</td><td>It is recommended that the number of poles for each motor be the same on both the master side and follower side. If the number of poles is different, depending on the machine system configuration (e.g., reduction ratio), construct the system so that the machine speed/position becomes equal for the master side and follower side.</td></tr>
</table>

■ Checking the encoder pulse count

Before beginning master-follower operation, be sure to check the encoder pulse count for both the master side and follower side. If the encoder pulse count is not correctly detected, it will not be possible to perform operation correctly when performing master-follower operation.

If the encoder pulse count is not correctly detected, it means that the number of motor poles (P01/A15), encoder pulse count (d15, d60), and pulse scaling factor 1/2 (d16/d17, d62/d63) settings do not match that of the actual machine configuration.

Check the PG pulse count in monitor numbers “4_15: PG pulse rate (Ch1 AB-phase)” and “4_17: PG pulse rate (Ch2 AB-phase)” in keypad menu number. 4 “I/O Checking.” For details on the pulse count display method, refer to Chapter 3 “3.4.4 Checking I/O signal status: “I/O Checking: 4. I_o”.”

Specification	Symbol, calculation formula	Calculation example
Operating frequency [Hz]	fset	20 [Hz]
Number of motor poles	P01/A15	4 poles
Encoder pulse count [P/r]	d15/d60	1000 [P/r]
Pulse scaling factor 1/2	d16/d17, d62/d63	1/30
Motor speed [r/min]	120×fset/P01	600 [r/min]
Motor speed [r/s]	2×fset/P01	10 [r/s]
I/O check 4_15 [kP/s] I/O check 4_17 [kP/s]	Motor speed [r/s] x Encoder pulse count [P/r] x Pulse scaling factor 1/2/1000	0.333 [kP/s]

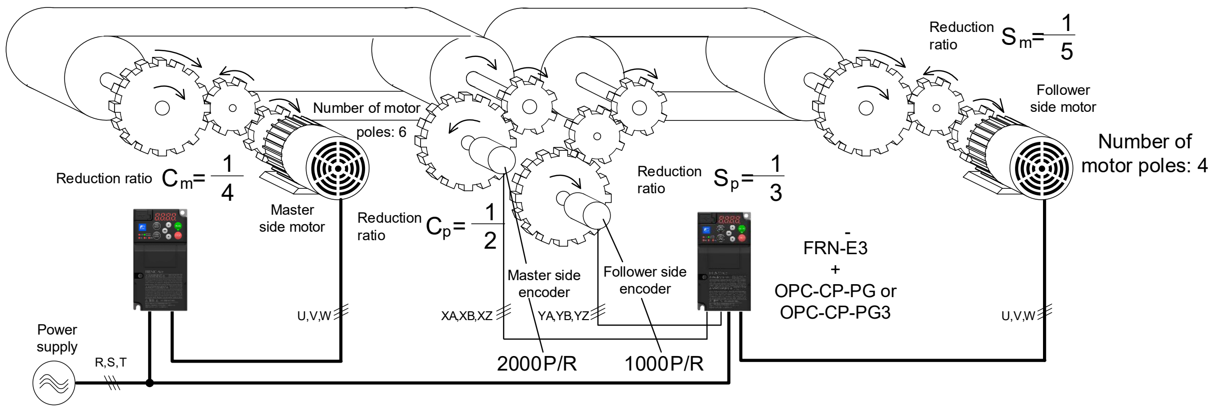
FUNCTION CODES

Chap 5

■ Speed synchronization

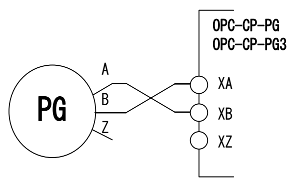
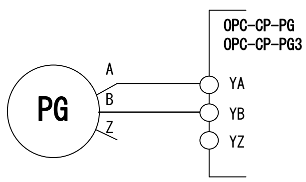
With speed synchronization, master-follower operation is performed in such a way as to keep the difference in speed between the master side and follower side to 0.

The follower side speed is controlled to ensure that the deviation between the master side pulse frequency and follower side pulse frequency is 0, but phase difference synchronization is not performed. Furthermore, even if the speed deviation nears 0, an “SY” synchronization complete signal is not output.



Speed synchronization system configuration example (when using gears)

Encoder connection

Master (command) side connection	Follower (feedback) side connection
	

*With speed synchronization, there is no need to connect to terminals [XZ] and [YZ].

*By switching the d14 and d59 setting values (“2” ↔ “3”) while keeping XA = A-phase and XB = B-phase, it is possible to switch between A-phase and B-phase.

Settings for speed synchronization

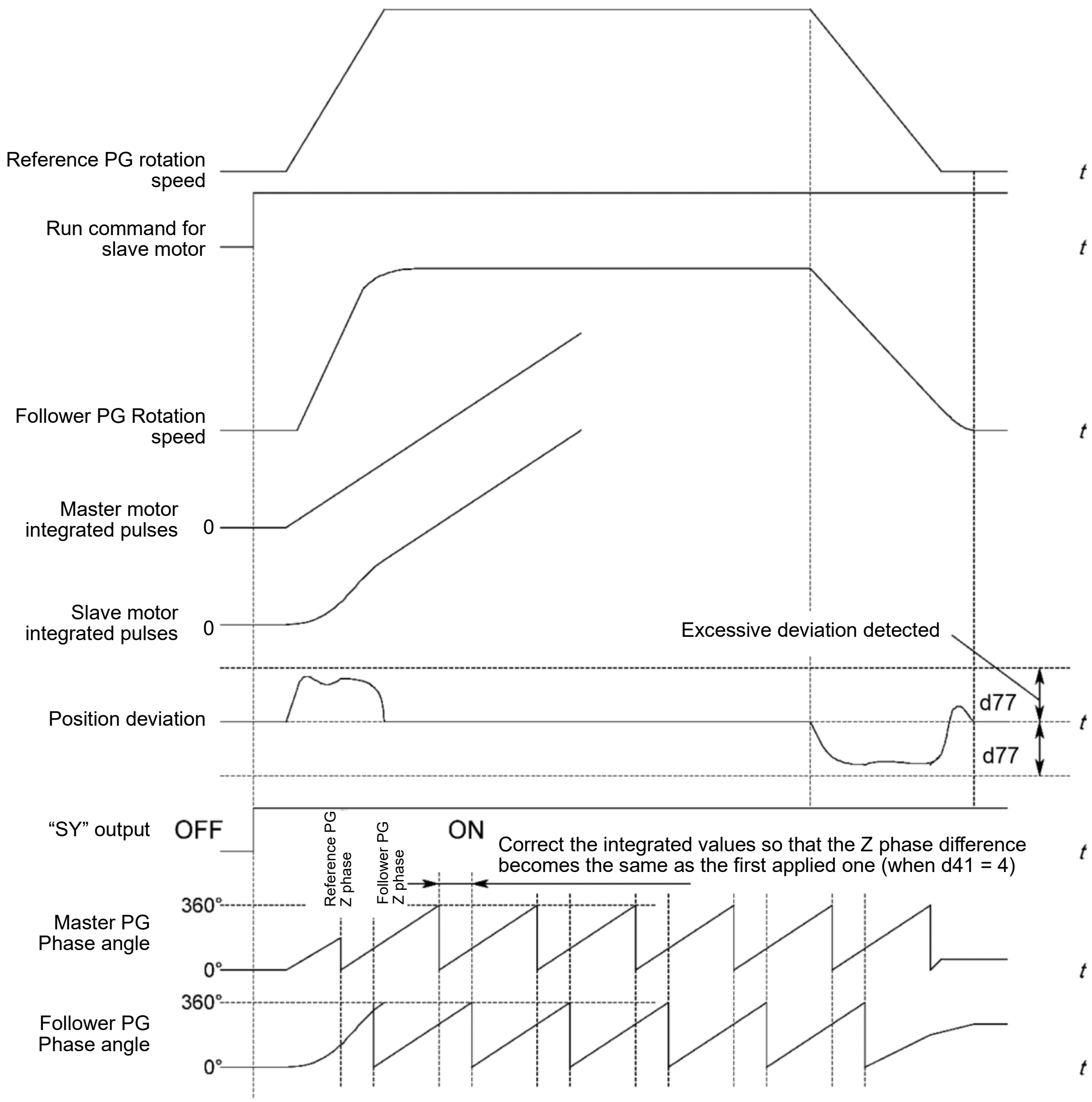
Function codes		Setting	Remarks
F01	Frequency setting 1	12	Pulse string input
F42	Control method selection 1	3 4	V/f control with sensor Dynamic torque vector control with sensor
P01	Number of motor poles	4	Sets the number of poles for the follower side motor. With speed synchronization, this does not necessarily have to match the number of motor poles for the master side.
d41	Application control selection	0	Disable (normal control)
d15	Feedback (feedback input) (Encoder pulse count)	03E8 (hexadecimal format) (1000)	With speed synchronization, this does not necessarily have to match the master side pulse count.
d16	(Pulse scaling factor 1)	1	$\frac{d17}{d16}=\frac{1}{S_m \times S_p}=\frac{1}{\frac{1}{5}\times\frac{1}{3}}=\frac{15}{1}$
d17	(Pulse scaling factor 2)	15	
d60	Command (pulse train input) (Encoder pulse count)	07d0 (hexadecimal format) (2000)	With speed synchronization, this does not necessarily have to match the follower side pulse count.
d62	(Pulse compensation coefficient 1)	1	$\frac{d63}{d62}=\frac{1}{S_m \times C_p}=\frac{1}{\frac{1}{5}\times\frac{1}{2}}=\frac{10}{1}$
d63	(Pulse compensation coefficient 2)	10	

■ Immediate synchronization (start at the same time) operation

With immediate synchronization (start at the same time) operation (d41 = 2, 4), master-follower operation is performed in such a way as to maintain the phase difference between the master side and follower side the moment operation is changed from independent operation to master-follower operation. The follower side speed and position are controlled to ensure that the deviation between the master side pulse total value and follower side pulse total value is 0. If the deviation reaches the synchronization complete detection angle (function code d77) or lower, an "SY" synchronization complete signal is output. Furthermore, if synchronization shifts, and the deviation exceeds the set Excessive deviation detection level value (10 times function code d78), an error alarm occurs, and output is cut off.

When d41 = 4, if a miscount occurs due to such reasons as noise in the total A/B-phase count, error correction is performed based on the phase difference for the Z-phase.

While the follower side run command is ON, the phase difference continues to be monitored even when the master side has stopped (provided that operation is not changed to independent operation), and when operation on the master side resumes, control is performed in such a way as to ensure that the phase difference for the Z-phase is kept constant again for both the master side and follower side.



■ **Start after synchronization operation**

Start after synchronization operation (d41 = 3) involves control which ensures that each Z-phase matches based on the initially detected master side and follower side Z-phase (position) after operation starts. At this time, the follower side is delayed by a maximum of 1 rotation when starting up (Start after synchronization operation). Once Start after synchronization is complete, Start after synchronization operation is never performed again provided that master-follower operation (Note 1) is not canceled.

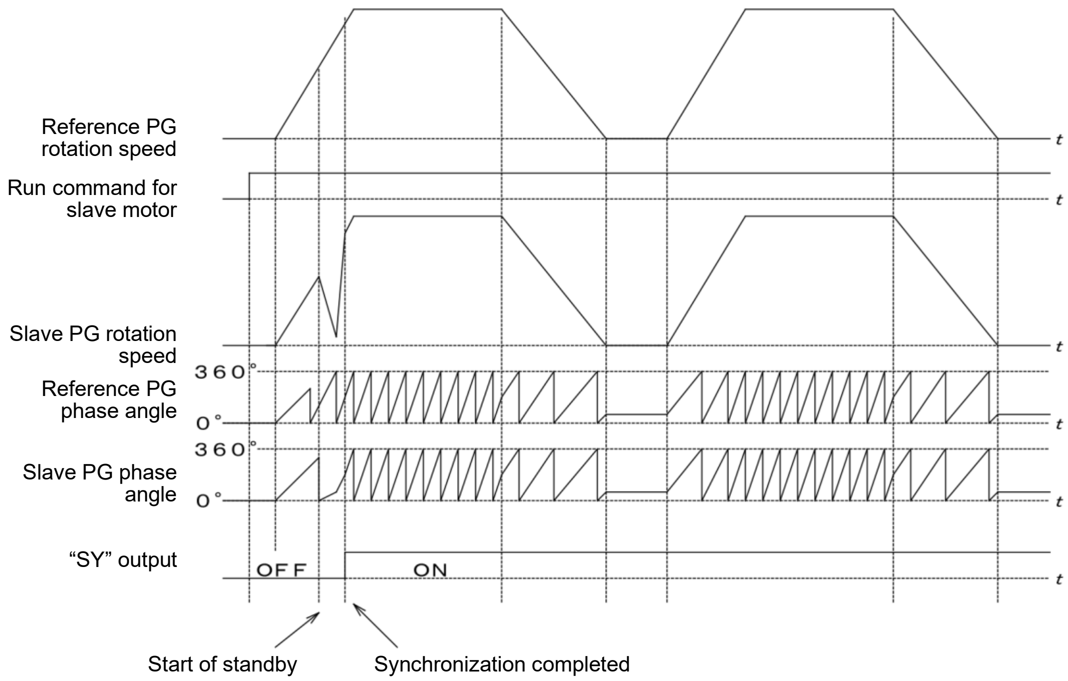
By changing the function code d76 setting, the Z-phase synchronization angle with the master side and follower side can be adjusted.

The follower side speed and position are controlled to ensure master side position and follower side position are added up inside the inverter, and the difference (hereinafter referred to as deviation) is always 0.

If a miscount occurs due to such reasons as noise in the total A/B phase count, error correction is performed based on the phase difference for the Z-phase.

If the deviation reaches the synchronization completion detection angle (function code d77) or lower, an “SY” synchronization complete signal is output.

If synchronization shifts, and the deviation exceeds the set Excessive deviation detection level (10 times function code d78), an error alarm occurs, and output is shut off.



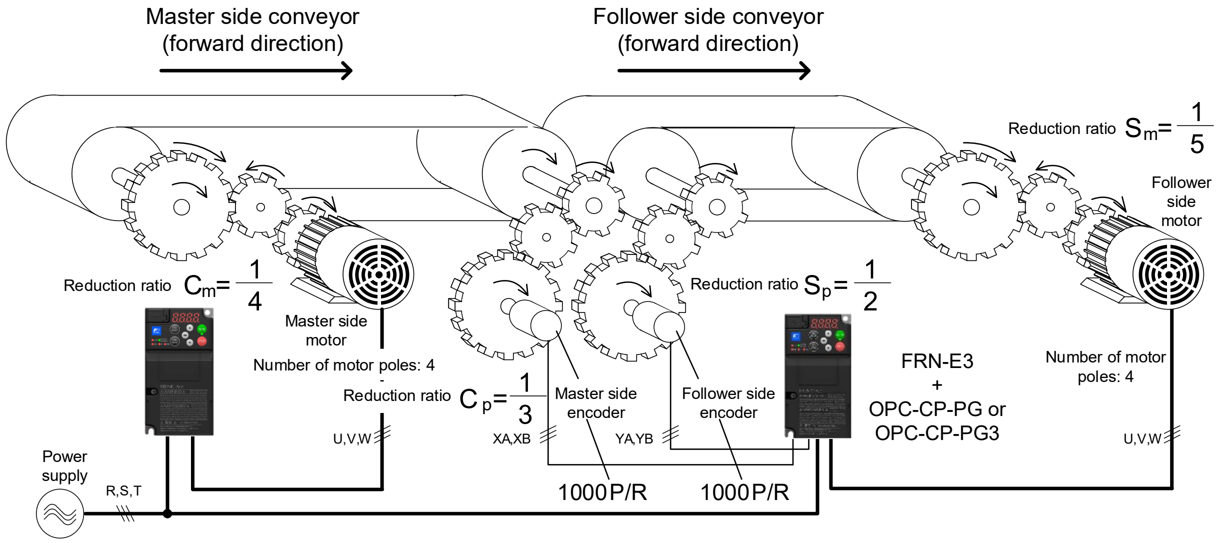
<u>Note 1: Master-follower operation cancellation conditions</u>

Master-follower operation is canceled in the following cases.

- When the follower side run command turns OFF
- When the “BX” coast-to-a-stop command turns ON, and the “STOP” forced stop command turns ON
- When an alarm occurs
- When switching to independent operation (realized by switching between F01 and C30 using “Hz2/Hz1” terminal functions)
- During torque control, or during operation with commercial power supply

Setting example

Setting example for master-follower operation without Z-phase compensation (d41 = 2) -(1)-



Master-follower operation system configuration example (without Z-phase compensation)

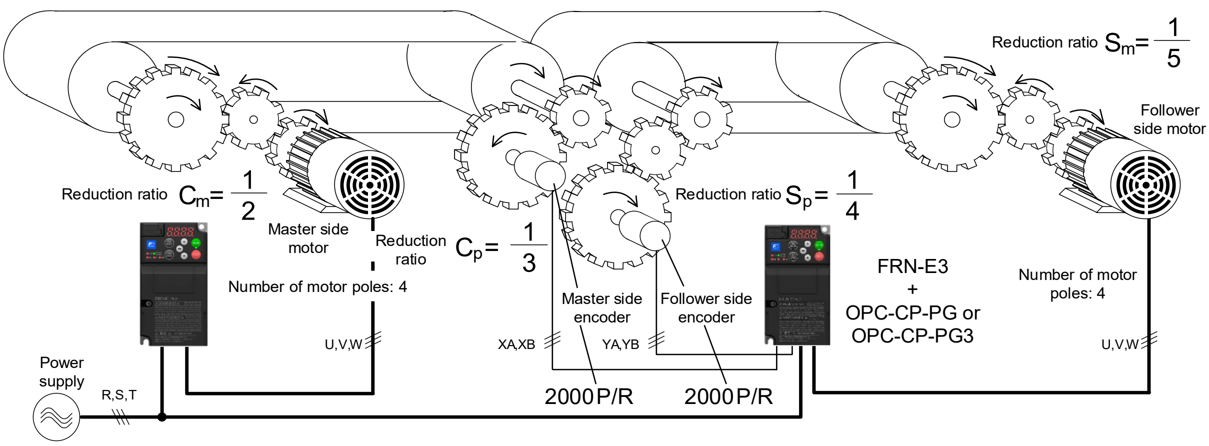
Settings when performing master-follower operation (d41 = 2)

	Function codes	Setting	Remarks
P01	Number of motor poles	4	Sets the number of poles for the follower side motor.
d15	Follower pulse (encoder pulse count)	03E8 (hexadecimal format) (1000)	When performing master-follower operation, the pulse count must be the same for the master side and follower side.
d16	(Pulse scaling factor 1)	1	$\frac{d17}{d16}=\frac{1}{S_m \times S_p}=\frac{1}{\frac{1}{5}\times\frac{1}{2}}=\frac{10}{1}$
d17	(Pulse scaling factor 2)	10	
d60	Master pulse (encoder pulse count)	03E8 (hexadecimal format) (1000)	Set the same value as d15.
d62	(Pulse compensation coefficient 1)	1	$\frac{d63}{d62}=\frac{1}{S_m \times C_p}=\frac{1}{\frac{1}{5}\times\frac{1}{3}}=\frac{15}{1}$
d63	(Pulse compensation coefficient 2)	15	

Rotational direction

Master side motor rotation direction	Master side PG Rotational direction	Follower side PG Rotational direction	Follower side run command	
			Forward rotation command (FWD)	Reverse rotation command (REV)
Forward rotation (FWD)	Forward	Forward	Forward	Reverse
Reverse rotation (REV)	Reverse	Reverse	Reverse	Forward

Setting example for master-follower operation without Z-phase compensation (d41 = 2) -(2)-



Master-follower operation system configuration example (without Z-phase compensation)

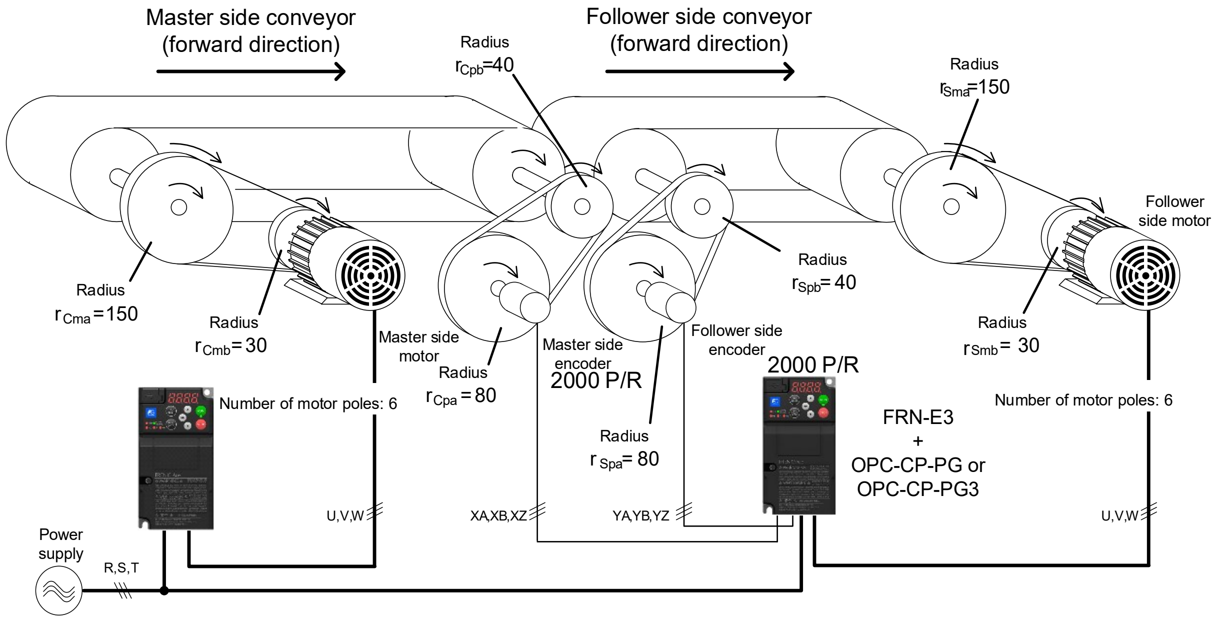
Settings when performing master-follower operation (d41 = 2)

Function codes		Setting	Remarks
P01	Number of motor poles	4	Sets the number of poles for the follower side motor.
d15	Follower pulse (encoder pulse count)	07d0 (hexadecimal format) (2000)	When performing master-follower operation, the pulse count must be the same for the master side and follower side.
d16	(Pulse scaling factor 1)	1	$\frac{d17}{d16} = \frac{1}{S_m \times S_p} = \frac{1}{\frac{1}{5} \times \frac{1}{4}} = \frac{20}{1}$
d17	(Pulse scaling factor 2)	20	
d60	Master pulse (encoder pulse count)	07d0 (hexadecimal format) (2000)	Set the same value as d15.
d62	(Pulse compensation coefficient 1)	1	$\frac{d63}{d62} = \frac{1}{S_m \times C_p} = \frac{1}{\frac{1}{5} \times \frac{1}{3}} = \frac{15}{1}$
d63	(Pulse compensation coefficient 2)	15	

Rotational direction

Master side motor rotation direction	Master side PG Rotational direction	Follower side PG Rotational direction	Follower side run command: Forward rotation command (FWD)	Follower side run command: Reverse rotation command (REV)
Forward rotation (FWD)	Reverse	Forward	Reverse	Forward
Reverse rotation (REV)	Forward	Reverse	Forward	Reverse

Setting example for master-follower operation with Z-phase compensation (d41 = 3, 4) -(1)-



Master-follower operation system configuration example (with Z-phase compensation)

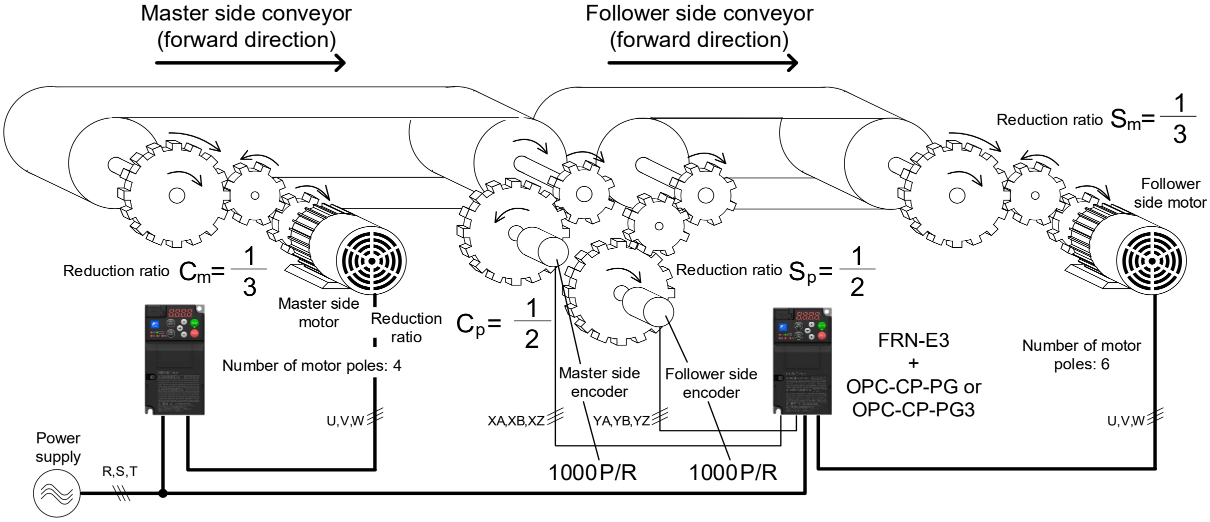
Settings when performing master-follower operation (d41 = 3,4)

Function codes		Setting	Remarks
P01	Number of motor poles	6	Sets the number of poles for the follower side motor.
d15	Follower pulse (encoder pulse count)	07d0 (hexadecimal format) (2000)	When performing master-follower operation, the pulse count must be the same for the master side and follower side.
d16	(Pulse scaling factor 1)	1	Each reduction ratio from the pulley radius is obtained as follows: Follower side motor reduction ratio $S_m = \frac{r_{Smb}}{r_{Sma}} = \frac{30}{150} = \frac{1}{5}$ Follower side encoder reduction ratio $S_p = \frac{r_{Spb}}{r_{Spa}} = \frac{40}{80} = \frac{1}{2}$ d16 and d17 are as follows: $\frac{d17}{d16} = \frac{1}{S_m \times S_p} = \frac{1}{\frac{1}{5} \times \frac{1}{2}} = \frac{10}{1}$
d17	(Pulse scaling factor 2)	10	
d60	Master pulse (encoder pulse count)	07d0 (hexadecimal format) (2000)	Design the machine configuration so that the reduction ratio (synchronized machine shaft - encoder axis) is the same on the master side and follower side, and set the same values as d15, d16, and d17.
d62	(Pulse compensation coefficient 1)	1	
d63	(Pulse compensation coefficient 2)	10	

Rotational direction

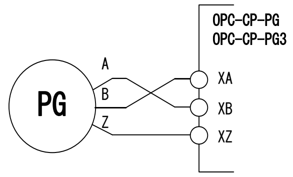
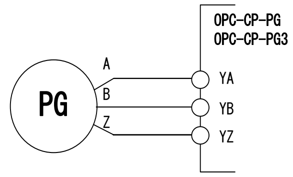
Master side motor rotation direction	Master side PG Rotational direction	Follower side PG Rotational direction	Follower side run command	
			Forward rotation command (FWD)	Reverse rotation command (REV)
Forward rotation (FWD)	Forward	Forward	Forward	Stopped
Reverse rotation (REV)	Reverse	Reverse	Stopped	Reverse

Setting example for master-follower operation with Z-phase compensation (d41 = 3, 4) -(2)-



Master-follower operation system configuration example (with Z-phase compensation)

PG connection

Master (command) side connection	Follower (feedback) side connection
	

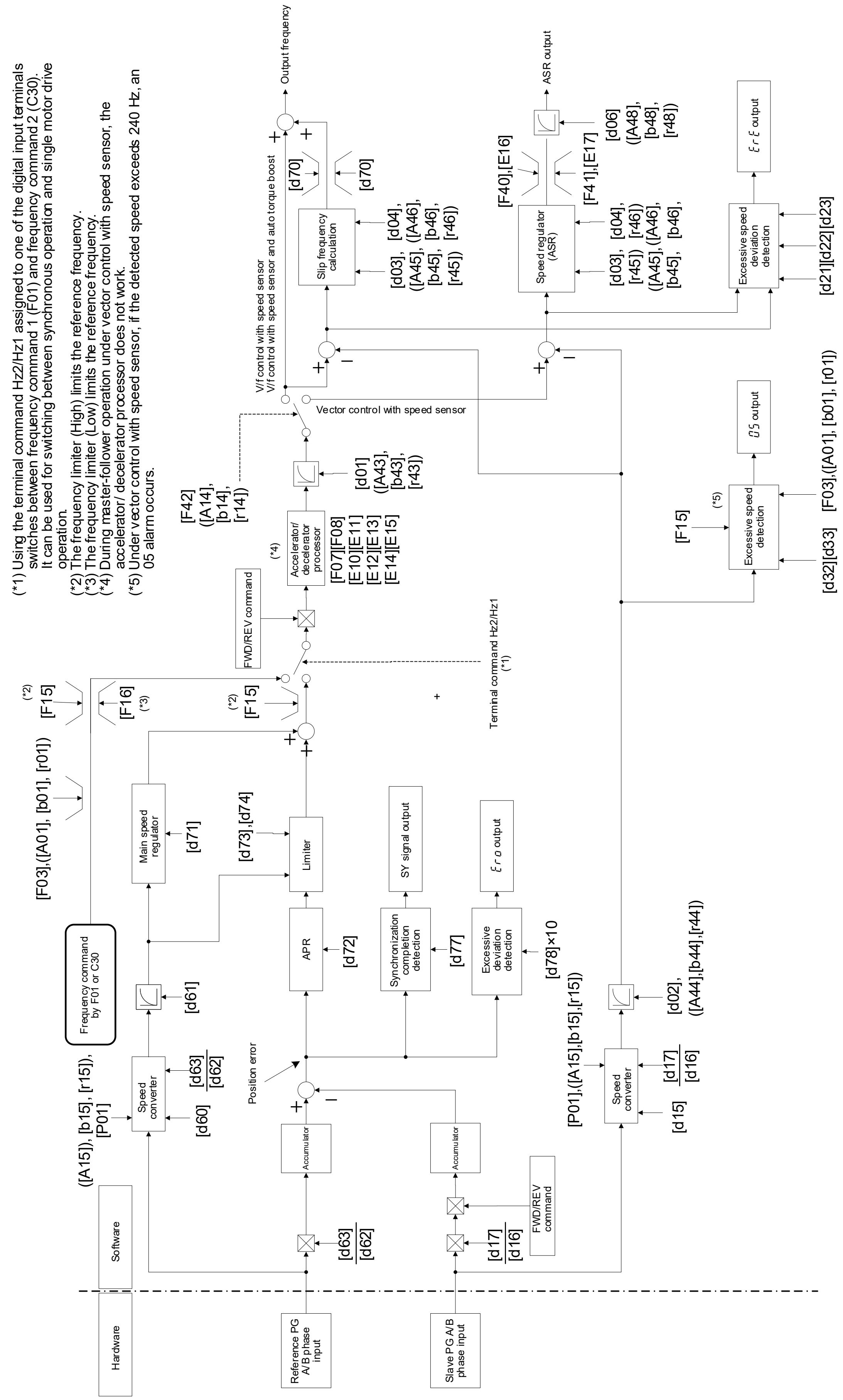
Settings when performing master-follower operation (d41 = 3,4)

Function codes		Setting	Remarks
P01	Number of motor poles	4	Sets the number of poles for the follower side motor.
d15	Follower pulse (encoder pulse count)	03E8 (hexadecimal format) (1000)	When performing master-follower operation, the pulse count must be the same for the master side and follower side.
d16	(Pulse scaling factor 1)	1	$\frac{d17}{d16}=\frac{1}{S_m \times S_p}=\frac{1}{\frac{1}{3}\times\frac{1}{2}}=\frac{6}{1}$
d17	(Pulse scaling factor 2)	6	
d60	Master pulse (encoder pulse count)	03E8 (hexadecimal format) (1000)	Design the machine configuration so that the reduction ratio (synchronized machine shaft - encoder axis) is the same at the master side and follower side, and set the same values as d15, d16, and d17.
d62	(Pulse compensation coefficient 1)	1	
d63	(Pulse compensation coefficient 2)	6	

Rotational direction

Master side motor rotation direction	Master side PG rotational direction	Follower side PG rotational direction	Follower side run command	
			Forward rotation command (FWD)	Reverse rotation command (REV)
Forward rotation (FWD)	Reverse	Forward	Forward	Stopped
Reverse rotation (REV)	Forward	Reverse	Stopped	Reverse

Control block diagrams

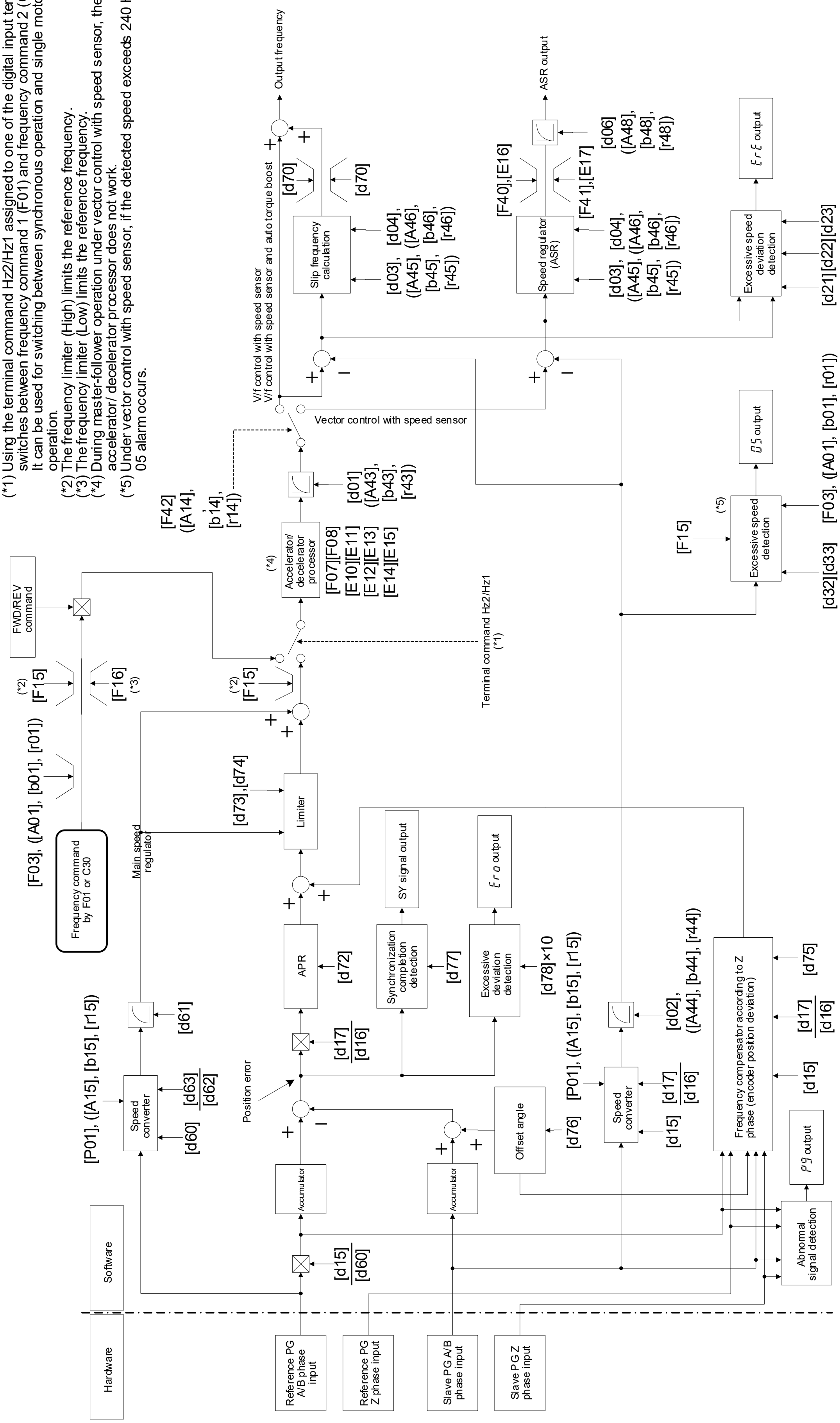


Synchronous operation (without Z phase) control block diagram (d41=2)

Chap 5 FUNCTION CODES

FUNCTION
F Codes
E Codes
C Codes
P Codes
H Codes
A Codes
b Codes
r Codes
J Codes
d Codes
U Codes
y Codes
O Codes
K Codes

(*1) Using the terminal command Hz2/Hz1 assigned to one of the digital input terminals switches between frequency command 1 (F01) and frequency command 2 (C30). It can be used for switching between synchronous operation and single motor drive operation.
(*2) The frequency limiter (High) limits the reference frequency.
(*3) The frequency limiter (Low) limits the reference frequency.
(*4) During master-follower operation under vector control with speed sensor, the accelerator/ decelerator processor does not work.
(*5) Under vector control with speed sensor, if the detected speed exceeds 240 Hz, an 05 alarm occurs.



Synchronous operation (with Z phase) control block diagram (d41=3 or 4)

■ **Master-follower operation monitoring**

The master-follower operation target position, current position, and current deviation (in angle units or pulse units) can be monitored from the keypad. Furthermore, the master-follower operation current control status can be monitored.

Monitor content

Operation monitor content for standard keypad

Standard keypad TP-M3 Remote keypad TP-E2	Multi-function keypad TP-A2SW		Item	Unit	Description
LED monitor display	Page No.	Symbol			
3_17	8	E	Target position pulse (master-follower operation)	Pulse	Displays the target position pulse count (master side position).
3_18	8	P	Current position (master-follower operation)	Pulse	Displays the current position pulse count (follower side position).
3_19	8	dP	Current deviation pulse (master-follower operation)	Pulse	Displays the current position deviation pulse count.
3_20	8	MODE	Control status monitor (master-follower operation)	-	Displays the current control status. For details, refer to the following master-follower operation status.
3_26	8	SY-d	Positioning deviation pulse (master-follower operation)	deg	Displays the current angle deviation.

Displaying system on the LED monitor

The pulse count range from -9,999,999 pulses to +9,999,999 pulses is handled on the standard keypad operation monitor pulse count display. To display such a large number, the 4-digit LED monitor shows alternately the upper and lower four digits.

The display repeatedly alternates between upper digits (1 s) → 4 lower digits (3 s) → upper digits (1 s) → 4 lower digits (3 s) → ...

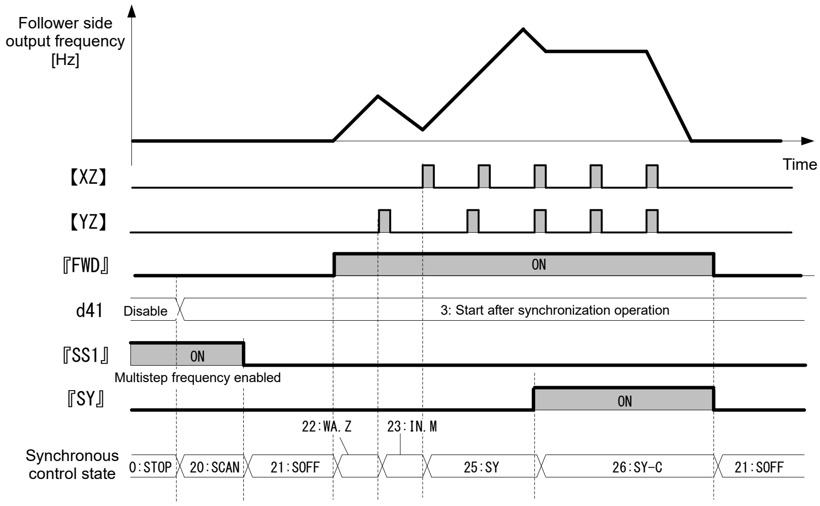
Multi-function keypad TP-A2SW displays all digits simultaneously.

Displaying system for pulse count

Pulse count	LED monitor on standard keypad, multi-function keypad, operation monitor on standard keypad		Remarks
	4 upper digits	4 lower digits	
+9,999,999	+999	9999.	Maximum display value
+19,999	+1	9999.	Empty upper digit spaces are not filled in with zeroes.
+10,000	+1	0000.	
+9,999	+0	9999.	
+10	+0	0010.	
0	0	0000.	
-10	-0	0000.	
-9,999	-0	9999.	
-10,000	-1	0000.	
-19,999	-1	9999.	
-9,999,999	-999	9999.	Minimum display value

Master-follower operation status

With master-follower operation, the running status can be monitored. The following diagram and table show a status example.



Master-follower operation status	Status name *1	Status No. *2	Description
Master-follower operation disable	STOP	0	With the function code set, master-follower operation is not selected. If **d41** is set to "Master-follower operation: 2 to 4", and **F01** or **C30** is set to "Pulse string command: 12," the setting changes to "Master-follower operation stop: 21."
Master-follower operation cancel	SCAN	20	Master-follower operation output is not enabled for reasons such as PID control being enabled, or torque control being enabled.
Master-follower operation stop	SOFF	21	The run command has not been input. If the run command is ON, and operation is being performed with Z-phase compensation, the setting changes to "22: Awaiting Z-phase detection"; if operation is performed without Z-phase compensation, the setting changes to "26: During master-follower operation (synchronization complete)."
Awaiting Z-phase detection	WA.Z	22	The Z-phase has not been detected for either the master or the follower side.
Master side Z-phase detection	IN.M	23	The master side Z-phase is detected, and the system is waiting for the follower side Z-phase to be detected.
Follower side Z-phase detection	IN.S	24	The follower side Z-phase is detected, and the system is waiting for the master side Z-phase to be detected.
During master-follower operation	SY	25	Displays the "During master-follower operation" status. However, the position deviation does not converge within the "synchronization complete" detection range.
During master-follower operation (synchronization complete)	SY-C	26	Displays the "synchronization complete" status. Outputs output terminal function "SY."

*1: The status name can be referenced on the LCD screen of the multi-function keypad TP-A2SW operation monitor.

*2: The status number can be referenced on the LCD screen of the multi-function keypad TP-A2SW operation monitor, and in Menu 3_20 "Positioning status monitor" on the standard keypad.

Alarm protective function

If the inverter protective function is triggered and an alarm occurs, an alarm code appears on the keypad LED monitor, and inverter output is shut off. As a result, the motor will coast to a stop.

Alarms relating to this option are shown in the following "List of option related alarms."

For details, refer to Chapter 6 "6.3.2 Alarm causes, checks and measures."

List of option related alarms

Alarm code	Alarm name	Function for which alarm occurred	
		Master-follower operation (without Z-phase compensation)	Master-follower operation (with Z-phase compensation)
OS	Overspeed protection	◎	◎
ErE	Speed inconsistency/excessive speed deviation	O	O
Ero	Positioning control error	◎	◎
PG *1	PG wire break	-	◎

*1 This alarm occurs if the follower side PG Z-phase detection is as follows during master-follower operation.

- If the Z-phase for 2 rotations or more is not detected since the last Z-phase detection.
- The Z-phase for 2 rotations or more has not been detected since the last Z-phase wire break detection alarm occurred.

The alarm subcode can be used to determine whether a master side Z-phase wire break or follower side Z-phase wire break has occurred.

Alarm subcode 10	Master side Z-phase wire break
Alarm subcode 11	Follower side Z-phase wire break

◎: Indicates an alarm that is always enabled when the function is selected.

O: Indicates an alarm for which the alarm protection function is enabled only when the function is selected and the function code is set to enable the alarm function.

-: Indicates an alarm that is not applicable when the function is selected.

■ **Unavailable function codes**

During master-follower operation, the following functions are not available.

F16	Frequency limiter (Lower limit)
C01 to C04	Jump frequency

Selecting "Vector control with sensor" (**F42** = 6) disables the settings of the following functions during master-follower operation, as well as making the above functions unavailable.

F07,F08	Acceleration time 1, Deceleration time 1
E10,E11	Acceleration Time 2/Deceleration Time 2
E13,E14	Acceleration Time 3/Deceleration Time 3
E15,E16	Acceleration Time 4/Deceleration Time 4
F24	Starting frequency (Holding time)
F39	Stop frequency (Holding time)

During master-follower operation, the following control should be disabled (**H18** = 0, **J01** = 0).

H18	Torque control
J01	PID control

To perform master-follower operation, be sure to select a control mode with sensor (**F42** = 3, 4 or 6) and configure the function codes given in this section. Set other function codes based on the following function code setting procedure.

d80	**Motor 1 (PMSM magnetic pole position pull-in frequency)** **Related function code: P30 Motor 1 (PMSMs magnetic pole position detection method selection)**

Under vector control with sensor for PMSMs, if using an encoder with A/B-phase and Z-phase output, the magnetic pole position will be unknown immediately after turning ON the power, and therefore magnetic pole position pull-in operation is performed at the frequency set at d80 until the Z-phase is detected. After the Z-phase is detected, the magnetic pole position based on the magnetic pole position sensor offset set in P95 is established, and operation switches to normal operation.

Basically, there is no need to modify the setting.

Data setting range: 0.1 to 10.0 Hz

d82 d83	**Magnetic flux weakening control (Sensorless vector control)** **Magnetic flux weakening lower limit (Sensorless vector control)**

By setting d82 to “1” (enable), the motor magnetic flux is controlled based on the command torque. If the command torque is low, the motor magnetic flux is weakened with d83 as the lower limit, and control stability is improved.

Set the magnetic flux weakening lower limit in % units in d83. If the value is too small, problems such as hunting or speed stagnation may occur. As long as there are no problems, use with the factory default.

d86	**Acceleration/deceleration output filter**

This code is described in detail in the F07 section.

d89	**Motor 1 (PMSM high-efficiency control)**

High-efficiency PMSM control is performed with motor constants. If wishing to run a PMSM without knowing the motor constants, or when unable to perform rotation tuning, operation may be possible by disabling high-efficiency control.

Setting	PMSM high-efficiency control
0	Disable
1	Enable

d90	**Magnetic flux level during deceleration**

This code is described in detail in the H71 section.

d79,d81 d84,d85 d88 d93 to d97	**For adjustment by manufacturer**

These function codes are for adjustment by the manufacturer. Do not access these function codes.

d91,d92 d98	**For special adjustment**

These function codes are reserved for special adjustment. There is normally no need to change these codes.

d99	**Extension function 1**

To enable the jogging operation “JOG” through communication, set bit 3=1 for this function.
d99 data can be changed using the "STOP key + ▲ key", or "STOP key + ▼ key" double operation.

Note Bits other than bit 3 of this function code are reserved bits. Do not change these bits.

FUNCTION CODES
Chap 5

FUNCTION
F Codes
E Codes
C Codes
P Codes
H Codes
A Codes
b Codes
r Codes
J Codes
d Codes
U Codes
y Codes
O Codes
K Codes

5.3.12 d1 codes (Applied functions 2)

d120 to d125	**For brake signal reverse rotation** **(Discharge current, Discharge frequency/speed, Discharge timer, Discharge torque, ON frequency/speed, ON timer)**

These codes are described in detail in the J68 section.

d132, d190, d192, d198	**For adjustment by manufacturer**

These function codes are for adjustment by the manufacturer. Do not access these function codes.

5.3.13 d2 codes (Applied functions 2)

[1] Orientation

d204 to d299	Orientation

■ **Orientation**

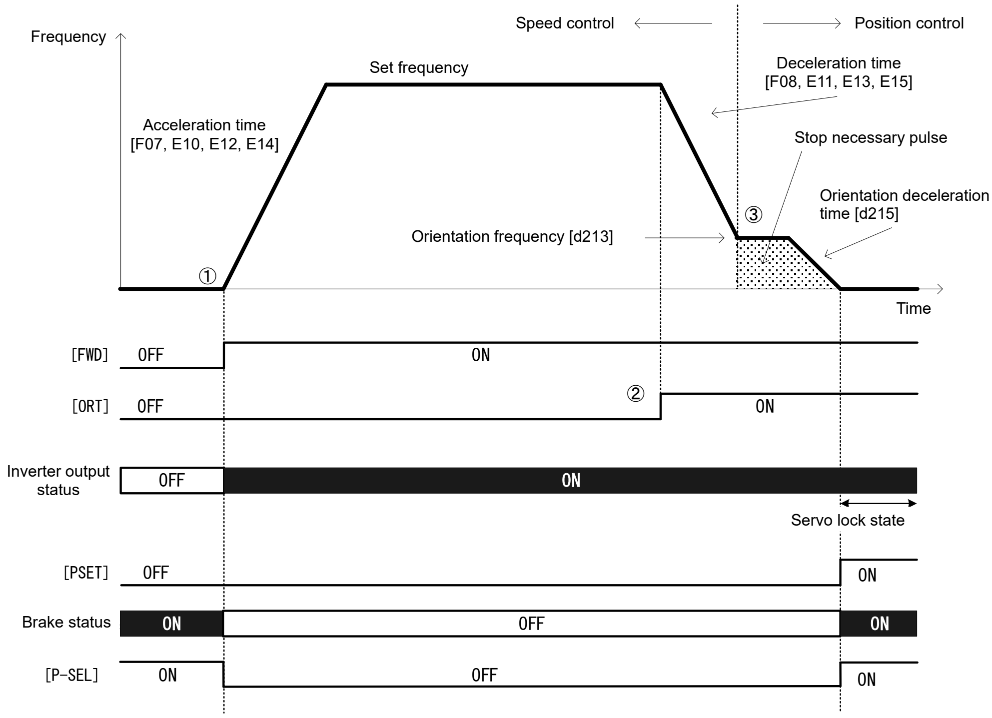
The orientation function can be used.
Orientation can be performed with speed control during operation or while stopped.

Orientation cannot be performed when using PMSMs.

Orientation during speed control

Move the motor being rotated under speed control to the prescribed machine position. By turning ON digital input “ORT” while the motor is being run under speed control, the motor decelerates to the orientation frequency d213 in the selected deceleration time, the mode changes to position control mode, the amount of rotation at which the motor is able to decelerate and stop at orientation deceleration time d215 from the current position to the selected positioning data position is calculated, and the motor then stops after rotating by that amount.

Positioning data can be selected with digital input positioning data selection signals “POS-SEL1”, “POS-SEL2”, and “POS-SEL4” from positioning data 1 to 8 (d244 to d259). If providing positioning data with the factory default absolute position (ABS), this will be the absolute position with the encoder Z-phase as the reference. If wishing to provide positioning data as the absolute position with the machine home position as the reference instead of the encoder Z-phase, by setting a position offset for the encoder Z-phase-machine home position in homing shift d242 and d243, positioning data 1 to 8 (d244 to d259) can be used as machine home position positioning data as is.



Orientation while performing speed control

Note By turning orientation command “ORT” OFF while stopped during orientation, the motor accelerates to the set frequency and speed control is resumed.

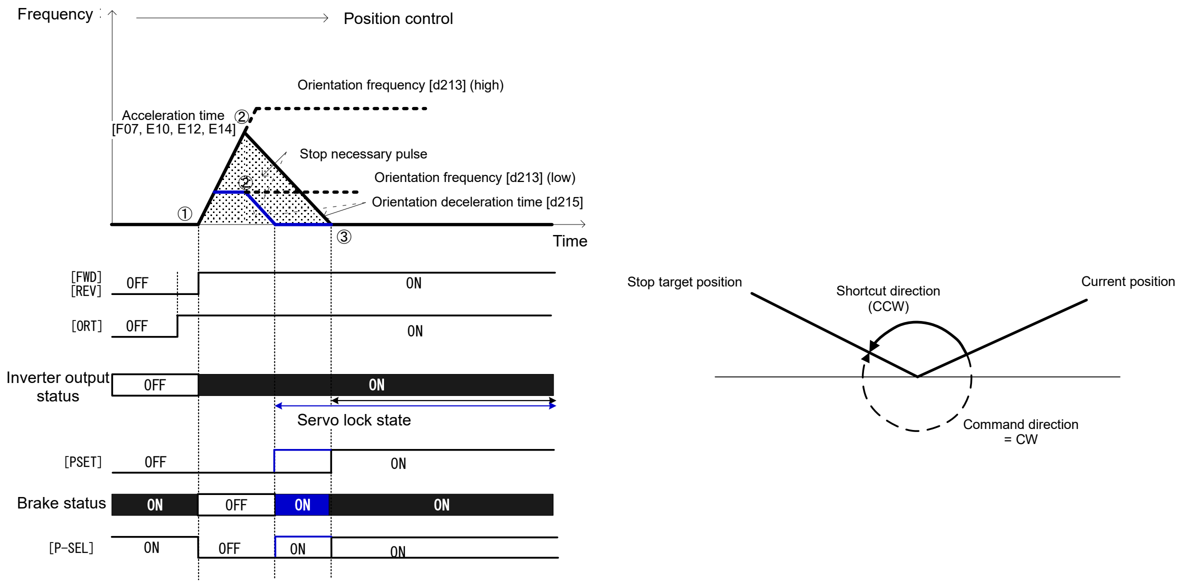
FUNCTION CODES

Chap 5

<u>Performing orientation while the motor is stopped</u>

When positioning with orientation is complete, if under vector control with sensor, the servo lock is applied, and digital output “PSET” is output if the position deviation is within in-position range d239. If the positioning position is changed, “POS-SET” is turned ON, and orientation is performed again from this condition, position control is applied, and positioning is performed within a single motor rotation. At this time, the “shortcut” operation which performs positioning in the shortest distance regardless of the direction in which the motor is running, and the “no shortcut” operation performed in the run command direction can be selected with d208.
If under V/f control with sensor, DC braking is applied, and the inverter maintains output.
If performing orientation while the motor is stopped, the motor will not rotate more than once, even if a value of more than one rotation is set in the positioning data.

By turning the run command ON after turning ON orientation command “ORT” while inverter output is stopped, orientation is performed immediately without running to the set frequency under speed control. However, if orientation command “ORT” is turned ON and operation is performed while the motor is stopped immediately after turning the power ON, orientation must be performed after running for one rotation or more under speed control in order to detect the Z-phase.



Orientation operation when the motor is stopped

Note If performing orientation, mount an encoder on the machine shaft. However, if the machine shaft is directly connected to the motor shaft, mount the encoder on the motor shaft. Orientation can be performed only if the Z-phase can be detected in the same positional relationship only once during one rotation of the machine axis.

If using the orientation function, and the motor/machine shaft transmission ratio (reduction ratio) is (approximately) 5 times or less, vector control with sensor used to perform speed feedback control with the machine shaft encoder can be selected for the control method.
Under vector control with sensor, the servo lock is applied after positioning stops, resistance torque is produced and the stop position is held, even if an external force is applied after stopping.

On the other hand, if the machine shaft and motor shaft transmission ratio (reduction ratio) is large, it will be difficult to detect the motor speed when the motor is rotating at low speed without the use of an encoder with high pulse count, and it may no longer be possible to demonstrate sufficient motor performance. On machines on which it is not possible to use an encoder with high pulse count, and with large transmission ratio, use V/f control with sensor instead of vector control with sensor which performs speed feedback control from the machine shaft encoder. Under v/f control with sensor, it is not possible to apply the servo lock. If an external force is applied after the motor stops, use the machine brake. Furthermore, under V/f control with sensor, torque is generated at ultra-low speed immediately before stopping, and therefore it may be necessary to adjust the torque boost or set auto torque boost.

Note Under feedback control with the machine shaft encoder, if the belt tension, etc. is insufficient for the connection between the “machine shaft” and “encoder shaft” or between the “machine shaft” and “motor shaft”, the performance of feedback control with the machine shaft encoder will drop, and in the worst-case scenario, an alarm may occur. It is therefore necessary to pay sufficient attention to mechanical system rigidity.

Function code	Name	Permissible setting range	Unit	Remarks
From E01 E05, E98, E99	Terminal [X1] to [X5] function Terminal [FWD] (Function selection) Terminal [REV] (Function selection)	78 (1078): Select speed control parameters 1 “MPRM1” 79 (1079): Select speed control parameters 2 “MPRM2” 135 (1135): Displacement/absolute position switching "INC/ABS" 136 (1136): Orientation command "ORT" 142 (1142): Position preset command "P-PRESET" 144 (1144): Positioning data change command "POS-SET" 145 (1145): Positioning data selection 1 "POS-SEL1" 146 (1146): Positioning data selection 2 "POS-SEL2" 147 (1147): Positioning data selection 4 "POS-SEL4"	-	
E20 to E22, E27	Terminal [Y1] to [Y2] (Function selection) Terminal [30A/B/C] (Function selection)	82 (1082): Positioning complete “PSET”	-	
d03, A45, b45, r45	Speed control P (Gain)	0.01 to 200.0	Times	
d04, A46, b46, r46	I (Integral time)	0.000 to 5.000	s	
d204	Position regulator gain	0.1 to 300.0	Times	
d206	Electronic gear denominator	1 to 65535	-	
d207	Electronic gear numerator	1 to 65535	-	
d208	Orientation mode selection	0: With shortcut (run command direction and reverse rotation) 1: Without shortcut (run command direction)	-	
d209	Orientation mode selection	0 to 15 (00 to 0F) Bit 7: Z-phase compensation 0: Disable 1: Enable	-	
d213	Homing frequency/orientation frequency	0.1 to 599.0	Hz	
d215	Homing deceleration time/orientation deceleration time	0.00 to 6000 * When set to 0.00, acceleration/deceleration time is canceled.	s	
d216	Positioning data teaching	0: Disable 1 to 8: Writes to positioning data 1 to 8	-	
d217	Homing shift teaching	0: Disable 1: Writing enabled	-	
d237	Positioning data selection (INC/ABS switching)	0: Handle positioning data as absolute position (ABS) 1: Handle positioning data as travel (INC)	-	
d238	Positioning data selection agreement timer	0.000 to 0.100	s	
d239	Positioning complete range	0 to 9999	U	

Function code	Name	Permissible setting range	Unit	Remarks
d240	Preset position - 4 higher order digits	-9999 to +9999	U	
d241	Preset position - 4 lower order digits	0 to 9999	U	
d242	Homing shift value - 4 higher order digits	0 to 9999	U	
d243	Homing shift value - 4 lower order digits	0 to 9999	U	
d244	Positioning data 1 - 4 higher order digits	-9999 to +9999	U	
d245	Positioning data 1 - 4 lower order digits	0 to 9999	U	
d246	Positioning data 2 - 4 higher order digits	-9999 to +9999	U	
d247	Positioning data 2 - 4 lower order digits	0 to 9999	U	
d248	Positioning data 3 - 4 higher order digits	-9999 to +9999	U	
d249	Positioning data 3 - 4 lower order digits	0 to 9999	U	
d250	Positioning data 4 - 4 higher order digits	-9999 to +9999	U	
d251	Positioning data 4 - 4 lower order digits	0 to 9999	U	
d252	Positioning data 5 - 4 higher order digits	-9999 to +9999	U	
d253	Positioning data 5 - 4 lower order digits	0 to 9999	U	
d254	Positioning data 6 - 4 higher order digits	-9999 to +9999	U	
d255	Positioning data 6 - 4 lower order digits	0 to 9999	U	
d256	Positioning data 7 - 4 higher order digits	-9999 to +9999	U	
d257	Positioning data 7 - 4 lower order digits	0 to 9999	U	
d258	Positioning data 8 - 4 higher order digits	-9999 to +9999	U	
d259	Positioning data 8 - 4 lower order digits	0 to 9999	U	
d277	Positioning data communication command selection	0: Disable positioning data communication command (S20, S21) 1: Enable positioning data communication command (S20, S21)	-	

■ **d204 Position regulator gain**

■ **d03, A45, b45, r45 Speed control P (Gain)**

■ **d04, A46, b46, r46 Speed control (Integral time)**

The position control responsiveness during deceleration and while the motor is stopped can be changed for the orientation operation.
The greater the setting value, the more the responsiveness improves, settling time is reduced, and the holding force while the stopped motor is being held by the servo lock increases, but hunting will occur if the setting value is too large. Adjust so that hunting does not occur.
Furthermore, if the speed regulator gain is too high, adjust the speed regulator (ASR) also.
If switching the speed control P (gain) and I (integral time), use parameter selection 1 “MPRM1” and 2 “MPRM2”.

Refer to the d03, d04 explanation for details on the speed control P (gain) and I (integral time).

Note
- By suddenly increasing the position regulator gain or speed regulator (ASR) gain, motor hunting may occur, possible resulting in equipment damage. Do not increase the setting values for these gain setting function codes suddenly. Furthermore, do not decrease the integral time setting function code data suddenly.
- If the encoder pulse count is low, it will not be possible to increase the gain setting value.

■ **d206, d207: Electronic gear ratio (Denominator, Numerator)**

Positioning data for orientation can be handled with user values such as angle and pulse count.

If using a PG with pulse count of 1024 (pulse/rev), and the travel per user value is set to 1 [pulse/user value] for the equivalent pulse count before multiplying the PG pulse by 4

$$\frac{\text{Electronic gear numerator}}{\text{Electronic gear denominator}} = \frac{\text{Travel per user value}}{\text{Travel per PG pulse}} = \frac{\frac{1}{4 \times 1024}\,[\text{rev/user value}]}{\frac{1}{1024}\,[\text{rev/pulse}]} = \frac{1}{4}\,[\text{pulse/user value}]$$

If handled with travel per user value of 0.01 [°/user value], travel of 360.00 [°/rev] per motor rotation, and PG pulse count of 4096 (1024 x multiplication by 4) [pulse/rev]

$$\frac{\text{Electronic gear numerator}}{\text{Electronic gear denominator}} = \frac{\text{Travel per user value}}{\text{Travel per PG pulse}} = \frac{0.01\,[°/\text{user value}]}{\frac{360.00\,[°/\text{rev}]}{4096\,[\text{pulse/rev}]}} = \frac{4096}{36000}\,[\text{pulse/user value}]$$

■ **d208: Orientation mode selection**

If d208 = 0, the motor rotates in the direction (shortcut) which requires the least movement to the positioning data specified from the current position, regardless of the run command direction. However, if the motor has not been run even once immediately after turning ON the power, the nearest direction will not be known, and therefore the motor runs in the run command direction, and orientation is performed. Positioning is then performed with a shortcut.
If d208 = 1, the motor starts moving in the normal run command direction, and orientation is performed.

■ **d209: Homing mode selection**

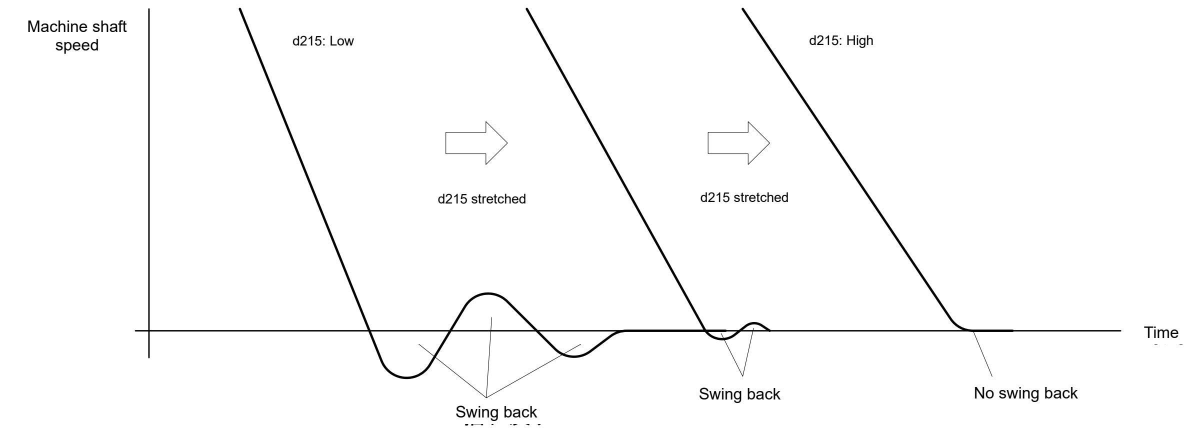
There may be variations in the output timing with the A-phase and B-phase pulses, and the Z-phase pulses in the pulse encoder.
When using the motor for forward rotation and reverse rotation, if a 1 pulse position displacement occurs at the machine side when positioning is performed to the same position, set d209 bit 7: Z-phase compensation to 1. By enabling this compensation, it is possible to suppress position displacement resulting from the rotation direction.

■ **d213 Homing/Orientation frequency**

This is the frequency used when switching from speed control to position control with orientation command “ORT” from speed control.
If the set frequency is high, the time until in-position is achieved will become longer, and if torque limiting deceleration is being performed, an Excessive position deviation (*d0*) alarm may occur. If performing torque limiting deceleration, set the frequency when switching from speed control to position control as low as possible.
If the set frequency is low under V/f control with sensor, it will be difficult to position the motor at the specified position without adjusting the torque boost or using auto torque boost. Adjust orientation deceleration time d215, and both Position regulator gain 1 (low speed range) (d203) and Position regulator gain 2 (high speed range) (d204) so that the prescribed settling time is obtained to suit the control method.

■ d215 Homing/Orientation deceleration time

Sets the deceleration time from orientation speed d213. Adjust this time if there is any overshoot or swing back relative to the specified position, allowing the settling time to be adjusted.

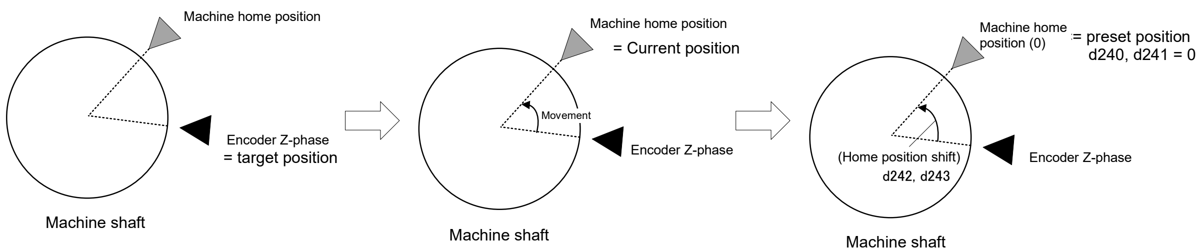


■ d240, d241: Preset position

The command current position and feedback current position can be set to the desired position with the machine homing position as the reference.
With orientation, the position offset with the machine homing position and encoder Z-phase are normally handled as the homing shift, and therefore preset position d240 and d241 should be set to 0.

■ d242, d243: Homing shift value

The homing shift value for orientation is equivalent to the position offset with the machine homing position and encoder Z-phase.
Adjust the homing shift using the following procedure.



1) By turning ON the orientation command with the target position as 0, positioning is performed with the encoder Z-phase as the home position.
2) After this, by setting d217 = 1, running the motor, moving the machine shaft to the machine home position and stopping, and turning ON Position preset “P-PRESET,” feedback current position monitor d298 and d299 and homing shift value d242 and d243 are automatically set based on preset position d240 and d241. Return d217 to 0 after setting. Be sure to rotate the encoder once or more and perform position preset after the Z-phase is detected.
3) For confirmation purposes, perform orientation again to set the target position to 0 (home position), perform orientation, and ensure that it can be performed to the machine home position.

■ d244 to d259 Positioning data 1 to 8, d238 Positioning data selection agreement timer

Sets the positioning position for orientation. Up to 8 points can be set, and multi-point positioning can be performed consecutively by using positioning data selection 1 to 4 (POS-SEL1 to 4). By using d216, the current machine shaft position is read, allowing positioning data to be set easily. When switching positioning data using the positioning data selection signal, set a time equal to or longer than the time required for chattering to settle for d238 in order to prevent malfunction due to chattering. If changes are made to the positioning data with the run command ON, be sure to turn ON Positioning data change command “POS-SET.” Positioning data changes while the run command is OFF are set again when starting operation, and therefore there will be no need to turn ON Positioning data change command “POS-SET.”
If performing orientation, unlike with position control, the position is automatically corrected to a position within a single rotation when running the motor, even if a value for a single rotation or more is set in the positioning data.

■ d277 Positioning data communication command selection

If wishing to perform positioning using positioning data (S20, S21) from communication to perform orientation, set d277 to 1 in the same way as with position control to enable positioning commands from communication.

■ Functions that are disabled with position control

The following functions are disabled when position control/speed control switching “POS/Hz” is ON and the run command is ON.

Jogging operation, PID control, start frequency hold, stop frequency hold, momentary power failure restart, retry, offline tuning, anti-regenerative control, overload prevention, deceleration mode (H11), torque control

■ Position monitor

The feedback current position and command current position can be monitored on the keypad. The feedback current position is the position converted to a user value by adding up the total number of feedback pulses. The command current position is not the target position, but rather the momentary command position based on the position command pattern, and is the same value as the feedback current position while the motor is stopped.

Function code	Name	Permissible setting range	Unit	Remarks
d296	Command current position monitor - 4 higher order digits	-9999 to +9999	U	
d297	Command current position monitor - 4 lower order digits	0 to 9999	U	
d298	Feedback current position monitor - 4 higher order digits	-9999 to +9999	U	
d299	Feedback current position monitor - 4 lower order digits	0 to 9999	U	

5.3.14 U codes (Customizable Logic)

5.3.15 U1 codes (Customizable Logic)

The customizable logic function allows the user to form a logic or operation circuit for digital/analog input/output signals, customize those signals as desired, and configure a simple relay sequence inside the inverter.
The customizable logic editor function in the FRENIC-Loader4 inverter support software can be used to create logic or operation circuits, convert them to function codes, and transfer settings to the inverter. For details, refer to the FRENIC-Loader4 Instruction Manual (INR-SI47-2104).

In the customizable logic,
(1) Digital 2 inputs, digital 1 output + logical operation (including timer)
(2) Analog 2 inputs, analog 1 output/digital 1 output + numerical operation
(3) Analog 1 input, digital 1 input, analog 1 output + numerical operation, logical operation
(4) Function code reading, writing, switching, linking, and bit extraction
can be set as a single step (configuration element), and sequences can be combined using up to 260 steps.

■ **Specifications**

Item	Specifications			
Input signal	Digital 2 input	Analog 2 input	Analog 1 input Digital 1 input	Function code operation
Operation block	Logical operation, counter, etc.: 15 types Timer: 5 types 66 type combinations	Numerical operation, comparator, limiter, etc.: 29 types	Selector, hold, etc.: 9 types	Reading, writing, etc.: 9 types
Output signal	Digital 1 output	Analog 1 output/ digital 1 output	Analog 1 output	Function code Digital 1 output
Max. number of steps	260 steps (single task)			
Customizable logic output signal	Total number digital, analog outputs: 14 Digital: Can be assigned to inverter [Y1] to [Y2], [30ABC], OPC-DIO option card [O1] to [O8], OPC-CP-RY option card [Y6A] to [Y8A] Analog: inverter [FM1], [FM2]			
User-defined alarm	Dedicated customizable logic alarms: 5 The inverter is stopped following an alarm, or a warning only can be output while the inverter continues to run (when warning assigned).			
Customizable logic processing cycle / Single task	2 ms (10 steps max.), 5 ms (50 steps max.), 10 ms (100 steps max.), 20 ms (260 steps max.) The cycle can be selected with function code U100, but it is dependent on the maximum number of steps. (1) All external input signals up to the maximum step are latched at the beginning of the processing cycle to maintain synchronism. (2) Calculations are performed in order from step 1 to the maximum step. The calculation cycle differs depending on the number of steps. (3) If output for a certain step is input to the next step, output for steps with high processing priority can be used with low priority steps in the same cycle. (4) 14 customizable logic output signals (CLO1 to 14) are updated simultaneously at the end of the processing cycle.			
Customizable logic cancellation command “CLC”	By assigning “CLC” to digital input terminal and turning it ON, all customizable logic operations can be stopped. It is used when you want to deactivate the customizable logic temporarily.			
Customizable logic timer cancellation command “CLTC”	By assigning “CLTC” to digital input terminal and turning it ON, all timers, counters, and previous values used with customizable logic are reset. It is used when a customizable logic is changed or if you want to synchronize it with external sequence.			

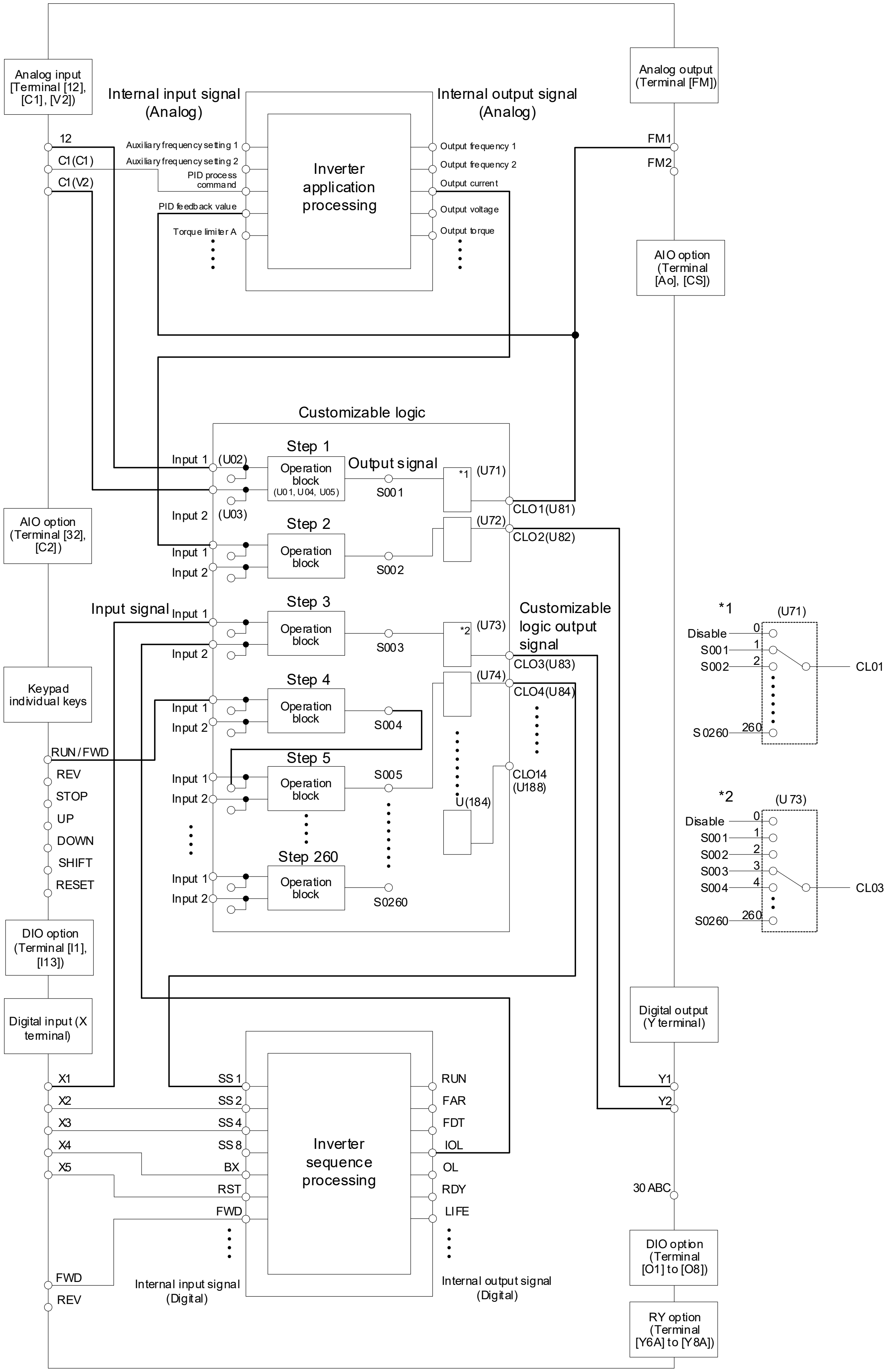
Note If you use the customizable logic cancellation command and customizable logic timer cancellation command, the inverter can unintentionally start because the speed command is unmasked, depending on the structure of the customizable logic. Be sure to turn OFF the operation command to turn it ON.

Failure to observe this could result in injury.

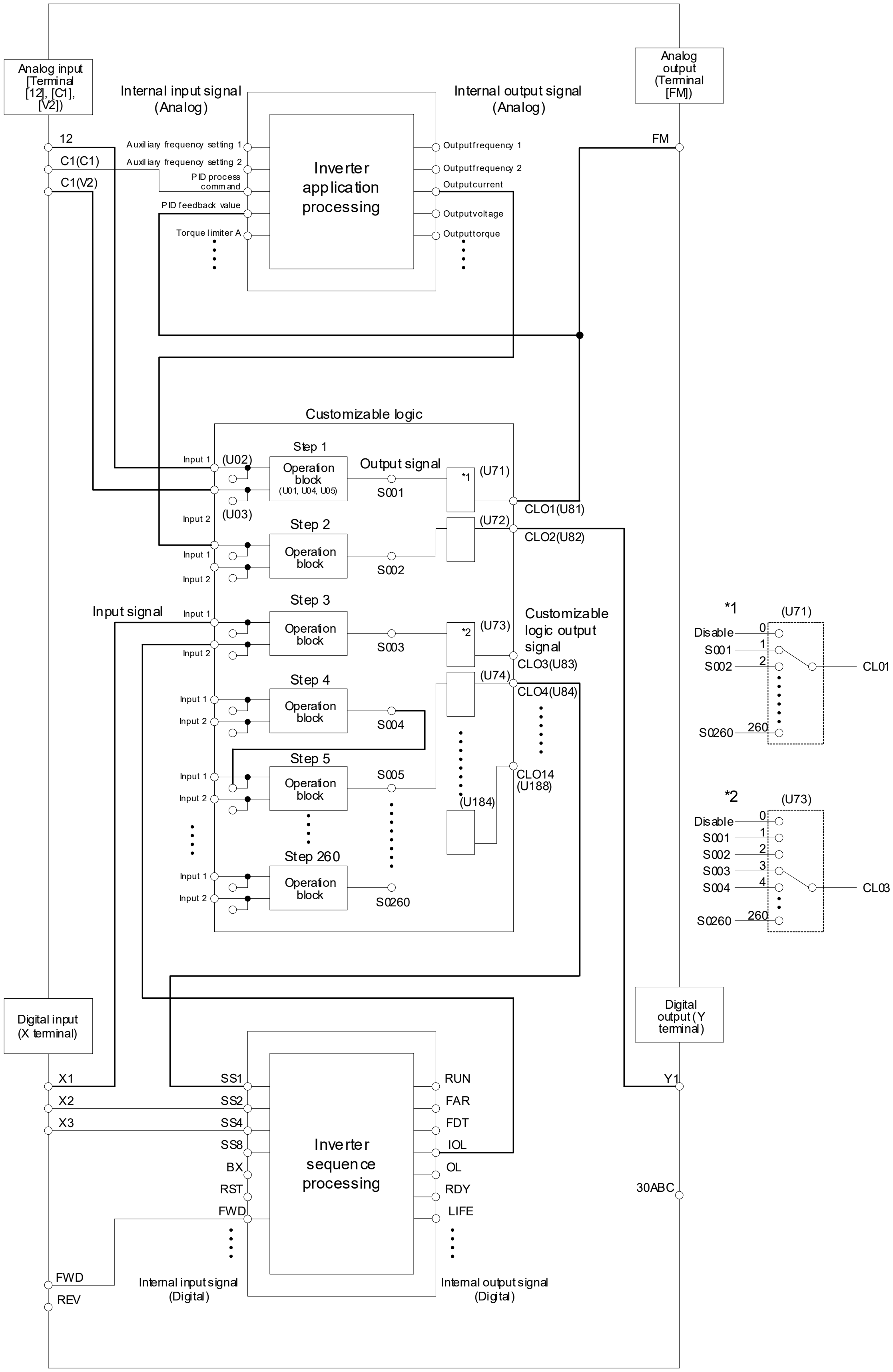
Failure to observe this could result in failure.

■ Block diagram

[E3S]



[E3N]



Note Mode selection function codes for enabling customizable logic can be modified during operation but the customizable logic output may become temporarily unstable due to the setting modification. Therefore, since unexpected operation can be performed, change the settings if possible when the inverter is stopped.

Failure to observe this could result in injury or failure.

FUNCTION CODES
Chap 5
FUNCTION
F Codes
E Codes
C Codes
P Codes
H Codes
A Codes
b Codes
r Codes
J Codes
d Codes
U Codes
y Codes
O Codes
K Codes

U00	**Customizable logic (Operation selection)**
U01 to U70	**Customizable logic: Step 1 to 14 (Block selection, Input 1/2, Function 1/2)**
U71 to U80	**Customizable logic: Output signal 1 to 10 (Output selection)**
U81 to U90	**Customizable logic: Output signal 1 to 10 (Function selection)**
U91	**Customizable logic: Timer monitor (Step selection)**
U92 to U97	**Customizable logic: Calculation coefficient**
U100	**Customizable logic: Task process cycle setting**
U101 to U106	**Customizable logic: Conversion operation 1 (X, Y) to 3 (X, Y)**
U107	**Customizable logic: Automatic conversion coefficient calculation**
U121 to U170	**Customizable logic: User parameters 1 to 50**
U171 to U180	**Customizable logic: Storage area 1 to 10**
U181 to U184	**Customizable logic: Output signal 11 to 14 (Function selection)**
U185 to U188	**Customizable logic: Output signal 11 to 14 (Output selection)**
U190 to U195	**Customizable logic: Step setting**

■ **Customizable Logic (Operation selection) (U00)**

U00 specifies whether to enable the sequence configured with the customizable logic function or disable it to run the inverter only via its input terminals or others.

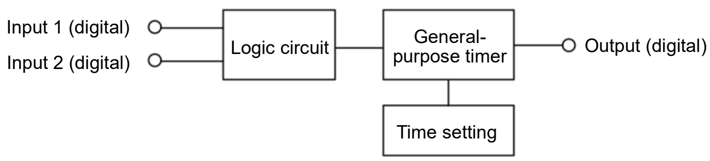
U00 data	Function
0	Disable
1	Enable (Customizable logic operation)

The ECL alarm occurs when changing U00 from 1 to 0 during operation.

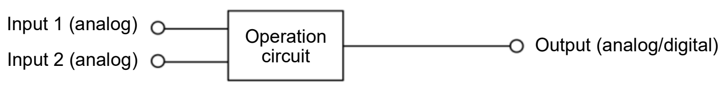
■ **Customizable Logic (Operation setting) (U01 to U70, U190 to U195)**

In the customizable logic, the steps are categorized in the following three types:

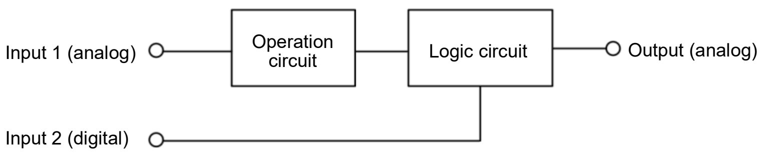
[Input: digital] Block selection (U01, U06, U11, etc.) = 1 to 1999



[Input: analog] Block selection (U01, U06, U11, etc.) = 2001 to 3999



[Input: digital, analog] Block selection (U01, U06, U11, etc.) = 4001 to 5999



The function code settings for each step are as follows:

• Steps 1 to 14

Step No.	Block selection	Input 1	Input 2	Function 1	Function 2	Output Note)
Step 1	U01	U02	U03	U04	U05	"SO01"
	= 1 to 1999	Digital input 1	Digital input 2	Time setting	Don't care	Digital output
	= 2001 to 3999	Analog input 1	Analog input 2	Value 1	Value 2	Analog/digital output
	= 4001 to 6999	Analog input 1	Digital input 2	Value 1	Value 2	Analog output
Step 2	U06	U07	U08	U09	U10	"SO02"
Step 3	U11	U12	U13	U14	U15	"SO03"
Step 4	U16	U17	U18	U19	U20	"SO04"
Step 5	U21	U22	U23	U24	U25	"SO05"
Step 6	U26	U27	U28	U29	U30	"SO06"
Step 7	U31	U32	U33	U34	U35	"SO07"
Step 8	U36	U37	U38	U39	U40	"SO08"
Step 9	U41	U42	U43	U44	U45	"SO09"
Step 10	U46	U47	U48	U49	U50	"SO10"
Step 11	U51	U52	U53	U54	U55`	"SO11"
Step 12	U56	U57	U58	U59	U60	"SO12"
Step 13	U61	U62	U63	U64	U65	"SO13"
Step 14	U66	U67	U68	U69	U70	"SO14"

Note) "Output" is not a function code. It indicates the output signal symbol.

• Steps 15 to 260

Specify a step number in U190, and set the block selection, input 1, input 2, function 1, function 2 in U191 to U195 respectively.

Step No.	U190	Block selection	Input 1	Input 2	Function 1	Function 2	Output
Step 15	15	U191	U192	U193	U194	U195	"SO15"
Step 16	16						"SO16"
...	···						...
Step 259	259						"SO259"
Step 260	260						"SO260"

Chap 5 FUNCTION CODES

FUNCTION
F Codes
E Codes
C Codes
P Codes
H Codes
A Codes
b Codes
r Codes
J Codes
d Codes
U Codes
y Codes
O Codes
K Codes

[Input: digital] Block function code setting

■ **Block selection (U01 etc.)**

The following items are available as logic circuits (with a general-purpose timer). Select the timer type with the units, and the logic circuit with the tens and the hundreds.

The data can be logically inverted by adding 1000.

Data	Logic circuit	Description
0	No function assigned	Output is always OFF.
10	Through output + General-purpose timer (No timer)	Only a general-purpose timer. No logic function block exists.
11	(On-delay timer)	Turning the input signal ON starts the on-delay timer. When the period specified by the timer has elapsed, the output signal turns ON. Turning the input signal OFF turns the output signal OFF.
12	(Off-delay timer)	Turning the input signal ON turns the output signal ON. Turning the input signal OFF starts the off-delay timer. When the period specified by the timer has elapsed, the output signal turns OFF.
13	(Pulse (One-shot))	Turning the input signal ON issues a one-shot pulse whose length is specified by the timer.
14	(Retriggerable timer)	Turning the input signal ON issues a one-shot pulse whose length is specified by the timer. If the input signal is turned ON again during the preceding one-shot pulse length, however, the logic function block issues another one-shot pulse.
15	(Pulse string output)	If the input signal turns ON, the logic function block issues ON and OFF pulses (whose lengths are specified by the timer) alternately and repeatedly. This function is used to flash a luminescent device. You can set the ON pulse time and the OFF pulse time separately by combining through output, logical AND, logical OR, logical XOR, and hold.
16	(On/Off-delay timer)	The functions of both the on-delay timer and off-delay timer can be used.
20 to 26	Logical AND + general-purpose timer	AND function with 2 inputs and 1 output, plus general-purpose timer.
30 to 36	Logical OR + general-purpose timer	OR function with 2 inputs and 1 output, plus general-purpose timer.
40 to 46	Logical XOR + general-purpose timer	XOR function with 2 inputs and 1 output, plus general-purpose timer.
50 to 55	Set priority flip-flop + general-purpose timer	Set priority flip-flop with 2 inputs and 1 output, plus general-purpose timer. The initial output status can be specified with function 2. (0: OFF, other than 0: ON)
60 to 65	Reset priority flip-flop + general-purpose timer	Reset priority flip-flop with 2 inputs and 1 output, plus general-purpose timer. The initial output status can be specified with function 2. (0: OFF, other than 0: ON)
70, 72, 73	Rising edge detector + general-purpose timer	Rising edge detector with 1 input and 1 output, plus general-purpose timer. This detects the rising edge of an input signal and outputs the ON signal for 1 ms(*1).

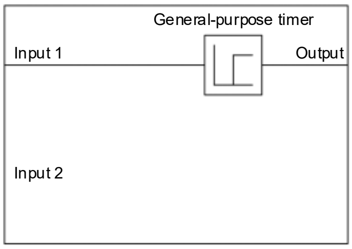
*1 Equals the task cycle. 2 ms for a task cycle of 2 ms, 5 ms for 5 ms, 10 ms for 10 ms, and 20 ms for 20 ms.

Data	Logic circuit	Description
80, 82, 83	Falling edge detector + general-purpose timer	Falling edge detector with 1 input and 1 output, plus general-purpose timer. This detects the falling edge of an input signal and outputs the ON signal for 1 ms (*1).
90, 92, 93	Rising & falling edges detector + general-purpose timer	Rising and falling edge detector with 1 input and 1 output, plus general-purpose timer. This detects both the falling and rising edges of an input signal and outputs the ON signal for 1 ms (*1).
100 to 106	Hold + general-purpose timer	Hold function of previous values of 2 inputs and 1 output, plus general-purpose timer. If the hold control signal is OFF, the logic function block outputs input signals; if it is ON, the logic function block retains the previous values of input signals.
110	Increment counter	Increment counter with reset input. By the rising edge of the input signal, the logic function block increments the counter value by one. When the counter value reaches the target one, the output signal turns ON. Turning the reset signal ON resets the counter to zero.
120	Decrement counter	Decrement counter with reset input. By the rising edge of the input signal, the logic function block decrements the counter value by one. When the counter value reaches zero, the output signal turns ON. Turning the reset signal ON resets the counter to the initial value.
130	Timer with reset input	Timer output with reset input. If the input signal turns ON, the output signal turns ON and the timer starts. When the period specified by the timer has elapsed, the output signal turns OFF, regardless of the input signal state. Turning the reset signal ON resets the current timer value to zero and turns the output OFF.
140 to 145	D flip-flop + general-purpose timer	2 input 1 output D flip-flop and general-purpose timer Applies the input 1 signal status to the output signal at the input 2 signal rising edge. The initial output status can be specified with function 2. (0: OFF, other than 0: ON)
150 to 155	T flip-flop + general-purpose timer	1 input 1 output T flip-flop and general-purpose timer Inverts the output signal at the input signal rising edge. The initial output status can be specified with function 2. (0: OFF, other than 0: ON)

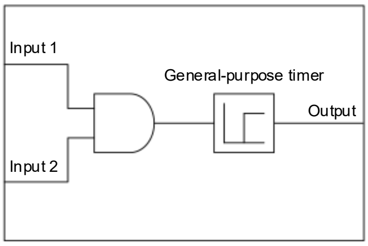
The data can be logically inverted by adding 1000.

The block diagrams for individual functions are given below.

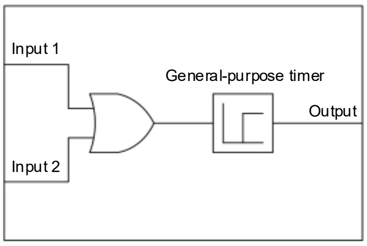
(Data=1☐) Through output



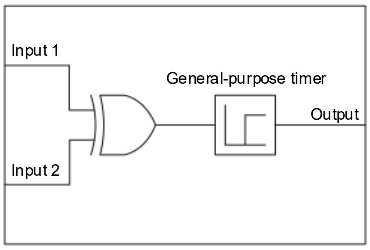
(Data=2☐) Logical AND



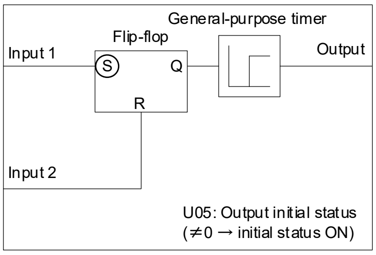
(Data=3☐) Logical OR



(Data=4☐) Logical XOR

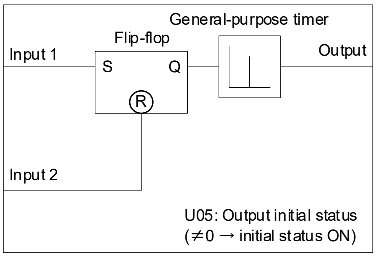


(Data=5☐) Set priority flip-flop



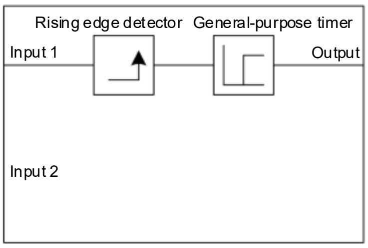
Input 1	Input 2	Previous output	Output	Remarks
OFF	OFF	OFF	OFF	Hold previous value
		ON	ON	
	ON	-	OFF	
ON	-	-	ON	Set priority

(Data=6☐) Reset priority flip-flop

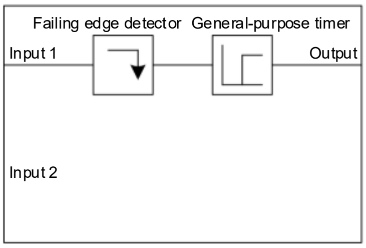


Input 1	Input 2	Previous output	Output	Remarks
OFF	OFF	OFF	OFF	Hold previous value
		ON	ON	
-	ON	-	OFF	Reset priority
ON	OFF	-	ON	

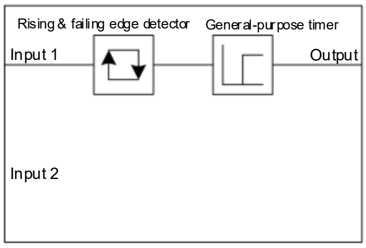
(Data=7☐) Rising edge detector



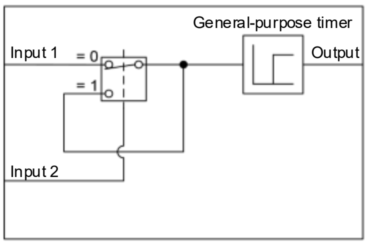
(Data=8☐) Falling edge detector



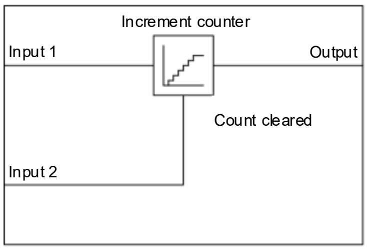
(Data=9☐) Rising & falling edges detector



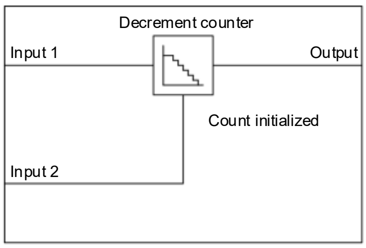
(Data=10☐) Hold



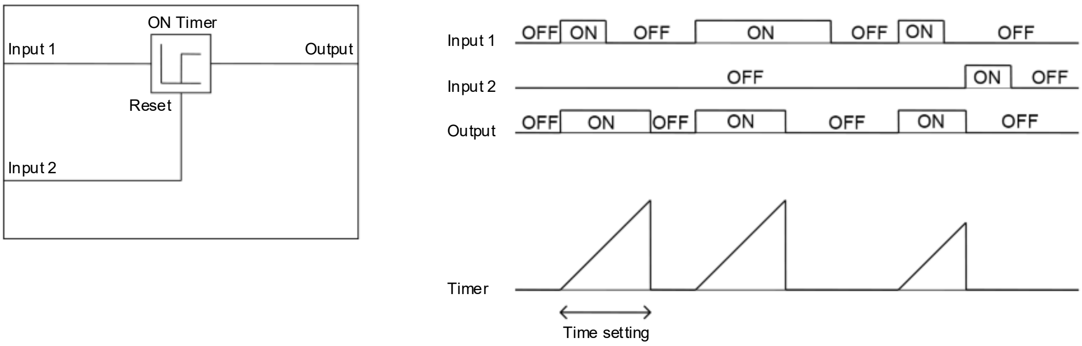
(Data=110) Increment counter



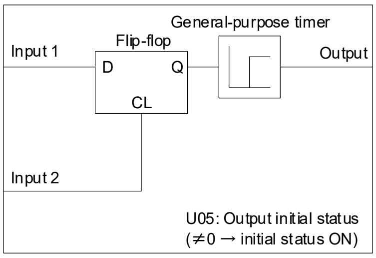
(Data=120) Decrement counter



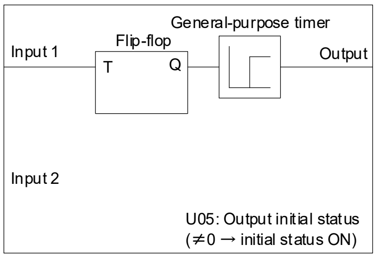
(Data=130) Timer with reset input



(Data=14☐) D flip-flop



(Data=15☐) T flip-flop

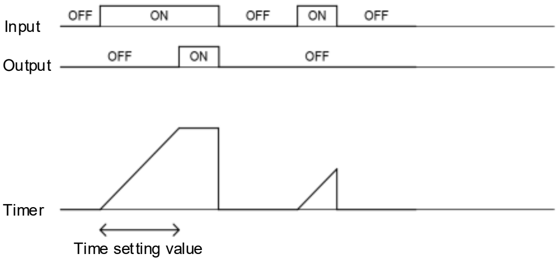


FUNCTION CODES
Chap 5
FUNCTION
F Codes
E Codes
C Codes
P Codes
H Codes
A Codes
b Codes
r Codes
J Codes
d Codes
U Codes
y Codes
O Codes
K Codes

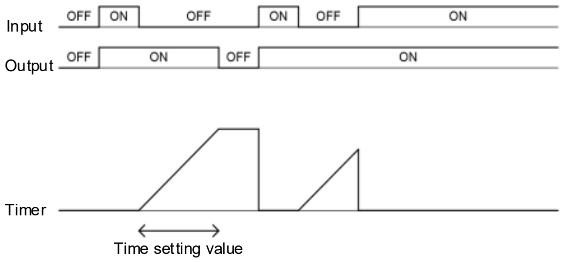
■ **Operation of general-purpose timer**

The operation schemes for individual timers are shown below.

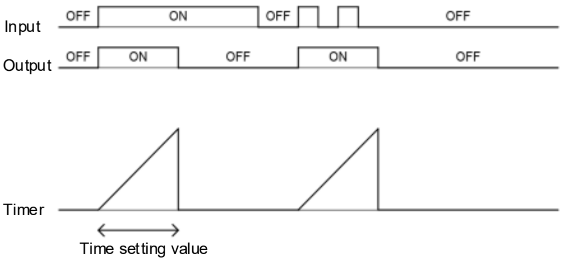
(End 1) On-delay timer



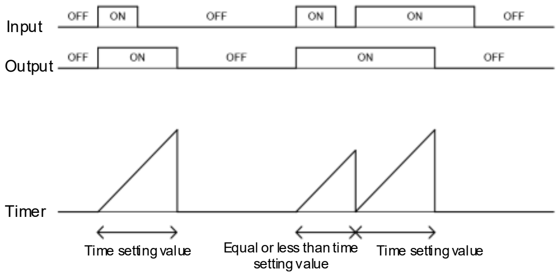
(End 2) Off-delay timer



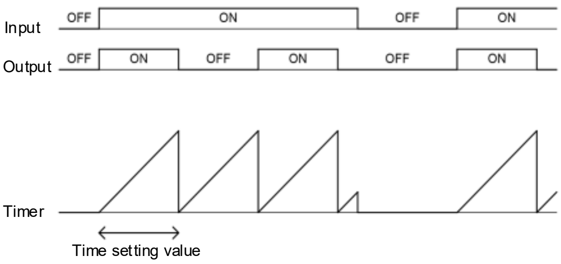
(End 3) Pulse (One-shot)



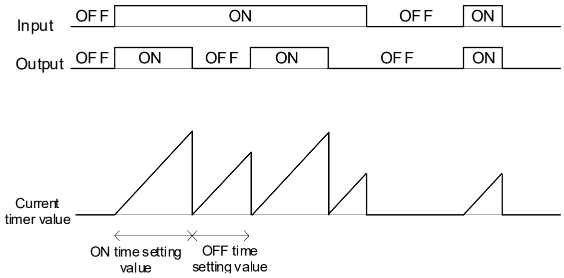
(End 4) Retriggerable timer



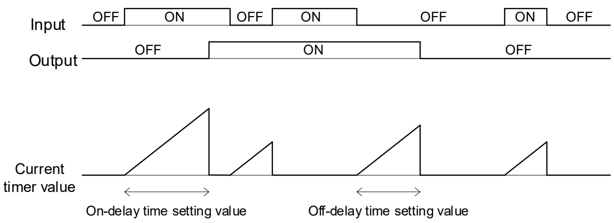
(End 5) Pulse string output



Pulse string output (when individual settings are possible)



(End 6) Off-delay timer



■ **Inputs 1 and 2 (U02, U03, etc.)**

The following digital signals are available as input signals. Value in ( ) is in negative logic.

Data	Selectable signals
0000（1000） ～ 0251（1251）	Digital output signals (Same as the ones specified by function code E20, e.g., "RUN" (Inverter running), FAR (Frequency (speed) arrival), "FDT" (Frequency (speed) detection), "LU" (Undervoltage detected (Inverter stopped), etc.) 27 (Universal DO) is not available. Customizable logic output signals from 111 (1111) to 124 (1124) cannot be selected. 100 means that no function is assigned.
2001（3001）	Step 1 output "SO01"
...	...
2260（3260）	Step 260 output "SO260"
4001（5001）	Terminal [X1] input "X1" (terminal block or communication command)
4002（5002）	Terminal [X2] input "X2" (terminal block or communication command)
4003（5003）	Terminal [X3] input "X3" (terminal block or communication command)
4004（5004）	Terminal [X4] input "X4" (terminal block or communication command)
4005（5005）	Terminal [X5] input "X5" (terminal block or communication command)
4010（5010）	Terminal [FWD] input "FWD" (terminal block or communication command)
4011（5011）	Terminal [REV] input "REV" (terminal block or communication command)
4021（5021）	Terminal [I1] input "I1" (option card OPC-DIO)
4022（5022）	Terminal [I2] input "I2" (option card OPC-DIO)
4023（5023）	Terminal [I3] input "I3" (option card OPC-DIO)
4024（5024）	Terminal [I4] input "I4" (option card OPC-DIO)
4025（5025）	Terminal [I5] input "I5" (option card OPC-DIO)
4026（5026）	Terminal [I6] input "I6" (option card OPC-DIO)
4027（5027）	Terminal [I7] input "I7" (option card OPC-DIO)
4028（5028）	Terminal [I8] input "I8" (option card OPC-DIO)
4029（5029）	Terminal [I9] input "I9" (option card OPC-DIO)
4030（5030）	Terminal [I10] input "I10" (option card OPC-DIO)
4031（5031）	Terminal [I11] input "I11" (option card OPC-DIO)
4032（5032）	Terminal [I12] input "I12" (option card OPC-DIO)
4033（5033）	Terminal [I13] input "I13" (option card OPC-DIO)
4041（5041）	By assigning input signals "CLI1" to "CLI9" to customizable logic inputs, switching is possible between terminals [X1] to [X5] simply by changing the E01 to E05 assignment without having to change created customizable logic. This can be used when necessary to switch signal lines. Terminal [CLI1] input "CLI1"
4042（5042）	Terminal [CLI2] input "CLI2"
4043（5043）	Terminal [CLI3] input "CLI3"
4044（5044）	Terminal [CLI4] input "CLI4"
4045（5045）	Terminal [CLI5] input "CLI5"
4046（5046）	Terminal [CLI6] input "CLI6"
4047（5047）	Terminal [CLI7] input "CLI7"
4048（5048）	Terminal [CLI8] input "CLI8"
4049（5049）	Terminal [CLI9] input "CLI9"
4081（5081）	Logic operations can be performed and stopped when triggered by keypad key operations. Key input RUN/FWD "KP-RUN/KP-FWD"
4082（5082）	Key input REV "KP-REV"

Data	Selectable signals
4083（5083）	Key input STOP "KP-STOP"
4084（5084）	Key input UP "KP-UP"
4085（5085）	Key input DOWN "KP-DOWN"
4088（5088）	Key input SHIFT "KP-SHIFT"
4091（5091）	Key input RESET "KP-RESET"
4101（5101）	Terminal [X1] input (terminal block only) “X1-TERM”
4102（5102）	Terminal [X2] input (terminal block only) “X2-TERM”
4103（5103）	Terminal [X3] input (terminal block only) “X3-TERM”
4104（5104）	Terminal [X4] input (terminal block only) “X4-TERM”
4105（5105）	Terminal [X5] input (terminal block only) “X5-TERM”
4110（5110）	Terminal [FWD] input (terminal block only) “FWD-TERM”
4111（5111）	Terminal [REV] input (terminal block only) “REV-TERM”
6000（7000）	Final run command RUN “FL_RUN” (ON when a run command is given)
6001（7001）	Final run command FWD “FL_FWD” (ON when a run forward command is given)
6002（7002）	Final run command REV “FL_REV” (ON when a run reverse command is given)
6003（7003）	Accelerating “DACC” (ON during acceleration)
6004（7004）	Decelerating “DDEC” (ON during deceleration)
6005（7005）	During anti-regenerative “REGA” (ON under anti-regenerative control)
6006（7006）	Within dancer position reference point “DR_REF” (ON when the dancer position is within the reference range)
6007（7007）	Presence of an alarm factor “ALM_ACT” (ON when there is no alarm factor)
6100	TRUE (1) fixed input “TRUE”: always ON. No logic inversion
6101	FALSE (0) fixed input “FALSE”: always OFF. No logic inversion

■ **Function 1 (U04 etc.)**

Specify the general-purpose timer period or the increment/decrement counter value.

Data	Function	Description
0.00 to +600.00	Timer	The period is specified in seconds.
	Counter value	The specified value is multiplied by 100 times. (If 0.01 is specified, it is converted to 1.)
-9990.00 to -0.01	-	The timer or counter value works as 0.00. (No timer)
+601.00 to +9990.00	Timer	The period is specified in seconds.

[Input: analog] Block function code setting

■ **Block selection, function 1, function 2 (U01, U04, U05, etc.) (Analog)**

The following items are available as operation circuits.

If the upper and lower limit values are the same, they will be limited in the -9990 to 9990 range.

Block selection (U01 etc.)	Operation circuit	Description	Function 1 (U04 etc.)	Function 2 (U05 etc.)
2001	Adder	Inputs 1 and 2 are added and output. This function has output limiters (upper/lower) specified with two function codes. The 1st function code provides upper limit value and the 2nd one provides lower limit value.	Upper limit	Lower limit
2002	Subtracter	Subtraction function with two inputs (input 1 and input 2). This function has output limiters (upper/lower) specified with two function codes. The 1st function code provides upper limit value and the 2nd one provides lower limit value.	Upper limit	Lower limit
2003	Multiplier	Multiplication function with two inputs (input 1 and input 2). This function has output limiters (upper/lower) specified with two function codes. The 1st function code provides upper limit value and the 2nd one provides lower limit value.	Upper limit	Lower limit
2004	Divider	Input 1 is divided by input 2 and output. This function has output limiters (upper/lower) specified with two function codes. The 1st function code provides upper limit value and the 2nd one provides lower limit value.	Upper limit	Lower limit
2005	Limiter	An upper/lower limiter is applied to input 1. This function has output limiters (upper/lower) specified with two function codes. The 1st function code provides upper limit value and the 2nd one provides lower limit value. If the upper and lower limit values are the same, the input value is output as is (limited to -9990 to 9990 range).	Upper limit	Lower limit
2006	Absolute value	Absolute value function of single input (input 1). Negative input numbers become positive.	Upper limit	Lower limit
2007	Inverting adder	Inverting addition function with single input (input 1). This function subtracts the input 1 to the value specified with the 1st function code, inverts the result. And furthermore, the function adds the result to the value specified with the 2nd function code and outputs the result.	Subtraction value (former)	Addition value (latter)
2008	Variable limiter	Input 1 is output as the upper limit value, and input 2 is output as the lower limit value for the step specified with function 1. The lower limit value is not used if the upper limit value is less than the lower limiter.	Step number	Either
2009	Linear function (Constant setting)	Linear function of single input (input 1). Set with KA as function 1, and KB as function 2. The output is limited within the range between -9990 and 9990 by the internal limiter. $y = K_A \times input1 + K_B$ If setting a constant, set KA = 0.0, and set a constant for KB.	Coefficient KA -9990.0 to +9990.0	Coefficient KB -9990.0 to +9990.0
2010	Remainder	Outputs the remainder when input 1 is divided by input 2. This function has output limiters (upper/lower) specified with two function codes. The 1st function code provides upper limit value and the 2nd one provides lower limit value.	Upper limit	Lower limit

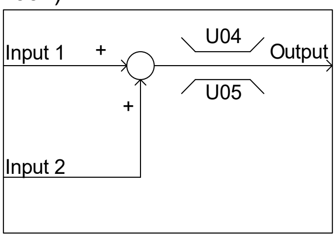
Block selection (U01 etc.)	Operation circuit	Description	Function 1 (U04 etc.)	Function 2 (U05 etc.)
2011	Limiter 2	Applies an upper/lower limiter for both positive and negative values to inverter input 1. The upper limit and lower limit values are set with functions 1 and 2. If the upper and lower limit values are the same, the input value is output as is. (limited to -9990 to 9990 range).	Upper limit	Lower limit
2013	Dead zone	A non-responsive area (output is 0) is applied to input 1. The upper limit and lower limit values are set with functions 1 and 2.	Upper limit	Lower limit
2014	Fixed adder	Input 1 and function 1 are added and the result is output.	Addition value	N/A
2015	Fixed subtracter	Subtracts function 2 from input 1 and the result is output.	Subtraction value	N/A
2016	Fixed multiplier	Input 1 and function 2 are multiplied and the result is output.	Multiplier value	N/A
2017	Fixed divider	Input 1 is divided by function 2 and the result is output.	Divider value	N/A
2051	Comparator 1	Subtracts input 2 from input 1, and ON is output if equal to or higher than the deviation set with function 1, and OFF is output if less than the deviation. The hysteresis width can be set with function 2.ON is output if both the ON and OFF conditions are established.	Deviation	Hysteresis width
2052	Comparator 2	Subtracts input 2 from input 1, and ON is output if greater than the deviation set with function 1, and OFF is output if smaller than the deviation (not including equal sign). The hysteresis width can be set with function 2.	Deviation	Hysteresis width
2053	Comparator 3	Subtracts input 2 from input 1 to obtain an absolute value, and ON is output if equal to or higher than the deviation set with function 1, and OFF is output if less than the deviation. The hysteresis width can be set with function 2. ON is output if both the ON and OFF conditions are established.	Deviation	Hysteresis width
2054	Comparator 4	Subtracts input 2 from input 1 to obtain an absolute value, and ON is output if greater than the deviation set with function 1, and OFF is output if smaller than the deviation (not including equal sign). The hysteresis width can be set with function 2.	Deviation	Hysteresis width
2055	Comparator 5	Input 1 is compared with the function 1 setting value, and ON is output if input 1 is equal to or higher than the function 1 setting value, and OFF is output if input 1 is smaller. The hysteresis width can be set with function 2.	Threshold value	Hysteresis width
2056	Comparator 6	Input 1 is compared with the function 1 setting value, and ON is output if input 1 is less than the function 1 setting value, and OFF is output if input 1 is larger. The hysteresis width can be set with function 2, but functions only when OFF conditions are met.	Threshold value	Hysteresis width

Block selection (U01 etc.)	Operation circuit	Description	Function 1 (U04 etc.)	Function 2 (U05 etc.)
2057	Comparator 7	Subtracts input 2 from input 1, and ON is output if greater than the deviation set with function 1, and OFF is output if less than the deviation (including equal sign). The hysteresis can be set with function 2.	Deviation	Hysteresis width
2058	Comparator 8	Subtracts input 2 from input 1 to obtain an absolute value, and ON is output if greater than the deviation set with function 1, and OFF is output if less than the deviation (including equal sign). The hysteresis can be set with function 2.	Deviation	Hysteresis width
2059	Equivalent comparator 2	Subtracts input 2 from input 1 to obtain an absolute value, and OFF is output if greater than the hysteresis width set with function 2, and ON is output if less than the hysteresis width (including equal sign).	Either	Hysteresis width
2060	Comparator 9	Subtracts input 2 from input 1, and ON is output if the result is equal to or higher (incl. equal sign) than the deviation set with function 1, and OFF is output if less than the deviation. The hysteresis width can be set with function 2.	Deviation	Hysteresis width
2071	Window comparator 1	ON is output if input 1 is within the upper threshold and lower threshold range (incl. threshold). Set the upper threshold with function 1, and the lower threshold with function 2.	Upper threshold	Lower threshold
2072	Window comparator 2	ON is output if input 1 is within the upper threshold and lower threshold range (not including threshold). Set the upper threshold with function 1, and the lower threshold with function 2.	Upper threshold	Lower threshold
2101	High selector	Input 1 and input 2 are compared, and the larger of the two is output. The 1st function code provides the upper limit value and the 2nd one provides the lower one.	Upper limit	Lower limit
2102	Low selector	Input 1 and input 2 are compared, and the smaller of the two is output. The 1st function code provides the upper limit value and the 2nd one provides the lower one.	Upper limit	Lower limit
2103	Average	This function receives two inputs (input 1 and input 2), averages them, and outputs the result. The 1st function code provides the upper limit value and the 2nd one provides the lower one.	Upper limit	Lower limit
2151	Function code	Function code S13 (PID command value): The scale for setting value 0 to 20000/0 to 100% is converted with the maximum scale and minimum scale. The 1st function code provides the maximum scale value of the range and the 2nd one provides the minimum scale value of the range.	Maximum scale	Minimum scale
2201	Inverse scale transformation	Input 1 is inverse-scaled from the minimum scale to maximum scale, 0 to 100%. The 1st function code provides the maximum scale value of the range and the 2nd one provides the minimum scale value of the range. Use this to connect to analog output terminals. This function can only be assigned to a maximum of 2 steps.	Maximum scale	Minimum scale

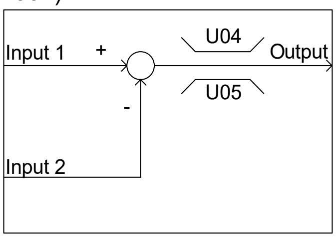
Block selection (U01 etc.)	Operation circuit	Description	Function 1 (U04 etc.)	Function 2 (U05 etc.)
2202	Scale transformation	Input 1 is transformed from the minimum and maximum scales to 0-100% on the minimum to maximum scale. The 1st function code provides the maximum scale value of the range and the 2nd one provides the minimum scale value of the range. The input 1 signal selection can only be used for setting values 8000 to 8021. This function can only be assigned to a maximum of 2 steps.	Maximum scale	Minimum scale
3001	Quadratic function	Input 1 is converted and output with the following formula. KA, KB, and KC are in exponential form, and are set for U92 to U97. Output = KA x $(\text{input } 1)^2$ + KB x input 1 + KC The 1st function code provides the upper limit value and the 2nd one provides the lower limit value. Either (3001) or (3002) is available to use, and only one of these functions can be used.	Upper limit	Lower limit
3002	Square root function	Input 1 is converted and output with the following formula. KA, KB, and KC are in exponential form, and are set for U92 to U97. $\text{Output} = \sqrt{\dfrac{\text{Input 1} + \text{KA}}{\text{KB}}} \times \text{KC}$ The 1st function code provides the upper limit value and the 2nd one provides the lower limit value. Either (3001) or (3002) is available to use, and can only be assigned to 1 step..	Upper limit	Lower limit

The block diagrams for each operation circuit are given below. The setting value for functions 1 and 2 is indicated with U04 and U05

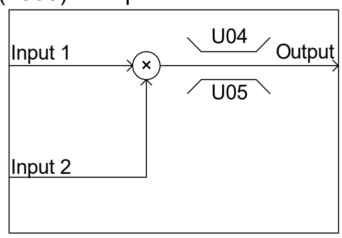
(2001) Adder



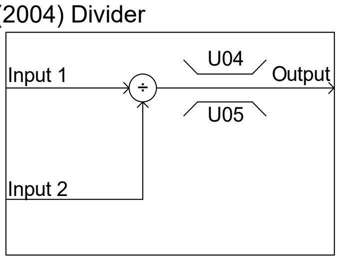
(2002) Subtracter



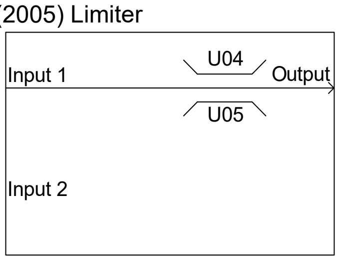
(2003) Multiplier



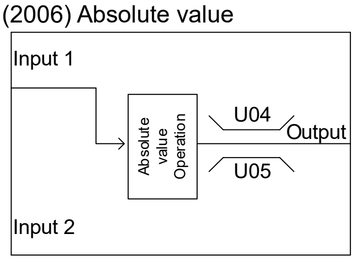
(2004) Divider



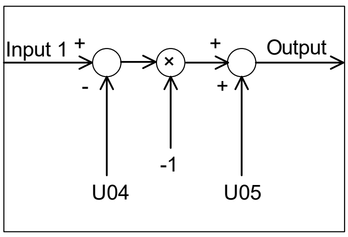
(2005) Limiter



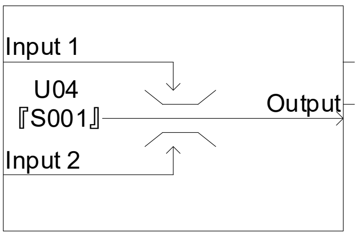
(2006) Absolute value



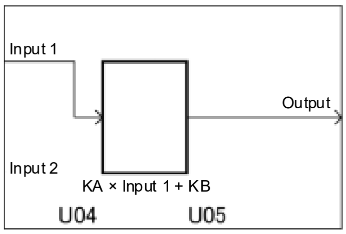
(2007) Inverting adder



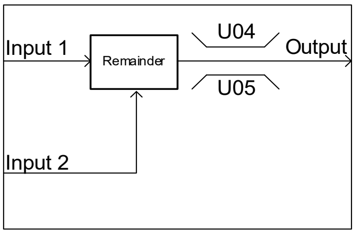
(2008) Variable limiter



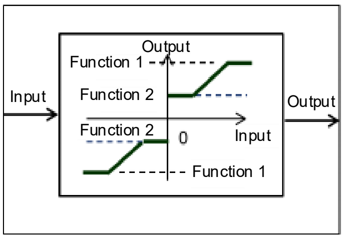
(2009) Linear function



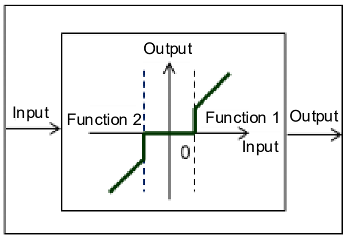
(2010) Remainder



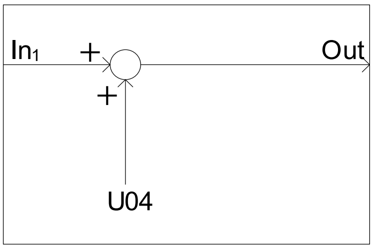
(2011) Limiter 2



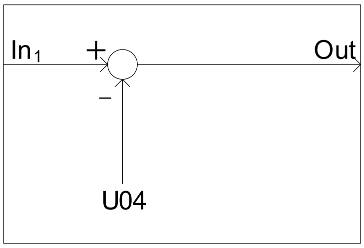
(2013) Dead zone



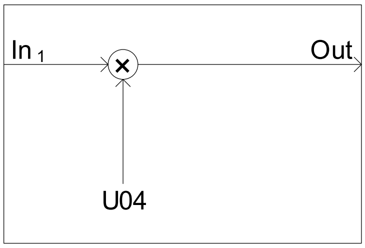
(2014) Fixed adder



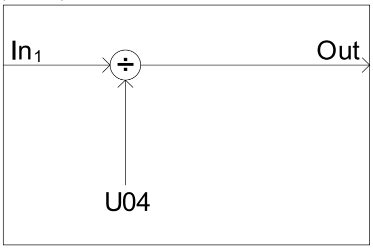
(2015) Fixed subtracter



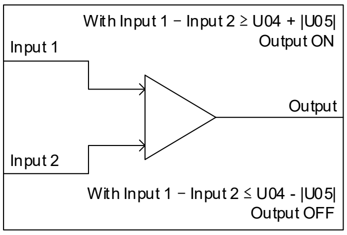
(2016) Fixed multiplier



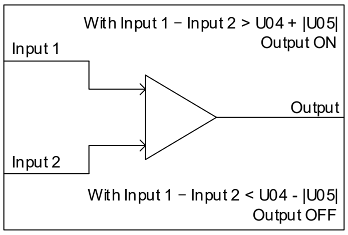
(2017) Fixed divider



(2051) Comparator 1

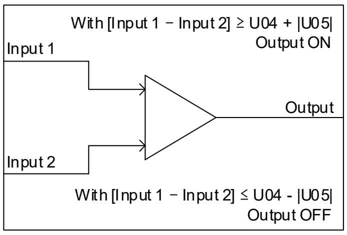


(2052) Comparator 2



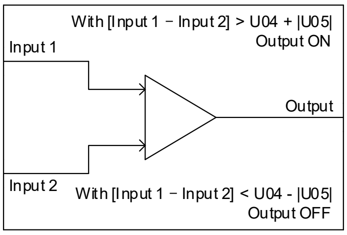
ON is prioritized when both conditions are satisfied.

(2053) Comparator 3

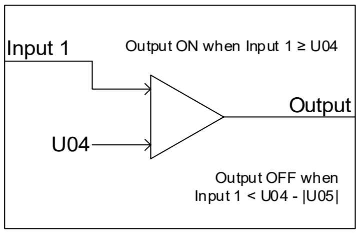


ON is prioritized when both conditions are satisfied.

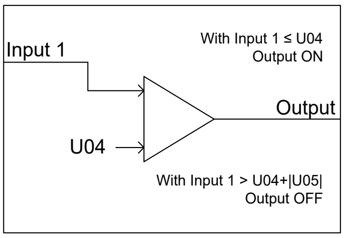
(2054) Comparator 4



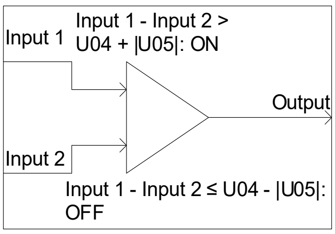
(2055) Comparator 5



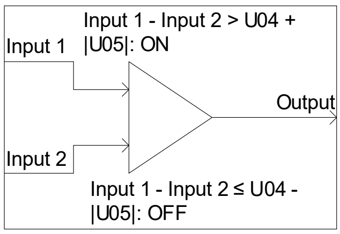
(2056) Comparator 6



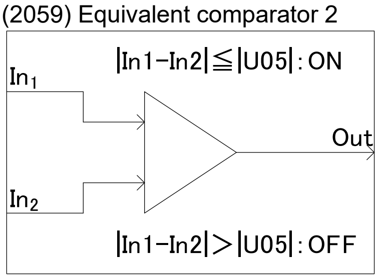
(2057) Comparator 7



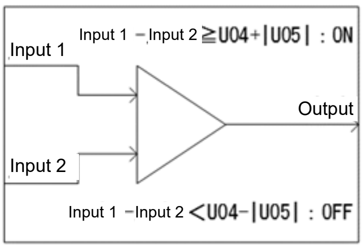
(2058) Comparator 8



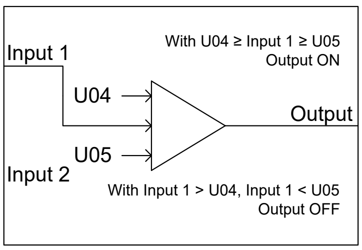
(2059) Equivalent comparator 2



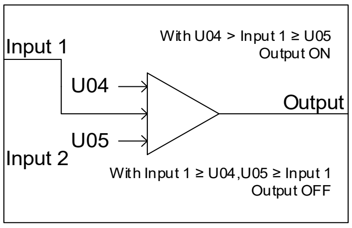
(2060) Comparator 9



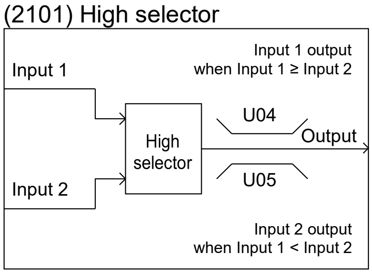
(2071) Window comparator 1



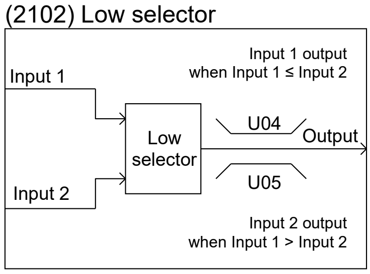
(2072) Window comparator 2



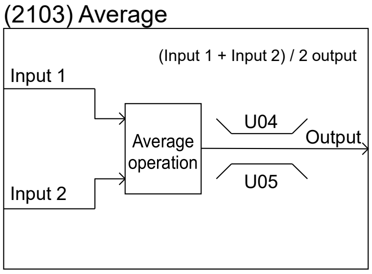
(2101) High selector



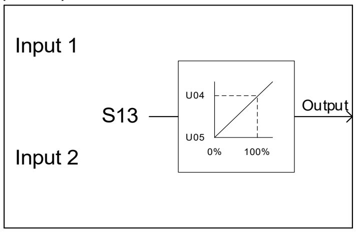
(2102) Low selector



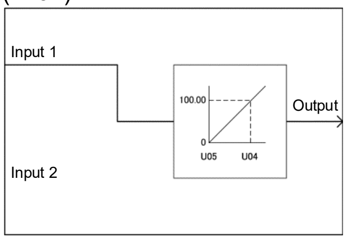
(2103) Average



(2151) Function code

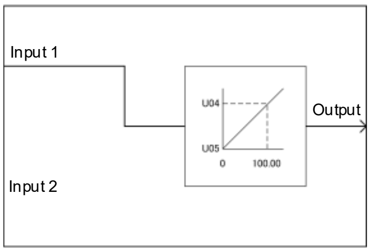


(2201) Inverse scale transformation



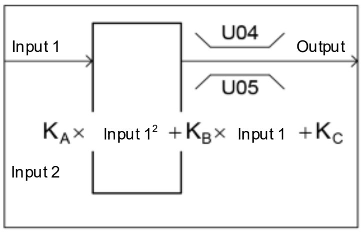
* Use this to connect to analog output terminals.
* Up to 2 steps can be used.

(2202) Scale transformation

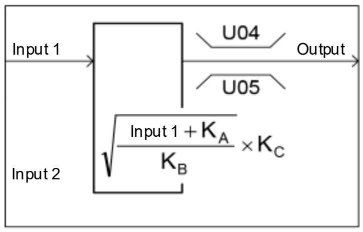


* The input 1 signal selection can only be used for setting values 8000 to 8085.
* Up to 2 steps can be used.

(3001) Quadratic function



(3002) Square root function



* Either (3001) or (3002) is available to use, and can be used for only 1 step.

■ **Inputs 1 and 2 (U02, U03, etc.)**

The following signals are available as analog input signals.

Data	Selectable signals
8000 ~ 8026	General-purpose analog output signal (same as analog output signals selected in function code F31: output frequency 1, output current, output torque, power consumption, DC intermediate circuit voltage, etc.) Example: For output frequency 1, maximum output frequency (100 %) is input as 100.00. Example: For output current, 200% of the inverter rated current is input 100.00. Note: 10 (Universal AO) is not available.
2001 to 2260	Step 1 to 260 output “SO01” to “SO260”
9001	Analog [12] terminal input signal “12”
9002	Analog [C1] terminal input signal “C1”
9003	Analog [V2] terminal input signal “V2”
9004	Analog [32] terminal input signal “32” (option card, OPC-AIO)
9005	Analog [C2] terminal input signal “C2” (option card, OPC-AIO)
9010	UP/DOWN value (when UP/DOWN command enabled) “UP/DOWN”

■ Function 1, Function 2 (U04, U05, etc.)

Sets the upper limit and lower limit of operation circuit.

Data	Function	Description
-9990.00 to 0.00 to +9990.00	Threshold value Hysteresis width Upper limit, Lower limit Upper threshold, Lower threshold Setting value Maximum scale, Minimum scale	Setting values for the operation circuit (selected with the corresponding function code such as U01).

■ Calculation coefficient settings (U92 to U97)

Sets the calculation coefficient function (3001, 3002) of operation circuit.

Function codes	Name	Data setting range	Remarks
U92	Coefficient K_A mantissa portion	Mantissa: -9.999 to 9.999	
U93	Coefficient K_A exponent portion	Exponent part: -5 to 5	
U94	Coefficient K_B mantissa portion		
U95	Coefficient K_B exponent portion		
U96	Coefficient K_C mantissa portion		
U97	Coefficient K_C exponent portion		

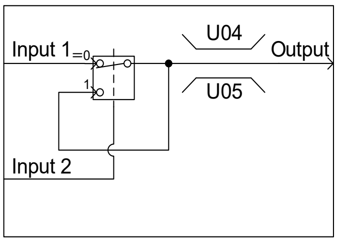
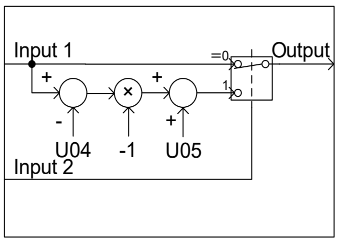
U92 to U97 can automatically be calculated based on measured data. For details, refer to the descriptions of U101 to U107.

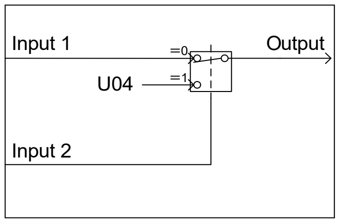
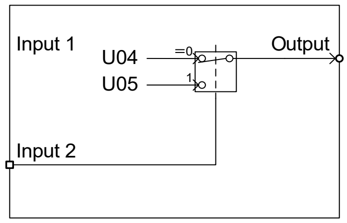
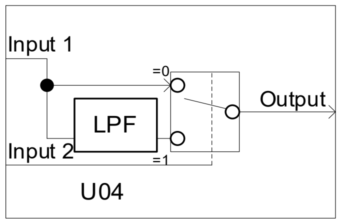
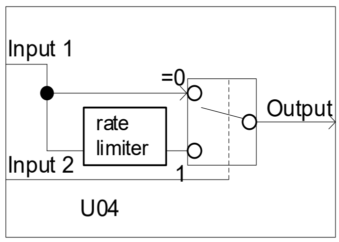
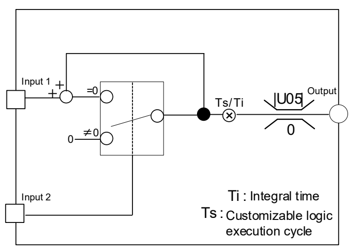
[Input: digital, analog] Block function code setting

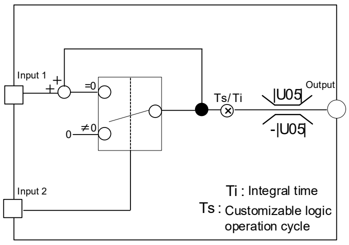
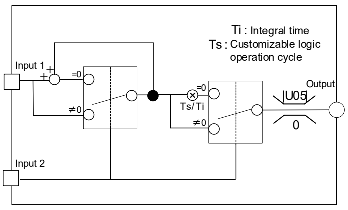
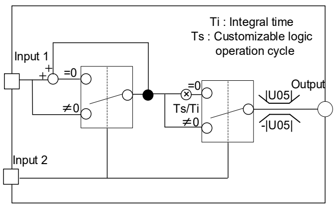
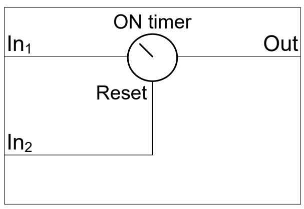
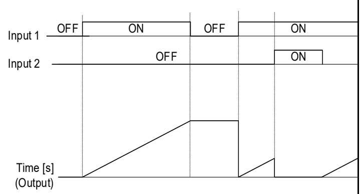
■ Block selection, function 1, function 2 (U01, U04, U05, etc.) (Analog)

The following items are available as operation circuits and logic circuits.

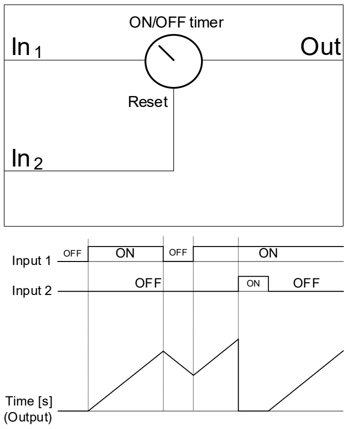
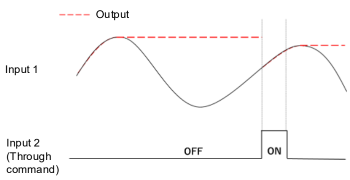
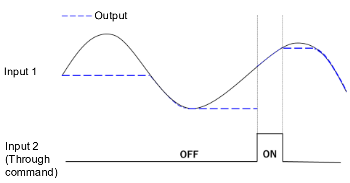
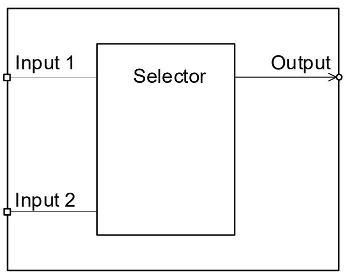
Note that if the upper and lower limits have the same value, there are no upper and lower limits.

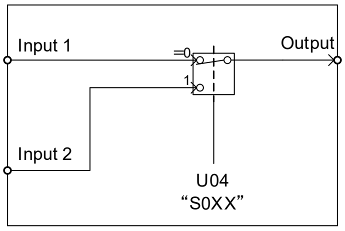
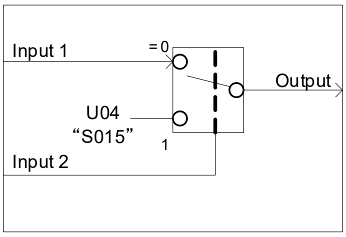
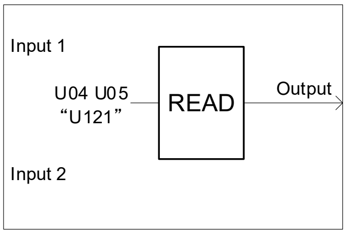
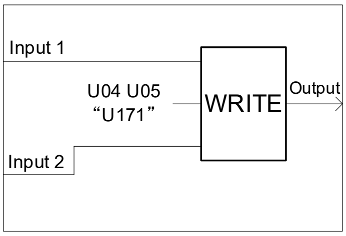
Block selection (U01 etc.)	Description	Block diagram	Function 1, Function 2 (U04, U05, etc.)
4001 Hold	When input 2 (digital input) is "1," input 1 (analog input) is output as is. When input 2 is "0," the output value is held. This function has output limiters (upper/lower) specified with two function codes. The 1st function code provides upper limit value and the 2nd one provides lower limit value.		Function 1: Upper limit value Function 2: Lower limit value
4002 Inverting adder switching	When input 2 (digital input) is "1," the function 1 setting value is subtracted from input 1 (analog input), the polarity is reversed, and the function 2 setting value is added and output. When input 2 is "0," input 1 is output as is. Output involves limiter processing in the -9990 to +9990 range.		Function 1: Subtraction value (former) Function 2: Addition value (latter)

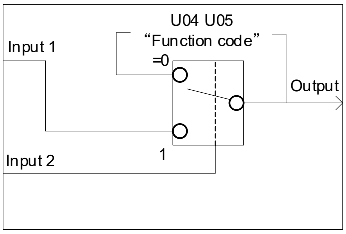
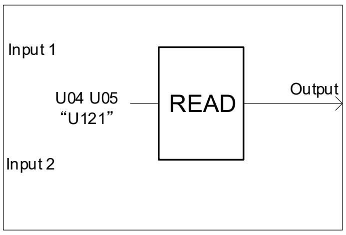
Block selection (U01 etc.)	Description	Block diagram	Function 1, Function 2 (U04, U05, etc.)
4003 Selector 1	When input 2 (digital input) is "1," the function 1 setting value is output. When input 2 is "0," input 1 (analog input) is output.		Function 1: Setting value Function 2: Not required
4004 Selector 2	When input 2 (digital input) is "0," the function 1 setting value is output. When input 2 is "1," the function 2 setting value is output.		Function 1: Setting value 1 Function 2: Setting value 2
4005 LPF (Low pass filter)	When input 2 (digital input) is "1," the value obtained by performing LPF is output to input 1 (analog input). When input 2 is "0," input 1 is output as is. The LPF circuit maintains the previous output value. Therefore, when the digital 2 input changes from "0" to "1," the output will be the value with the previous output value added as the initial value of LPF. There is no upper/lower limiter.		Function 1: Time constant 0: No filter 0.01 to 5.00 s Function 2: Fixed at 0
4006 Rate limiter	When input 2 (digital input) is "0," input 1 (analog input) is output as is. When input 2 is "1," the input 1 change is restricted with the rate of change specified with function 1 and 2. The initial value is the input 1 value when input 2 changes from "0" to "1." When terminal [CLC] is ON, the previous output value is cleared to zero.		Function 1: Rise rate of change Time taken to change by 100% 0: No restriction 0.01 to 600 s Function 2: Fall rate of change Time taken to change by 100% 0: Same rate of change as function 1 0.01 to 600 s
4007 Integrator 1	When input 2 (digital input) is "0," the integral of input 1 (analog input) is calculated with 1 s of the integral time and the result is output. When input 2 (digital input) is "1," "0" is output. The upper limit is |function 2| (absolute value of function 2) and the lower limit is "0."		Function 1: None Function 2:Upper limit (applied as absolute value)

Block selection (U01 etc.)	Description	Block diagram	Function 1, Function 2 (U04, U05, etc.)
4008 Integrator 2	When input 2 (digital input) is “0,” the integral of input 1 (analog input) is calculated with 1 s of the integral time and the result is output. When input 2 (digital input) is “1,” “0” is output. The upper limit is |function 2| (absolute value of function 2) and the lower limit is -|function 2|.		Function 1: None Function 2: Upper and Lower limit value
4009 Integrator 3	When input 2 (digital input) is “0,” the integral of input 1 (analog input) is calculated with 1 s of the integral time and the result is output. When input 2 is 0, input 1 is output as is. The upper limit is |function 2| (absolute value of function 2) and the lower limit is “0.”		Function 1: None Function 2: Upper limit (applied as absolute value)
4010 Integrator 4	When input 2 (digital input) is “0,” the integral of input 1 (analog input) is calculated with 1 s of the integral time and the result is output. When input 2 is 0, input 1 is output as is. The upper limit is |function 2| (absolute value of function 2) and the lower limit is -|function 2|.		Function 1: None Function 2: Upper and Lower limit value
4011 Pulse length measurement	When input 2 (digital input) is “0,” the ON time of input 1 (digital input) is calculated and the result is output. When input 2 is “1,” “0” is output. The time calculated with the edge when input 1 turns from OFF to ON is cleared to “0” and the measurement starts.		N/A

FUNCTION CODES
Chap 5
FUNCTION
F Codes
E Codes
C Codes
P Codes
H Codes
A Codes
b Codes
r Codes
J Codes
d Codes
U Codes
y Codes
O Codes
K Codes

<table>
<tr><th>Block selection (U01 etc.)</th><th>Description</th><th>Block diagram</th><th>Function 1, Function 2 (U04, U05, etc.)</th></tr>
<tr><td>4012
Totalizer</td><td>When input 2 (digital input) is “0,” the ON time is added when input 1 (digital input) is ON, or the OFF time is subtracted when input 1 is OFF, and the result is output.
When input 2 is “1,” “0” is output.</td><td>
</td><td>N/A</td></tr>
<tr><td>4013
Peak hold (Max.)</td><td>When input 2 (digital input) is “0,” input 1 (analog input) is output if input 1 is higher than the previous output value, or the output value is held if input 1 is lower than the previous output value.
When input 2 is "1", input 1 is output as is.
This function has output limiters (upper/lower) specified with two function codes. The 1st function code provides upper limit value and the 2nd one provides lower limit value.</td><td>
</td><td>Function 1: Upper limit value
Function 2: Lower limit value</td></tr>
<tr><td>4014
Peak hold (Min.)</td><td>When input 2 (digital input) is “0,” input 1 (analog input) is output if input 1 is lower than the previous output value, or the output value is held if input 1 is higher than the previous output value.
When input 2 is "1", input 1 is output as is.
This function has output limiters (upper/lower) specified with two function codes. The 1st function code provides upper limit value and the 2nd one provides lower limit value.</td><td>
</td><td>Function 1: Upper limit value
Function 2: Lower limit value</td></tr>
<tr><td>4016
Decoder</td><td>The values “0” to “3” are output based on the combination of inputs 1 and 2 as shown below.
<table>
<tr><th>Input 2</th><th>Input 1</th><th>Output</th></tr>
<tr><td>OFF</td><td>OFF</td><td>0</td></tr>
<tr><td>OFF</td><td>ON</td><td>1</td></tr>
<tr><td>ON</td><td>OFF</td><td>2</td></tr>
<tr><td>ON</td><td>ON</td><td>3</td></tr>
</table></td><td>
</td><td>N/A</td></tr>
</table>

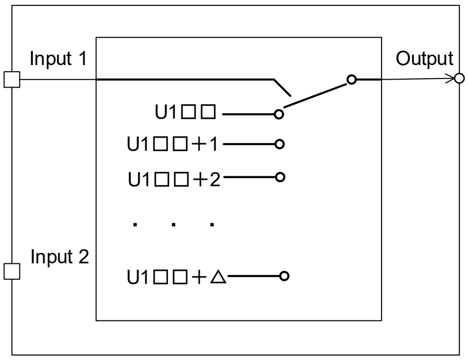
Block selection (U01 etc.)	Description	Block diagram	Function 1, Function 2 (U04, U05, etc.)
5000 Selector 3	When the step output signal (SOXX) specified with function 1 is “0,” input 1 (analog input) is output as is. When the step output signal specified with function 1 is “1,” input 2 (analog input) is output as is.	 	Function 1: Step number Function 2: Not required The setting values after the decimal point are ignored.
5100 Selector 4	When input 2 (digital input) is “0,” input 1 is output as is. When input 2 is “1,” the step output signal set with function 1 is output.	 	Function 1: Step number Function 2: Not required The setting values after the decimal point are ignored.
6001 Reading of function codes	The function code is specified with function 1 and 2, and function code data is output. The function code type is specified with function 1, and the last two digits of the function code are specified with function 2. The format in which data is read correctly is shown below. (However, values are restricted to the -9990 to 9990 range.) Furthermore, [29] expresses 20000 as 100%.) [1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [12], [22], [24], [29], [35], [37], [45], [61], [67], [68], [74], [92], [93] Data formats other than the above cannot be read correctly. Do not use any other format.	 	Function 1: Function code type 0 to 255 Function 2: Function code number 0 to 99 The setting values after the decimal point are ignored. For details on function code types, refer to Table 5.3-16 in “■ Configuration of function codes.” For details on data format numbers, refer to the Communication User’s Manual (24A7-E-0082).
6002 Writing of function codes	Applies the input 1 value to a specific function code (U171 to U180) when input 2 is “1.” When input 2 is “0,” the previous value is maintained for the specific function code. Data is written to nonvolatile memory when the inverter detects undervoltage. Do not use more than one of these operation circuits for a single function code.	 	Function 1: Fixed at 39 Function 2: 71 to 75 The setting values after the decimal point are ignored.

Block selection (U01 etc.)	Description	Block diagram	Function 1, Function 2 (U04, U05, etc.)
6003 Temporary rewriting of function codes	Specific function code (see separate table) values in the memory are selected between the input 1 value and input 2 value with the input 2 value. Set the function code type for function 1. Set the last two digits of the function code number for function 2. When input 2 is "0," the value in memory for that function code reflects the current value. When input 2 is "1," the input 1 value is applied. If the function code designation is not a specific function code, data 0 will be applied, and therefore caution is advised. For details on the applicable function codes, refer to Table 5.3-15 in "■ Specific function codes." This operation circuit is used by replacing this specific function code value. Consequently, do not use by entering another LE. If changing a single function code, do not use more than one of these operation circuits. If function codes are temporarily changed using 6003 while operating a customizable logic, by performing a read operation with FRENIC-Loader4, or copying data to the keypad, the data that is being temporarily changed may be copied instead of nonvolatile memory data. If performing these operations, do so after stopping the customizable logic. 		Function 1: Function code type 0 to 255 Function 2: Function code number 0 to 99 The setting values after the decimal point are ignored. For details on function code types, refer to Table 5.3-16 in "■ Configuration of function codes."For details on data format numbers, refer to the Communication User's Manual.
6004 Function codes link	When a Customizable logic function is the subject of password protection, it will not be possible to change function codes other than User parameters 1-50 and Storage area 1-10. Using this function, by setting function codes that can no longer be changed when the password function is applied to input 1, and linking them with User parameters 1 to 50 and Storage area 1 to 10 specified with function 1 and function 2, function codes within Customizable logic can be changed even when the password function is applied. 		Function 1: Function code type 0 to 255 Function 2: Function code number 0 to 99 The setting values after the decimal point are ignored. For details on function code types, refer to Table 5.3-16 in "■ Configuration of function codes." For details on data format numbers, refer to the Communication User's Manual.

<table>
<tr><th>Block selection (U01 etc.)</th><th colspan="2">Description / Block diagram</th><th>Function 1, Function 2 (U04, U05, etc.)</th></tr>
<tr><td>6005
Reading from the function code</td><td colspan="2">Output the U1 function code data selected in input 1 (analog input).
Specify the number of the first U1 function code in the reading targets with function 1 and specify the maximum selection range with function 2.
Example: When function 1 is “30” and function 2 is “4,” the 5 data items from U130 to U134 are selected and output.

The relation between the input values and the selected function codes is as follows.
(□□ indicates function 1 and △ indicates function 2).

Input value | Selected function code
0 | U1□□
1 | U1□□+1
2 | U1□□+2
… | …
△ | U1□□+△

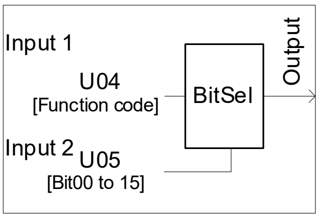


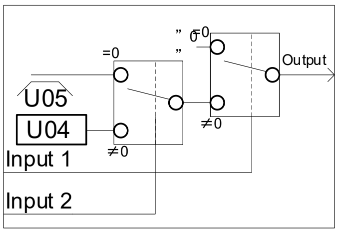
The output value is “0” in the following cases.
・ Input 1＞ function 2
・ Input 1 ＜ 0
・ Function 1 or function 2 are set outside the valid range.</td><td>Function 1: U1 function code number
21 to 80
Function 2: Maximum selection range
0 to 59

The setting values after the decimal point are ignored.</td></tr>
</table>

<table>
<tr><th>Block selection (U01 etc.)</th><th>Description</th><th>Block diagram</th><th>Function 1, Function 2 (U04, U05, etc.)</th></tr>
<tr><td>6011
Bit extraction [S]</td><td colspan="2">By specifying the appropriate bit in the function code belonging to the S group, that condition is output as logic.</td><td rowspan="5">Function 1: Function code number
0 to 99
Function 2:
Applicable bit 0 to 15

The setting values after the decimal point are ignored.

For details on S, M, W, X, and Z group function codes, refer to the Communication User's Manual.</td></tr>
<tr><td>6012
Bit extraction [M]</td><td colspan="2">By specifying the appropriate bit in the function code belonging to the M group, that condition is output as logic.</td></tr>
<tr><td>6013
Bit extraction [W]</td><td colspan="2">By specifying the appropriate bit in the function code belonging to the W group, that condition is output as logic.</td></tr>
<tr><td>6014
Bit extraction [X]</td><td colspan="2">By specifying the appropriate bit in the function code belonging to the X group, that condition is output as logic.</td></tr>
<tr><td>6015
Bit extraction [Z]</td><td colspan="2">By specifying the appropriate bit in the function code belonging to the Z group, that condition is output as logic.

Of groups S to Z, the format in which data is read correctly is shown below.
[14], [15], [16], [43], [44], [77], [78], [91]</td></tr>
<tr><td>6101
PID dancer output gain frequency</td><td colspan="2">This is used with the dancer control PID.
It is possible to switch between calculating the frequency compensation with a PID output of 100% as equivalent to the maximum output frequency, and calculating the frequency compensation as equivalent to the specified frequency (line speed command). With input 1, it is possible to switch between whether or not to enable this block.
The frequency compensation is selected with input 2 and the gain ratio.
When input 2 is OFF, and U04 ≠ 0%
Output: Frequency compensation = (PID output) x (Line speed command)
When input 2 is ON, and U04 ≠ 0%:
Output: Frequency compensation = (PID output x gain ratio (U04)) x (Maximum output frequency)

When a gain ratio of 0% is set, the calculation formula will be as follows, regardless of input 2.
Output: Frequency compensation = (PID output) x (Line speed command)
</td><td>Function 1: Gain ratio
0 to 200%

Function 2:
Frequency lower limit value
0 to 599 Hz</td></tr>
</table>

■ **Output signal**

Each customizable logic step is output to SO01 to SO260.

SO01 to SO260 differ in configuration depending upon the connection destination, as listed below. To relay those outputs to any function other than the customizable logic, route them via customizable logic outputs CL01 to CLO14.

Connection destination of each step output	Setting method	Function codes
Customizable logic input	Internal step output signals “SO01” to “SO260” are selected by setting the customizable logic input.	U02, U03, etc.
Inverter sequence processing input (digital ON/OFF) (Multi-step speed “SS1” and run command “FWD” etc.)	Select one of the internal step output signals “SO01” to “SO260” to be connected to customizable logic output signals 1 to 14 (“CL01” to “CLO14”).	U71 to U80 U181 to U184
	Select an inverter’s sequence processor input function to which one of the customizable logic output signals 1 to 14 (“CL01” to “CLO14”) is to be connected. (Same as in E01)	U81 to U90 U185 to U188
Analog input (Auxiliary frequency commands, PID process commands, etc.)	Select one of the internal step output signals “SO01” to “SO260” to be connected to customizable logic output signals 1 to 14 (“CL01” to “CLO14”).	U71 to U80 U181 to U184
	Select an analog input function to which one of the customizable logic output signals 1 to 14 (“CL01” to “CLO14”) is to be connected. (Same as in E61)	U81 to U90 U185 to U188
General-purpose digital output (terminals [Y1] to [Y2]) Option digital output (terminals [01] to [08]) Option relay output (terminals [Y6A] to [Y8A])	Select one of the internal step output signals “SO01” to “SO260” to be connected to customizable logic output signals 1 to 14 (“CL01” to “CLO14”).	U71 to U80 U181 to U184
	To specify a general-purpose digital output function (on [Y] terminals) to which one of the customizable logic output signals 1 to 14 (“CL01” to “CLO14”) is to be connected, select one of “CLO1” to “CLO14” by specifying the general-purpose digital output function on any Y terminal.	E20 to E22 E27 o01 to o03 o121 to o128
General-purpose analog output (Terminals [FM1], [FM2])	Select one of the internal step output signals “SO01” to “SO260” to be connected to customizable logic output signals 1 to 14 (“CL01” to “CLO14”).	U71 to U80 U181 to U184
	To set the general-purpose analog output (terminals [FM1], [FM2]) to be connected to the customizable logic output signals 1 “CLO1” to 14 “CLO14”, select “CLO1” to “CLO14” on the function selection side of the general-purpose analog output (terminals [FM1], [FM2]).	F31, F61 F35
User-defined alarm	Select one of the internal step output signals “SO01” to “SO260” to be connected to customizable logic output signals 1 to 14 (“CL01” to “CLO14”).	U71 to U80 U181 to U184
	Select user-defined alarms to be connected to customizable logic output signals 1 “CLO1” to 14 “CLO14.”	U81 to U90 U185 to U188

Note General-purpose digital outputs (on [Y] terminals) are updated every 5 ms. To securely output a customizable logic signal via [Y] terminals, include on- or off-delay timers in the customizable logic. In some cases, a short ON/OFF signal may not be reflected on the [Y] terminals.

Function Code	Name	Data setting range	Remarks
U71	Customizable logic output signal 1 (Output selection)	0: Disable 1: Output of step 1, “SO01” 2: Output of step 2, “SO02” ... 259: Output of step 259, “SO259” 260: Output of step 260, “SO260”	
U72	Customizable logic output signal 2 (Output selection)		
U73	Customizable logic output signal 3 (Output selection)		
U74	Customizable logic output signal 4 (Output selection)		
U75	Customizable logic output signal 5 (Output selection)		
U76	Customizable logic output signal 6 (Output selection)		
U77	Customizable logic output signal 7 (Output selection)		
U78	Customizable logic output signal 8 (Output selection)		
U79	Customizable logic output signal 9 (Output selection)		
U80	Customizable logic output signal 10 (Output selection)		
U181	Customizable logic output signal 11 (Output selection)		
U182	Customizable logic output signal 12 (Output selection)		
U183	Customizable logic output signal 13 (Output selection)		
U184	Customizable logic output signal 14 (Output selection)		

Function Code	Name	Data setting range	Remarks
U81	Customizable logic output signal 1 (Function selection)	■ **If a step output is digital** **The same value as E98 can be specified.** 0 (1000): Select multistep frequency (0 to 1 steps) "SS1" 1 (1001): Select multistep frequency (0 to 3 steps) "SS2" 2 (1002): Select multistep frequency (0 to 7 steps) "SS4" 3 (1003): Select multistep frequency (0 to 15 steps) "SS8" 4 (1004): Select ACC/DEC time (2 steps) "RT1" 5 (1005): Select ACC/DEC time (4 steps) "RT2" 6 (1006): Select self hold "HLD" 7 (1007): Coast-to-a-stop command "BX" 8 (1008): Alarm (error) reset "RST" 9 (1009): External alarm "THR" (9 = Active OFF/1009 = Active ON) etc. ■ **If a user-defined alarm occurs with step output** 241 (1241): User-defined alarm 1 "CA1" 242 (1242): User-defined alarm 2 "CA2" 243 (1243): User-defined alarm 3 "CA3" 244 (1244): User-defined alarm 4 "CA4" 245 (1245): User-defined alarm 5 "CA5" ■ **If a step output is analog** 8001: Auxiliary frequency setting 1 8002: Auxiliary frequency setting 2 8003: PID command 1 8005: PID feedback value 8006: Ratio setting 8007: Analog torque limiter A 8008: Analog torque limiter B 8009: Torque bias 8010: Torque command 8011: Torque current command 8012: Acceleration/deceleration time ratio setting 8013: Upper limit frequency 8014: Lower limit frequency 8015: Auxiliary frequency setting 3 8016: Auxiliary frequency setting 4 8017: Analog speed limit for forward rotation 8018: Analog speed limit for reverse rotation 8020: Analog input monitor	
U82	Customizable logic output signal 2 (Function selection)		
U83	Customizable logic output signal 3 (Function selection)		
U84	Customizable logic output signal 4 (Function selection)		
U85	Customizable logic output signal 5 (Function selection)		
U86	Customizable logic output signal 6 (Function selection)		
U87	Customizable logic output signal 7 (Function selection)		
U88	Customizable logic output signal 8 (Function selection)		
U89	Customizable logic output signal 9 (Function selection)		
U90	Customizable logic output signal 10 (Function selection)		
U185	Customizable logic output signal 11 (Function selection)		
U186	Customizable logic output signal 12 (Function selection)		
U187	Customizable logic output signal 13 (Function selection)		
U188	Customizable logic output signal 14 (Function selection)		

■ **Specific function codes**

The following function codes can be changed in memory by using the customizable logic “Temporary rewriting of function codes (6003).” Overwritten values are cleared with power OFF.

Note
- If using “Temporary rewriting of function codes (6003),” there is a risk of function code setting values being changed suddenly, adversely affecting the motor due to a sudden change in speed and torque. To ensure that setting values do not change suddenly, use “Rate limiter (4006)” to suppress setting value changes, and give careful consideration to and check whether sudden changes in setting values will cause problems before use.

Table 5.3-15

No.	Name	No.	Name	No.	Name
F07	Acceleration time 1	E38	Current detection 2/Low current detection (Timer time)	C43	Analog input adjustment (Terminal [V2]) (Filter)
F08	Deceleration time 1	E39	Constant feed time coefficient 1/Speed display auxiliary coefficient 1	P07	Motor 1 (%R1)
F09	Torque boost 1	E42	LED display filter	P09	Motor 1 (Slip compensation gain for driving)
F14	Momentary power failure restart (mode selection)	E43	LED monitor (Item selection)	P10	Motor 1 (Slip compensation response time)
F15	Frequency limiter (Upper limit)	E44	LED monitor (display when stopped)	P11	Motor 1 (Slip compensation gain for braking)
F16	Frequency limiter (Lower limit)	E48	LED monitor details (Speed monitor selection)	P74	Motor 1 (PMSMs - current command value on startup)
F20	DC braking 1 (Starting frequency)	E49	Torque command monitor (Polarity selection)	P89	Motor 1 (PMSM control switching level)
F21	DC braking 1 (Operation level)	E50	Display coefficient for speed monitor	H07	Curvilinear acceleration/ deceleration
F22	DC braking 1 (Braking time)	E54	Frequency detection 3 (Operation level)	H08	Rotational direction limitation
F23	Starting frequency 1	E55	Current detection 3 (Operation level)	H09	Startup characteristics (Auto search mode)
F24	Starting frequency 1 (Holding time)	E56	Current detection 3 (Timer time)	H11	Deceleration mode
F25	Stop frequency	E65	Reference loss detection (Continued operation frequency)	H13	Restart mode after momentary power failure (Wait time)
F26	Motor sound (Carrier frequency)	E76	DC link bus low-voltage detection level	H14	Momentary power failure restart (Frequency fall rate)
F38	Stop frequency (Detection method)	E78	Torque detection 1 (Operation level)	H15	Momentary power failure restart (Continued operation level)
F39	Stop frequency (Holding time)	E79	Torque detection 1 (Timer time)	H27	Motor 1 (Thermistor operation level))
F40	Torque limiter 1 (Driving)	E80	Torque detection 2/Low torque detection (Operation level)	H28	Droop control
F41	Torque limiter 1 (Braking)	E81	Torque detection 2/Low torque detection (Timer time)	H50	Non-linear V/f 1 (Frequency)
F43	Current limiter (Mode selection)	C01	Jump frequency 1	H51	Non-linear V/f 1 (Voltage)
F44	Current limiter (Operation level)	C02	Jump frequency 2	H52	Non-linear V/f 2 (Frequency)
F58	Terminal [FM1] (Filter)	C03	Jump frequency 3	H53	Non-linear V/f 2 (Voltage)
F59	Terminal [FM1] (Bias)	C04	Jump frequency (Skip range)	H56	Deceleration time for forced stop
F62	Terminal [FM2] (Filter)	C05	Multistep frequency 1	H57	1 S-curve acceleration range (When starting)
F63	Terminal [FM2] (Bias)	C06	Multistep frequency 2	H58	2 S-curve acceleration range (When finished)
E10	Acceleration time 2	C07	Multistep frequency 3	H59	1 S-curve acceleration range (When starting)
E11	Deceleration time 2	C08	Multistep frequency 4	H60	2 S-curve acceleration range (When finished)
E12	Acceleration time 3	C09	Multistep frequency 5	H63	Lower limit limiter (Operation selection)
E13	Deceleration time 3	C10	Multistep frequency 6	H65	Non-linear V/f 3 (Frequency)
E14	Acceleration time 4	C11	Multistep frequency 7	H66	Non-linear V/f 3 (Voltage)
E15	Deceleration time 4	C12	Multistep frequency 8	H71	Deceleration characteristics (forced brake)
E16	Torque limiter 2 (Driving)	C13	Multistep frequency 9	H84	Pre-excitation (Level)
E17	Torque limiter 2 (Braking)	C14	Multistep frequency 10	H85	Pre-excitation (Time)
E29	Frequency arrival delay (FAR2)	C15	Multistep frequency 11	H91	Current input wire break detection
E30	Frequency arrival detection range (Detection range)	C16	Multistep frequency 12	H92	Continued operation (P)
E31	Frequency detection (Operation level)	C17	Multistep frequency 13	H93	Continued operation (I)
E32	Frequency detection (Hysteresis width)	C18	Multistep frequency 14	H96	STOP key priority/Start check function
E34	Overload early warning/Current detection (Operation level)	C19	Multistep frequency 15	H114	Anti-regenerative control (Operation level)
E35	Overload early warning/Current detection (Timer time)	C20	Jogging frequency	H118	Forced operation (Fire Mode) (Reference frequency)
E36	Frequency detection 2	C33	Analog input adjustment (Terminal [12]) (Filter)	H121	Forced operation (Fire Mode) (Waiting time)
E37	Current detection 2/Low current detection (Operation level)	C38	Analog input adjustment (Terminal [C1] (C1 function)) (Filter)	H130	For special adjustment (Torque limiting)

No.	Name	No.	Name	No.	Name
H131	For special adjustment (Torque limiting)	b45	Speed control 3 (P gain)	J71	Brake control signal (Brake-apply frequency/speed)
H133	For special adjustment (Anti-regenerative control)	b46	Speed control 3 (I integral time)	J72	Brake control signal (Brake-apply timer)
H134	For special adjustment (Anti-regenerative control)	b47	Speed control 3 (FF gain)	J90	Overload stop (Torque limiter P (Gain)
H147	Speed control (JOG) (Feed forward gain)	b48	Speed control 3 (Output filter)	J91	Overload stop (Torque limiter I (Integral time))
H155	Torque bias (Level 1)	b49	Speed control 3 (Notch filter resonance frequency)	J92	Overload stop (Current command level)
H156	Torque bias (Level 2)	b50	Speed control 3 (Notch filter attenuation level)	J95	Brake control signal (Brake-release torque)
H157	Torque bias (Level 3)	b58	Speed control 3 (Notch filter width)	J97	Servo lock (Gain)
H158	Torque bias (Mechanical loss compensation)	r43	Speed control 4(Speed command filter)	J98	Servo lock (Completion timer)
H159	Torque bias (Startup timer)	r44	Speed control 4 (Speed detection filter)	J99	Servo lock (Completion range)
H161	Torque bias (Shutdown timer)	r45	Speed control 4 (P gain)	J105	PID control (Display unit)
H162	Torque bias (Limiter)	r46	Speed control 4 (I integral time)	J136	PID control 1 (PID multistep commands 1)
H173	Magnetic flux level at light load	r47	Speed control 4 (FF gain)	J137	PID control 1 (PID multistep commands 2)
H180	Brake control signal (Check-time for brake operation)	r48	Speed control 4 (Output filter)	J138	PID control 1 (PID multistep commands 3)
H195	DC braking (Braking time at startup)	r49	Speed control 4 (Notch filter resonance frequency)	d01	Speed control 1 (Speed command filter)
H196	For adjustment by manufacturer	r50	Speed control 4 (Notch filter attenuation level)	d02	Speed control 1 (Speed detection filter)
A05	Torque boost 2	r58	Speed control 4 (Notch filter width)	d03	Speed control 1 (P (Gain))
A09	DC braking 2 (Braking starting frequency)	J03	PID control P (Gain)	d04	Speed control 1(I (Integral time))
A10	DC braking 2 (Operation level)	J04	PID control I (Integral time)	d05	Speed control 1 (FF gain)
A11	DC braking 2 (Braking time)	J05	PID control D (Differential time)	d06	Speed control 1 (Output filter)
A12	Starting frequency 2	J06	PID control (Feedback filter)	d07	Speed control 1 (Notch filter resonance frequency)
A21	Motor 2 (%R1)	J08	PID control (Pressurization starting frequency)	d08	Speed control 1 (Notch filter attenuation level)
A23	Motor 2 (Slip compensation gain for driving)	J09	PID control (Pressurizing time)	d09	Speed control (JOG) (Speed command filter)
A24	Motor 2 (Slip compensation response time)	J10	PID control (Anti-reset windup)	d10	Speed control (JOG) (Speed detection filter)
A25	Motor 2 (Slip compensation gain for braking)	J12	PID control (Upper limit alarm (AH))	d11	Speed control (JOG) P (gain)
A43	Speed control 2 (Speed command filter)	J13	PID control (Lower limit alarm (AL))	d12	Speed control (JOG) I (Integral time)
A44	Speed control 2 (Speed detection filter)	J15	PID control (Low liquid level stop/start frequency level)	d13	Speed control (Jogging) (Output filter)
A45	Speed control 2 (P (Gain))	J16	PID control (Low liquid level stop elapsed time)	d16	PG option Ch2 (Pulse scaling factor 1)
A46	Speed control 2 (I (Integral time))	J17	PID control (Starting frequency)	d17	PG option Ch2 (Pulse scaling factor 2)
A47	Speed control 2 (FF gain)	J18	PID control (Upper limit of PID output)	d18	PG option Ch2 (Filter time constant)
A48	Speed control 2 (Output filter)	J19	PID control (Lower limit of PID output)	d21	Speed agreement / PG error (Detection range)
A49	Speed control 2 (Notch filter resonance frequency)	J58	PID control (Detection range of dancer standard position error)	d22	Speed agreement / PG error (Detection timer)
A50	Speed control 2 (Notch filter attenuation level)	J59	PID control P (Gain) 2	d24	Zero speed control
A58	Speed control 2 (Notch filter width)	J60	PID control I (Integral time) 2	d25	ASR switching time
A60	Speed display coefficient 2	J61	PID control D (Differential time) 2	d29	Speed control 1 (Notch filter width)
A61	Constant feed time coefficient 2/Speed display auxiliary coefficient 2	J62	PID control block selection	d32	Speed limit / Overspeed level (Level 1)
A62	Starting frequency 2 (Holding time)	J63	Overload stop (Detection value)	d33	Speed limit / Overspeed level (Level 2)
A63	Stop frequency 2	J64	Overload stop (Detection level)	d35	Overspeed detection level
A64	Stop frequency 2 (Detection method)	J67	Overload stop (Timer time)	d61	PG option Ch1 / X terminal (Pulse string input filter time constant)
A65	Stop frequency 2 (Holding time)	J68	Brake control signal (Brake-release current)	d62	PG option Ch1 / X terminal (Pulse compensation coefficient 1)
b43	Speed control 3 (Speed command filter)	J69	Brake control signal (Brake-release frequency/speed)	d63	PG option Ch1 / X terminal (Pulse compensation coefficient 2)
b44	Speed control 3 (Speed detection filter)	J70	Brake control signal (Brake-release timer)	d70	Speed control limiter

No.	Name	No.	Name	No.	Name
d71	Master-follower operation (Main speed regulator gain)	d90	Magnetic flux level during deceleration	d204	Position regulator gain
d72	Master-follower operation (APR P gain)	d90	Magnetic flux level during deceleration	d208	Orientation mode selection
d73	Master-follower operation (APR P gain)	d91	For special adjustment	d213	Homing frequency/orientation frequency
d74	Master-follower operation (APR output + side limiter)	d120	Brake control signal (Brake-release current)	d215	Homing deceleration time/orientation deceleration time
d75	Master-follower operation (Z phase alignment gain)	d121	Brake signal (Brake-release frequency/speed)	d217	Homing shift teaching
d76	Master-follower operation ((Offset angle between master and follower)	d122	Brake control signal (Brake-release timer)	d239	Positioning complete range
d77	Master-follower operation (Synchronous completion detection angle)	d123	Brake signal (Brake-release torque)	d277	Positioning data communication command selection
d86	Acceleration/deceleration output filter	d125	Brake signal (Brake-apply timer)		

■ **Function codes for the customizable logic**

Function code number	Name	Range	Minimum unit	Remarks
U121 to U170	User parameters 1 to 50	-9990.00 to 9990.00 Effective number are 3 digits.	0.01 to 10	
U171 to U180	Storage area 1 to 10	-9990.00 to 9990.00 Effective number are 3 digits.	0.01 to 10	Memorizes the data when powered OFF.

■ **Configuration of function codes**

If specifying function codes, set the code values (decimal values on left, hexadecimal values on right) in the following table for function 1 (U04, etc.), and set the last two digits of the function code number for function 2 (U05, etc.) Function codes that are not found in the following table cannot be specified. The data format that can be accessed correctly is as follows. (However, values are restricted to the -9990 to 9990 range) [1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [12], [22], [24], [29], [35], [37], [45], [61], [67], [68], [74], [92], [93]

Data formats other than the above cannot be accessed correctly, and should therefore not be used.

Table 5.3-16

Group	Code		Group	Code	
F	0	00_H	Z	17	11_H
E	1	01_H	b	18	12_H
C	2	02_H	d	19	13_H
P	3	03_H	W1	22	16_H
H	4	04_H	X1	25	19_H
A	5	05_H	K	28	$1C_H$
o	6	06_H	H1	31	$1F_H$
M	8	08_H	M1	35	23_H
r	10	$0A_H$	o1	37	25_H
U	11	$0B_H$	U1	39	27_H
J	13	$0D_H$	J1	48	30_H
y	14	$0E_H$	d1	54	36_H
W	15	$0F_H$	d2	55	37_H
X	16	10_H			

■ **Task process cycle setting (U100)**

U100 data	Content
0	Automatically adjusts the task cycle from 2 ms to 20 ms depending on the number of used steps. It is recommended to use this value.
2	2 ms: Up to 10 steps. If it exceeds 20 steps, the customizable logic does not work.
5	5 ms: Up to 50 steps. If it exceeds 50 steps, the customizable logic does not work.
10	10 ms: Up to 100 steps. If it exceeds 100 steps, the customizable logic does not work.
20	20 ms: 20 is set if 100 steps is exceeded.

Note that if it exceeds the steps defined in 2, 5 or 10, the customizable logic does not work.

■ **Operating precautions**

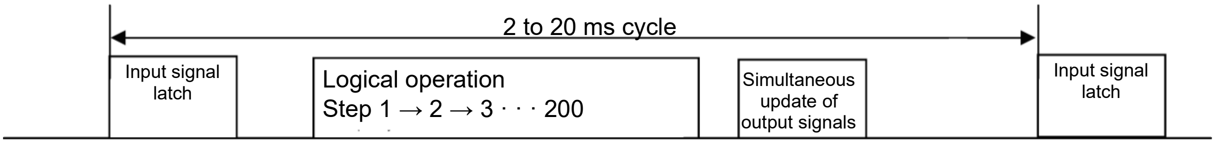
The customizable logics are executed within 2 ms to 20 ms (according to U100) and processed in the following procedure:

(1) First, latch the external input signals for all the customizable logics from step 1 to 260 to maintain synchronism.

(2) Perform logical operations sequentially from step 1 to 260.

(3) If an output of a step is an input to the next step, outputs of steps with high priority can be used in the same process.

(4) The customizable logic simultaneously updates 14 output signals.



Note that if you do not consider the process order of customizable logic when configuring a function block, the expected output may not be obtained, the operation can be slower or a hazard signal can occur, because the output signal of a step is not available until the next cycle.

⚠CAUTION
Changing a function code related to the customizable logic (U code etc.) or turning ON the customizable logic cancel signal “CLC” causes a change in operation sequence depending on the setting, which may suddenly start an operation or start an unexpected action. Carry out a sufficient safety check beforehand. **Failure to observe this could result in an accident or injury.**

Chap 5 FUNCTION CODES

■ **Customizable logic timer monitor (Step selection) (U91, X89 to X93)**

The monitor function codes can be used to monitor the I/O status or timer’s operation state in the customized logics.

Selection of monitor timer

Function codes	Function	Remarks
U91	0: Monitor disabled (the monitor data is 0) 1 to 260: set the step number to monitor	The setting value is cleared to “0” when powered OFF.

Monitor method

Monitor method	Function codes	Content
Communication	X89 customizable logic (digital I/O)	Digital I/O data for the step defined in U91 (only for monitoring)
	X90 customizable logic (timer monitor)	Data of the timer/counter value for the step defined in U91 (only for monitoring)
	X91 customizable logic (analog input 1)	Analog input 1 data for the step defined in U91 (only for monitoring)
	X92 customizable logic (analog input 2)	Analog input 2 data for the step defined in U91 (only for monitoring)
	X93 customizable logic (analog output)	Analog output data for the step defined in U91 (only for monitoring)

■ **Customizable logic output monitor (Step selection) (U98)**

■ **Customizable logic output monitor (Display unit selection) (U99)**

The output status of the desired customizable logic steps can be monitored on the keypad.
This is enabled by setting "32: Customizable logic output" with keypad monitor selection E43.
Furthermore, when using the multi-function keypad (TP-A2SW), the desired display units can be selected.

<table>
<tr><th>Function codes</th><th colspan="4">Function</th><th>Remarks</th></tr>
<tr><td>U98</td><td colspan="4">0: Monitor disabled
(the monitor data is "0")
1 to 260: set the step number to monitor</td><td>Setting values are retained even when the power is turned OFF.</td></tr>
<tr><td>U99</td><td>1 : No unit
2 : %
4 : r/min
7 : kW
8 : HP
10 : mm/s
11 : mm/m
12 : mm/h
13 : m/s
14 : m/min
15 : m/h
16 : FPS
17 : FPM
18 : FPH
19 : SPM
20 : m3/s
21 : m3/min</td><td>22 : m3/h
23 : L/s
24 : L/min
25 : L/h
26 : GPS
27 : GPM
28 : GPH
29 : CFS
30 : CFM
31 : CFH
32 : kg/s
33 : kg/m
34 : kg/h
35 : lb/s
36 : lb/m
37 : lb/h
38 : AF/Y</td><td>40 : Pa
41 : kPa
42 : MPa
43 : mbar
44 : bar
45 : mmHg
46 : PSI
47 : mWG
48 : inWG
49 : inHg
50 : WC
51 : Ft WG
52 : ATM
60 : K
61 : °C
62 : °F
65 : Nm</td><td>66 : lb Ft
70 : mm
71 : cm
72 : m
73 : km
74 : in
75 : Ft
76 : Yd
77 : mi
80 : ppm
90 : m3
91 : L
92 : GAL
93 : OZ</td><td>These are valid only when using the multi-function keypad (TP-A2SW).</td></tr>
</table>

■ **Cancel customizable logic "CLC" (Function codes E01 to E05, data = 80)**

Customizable logic operations can temporarily be disabled so that the inverter can be operated without the customizable logic's logical circuit and timer operation, for example during maintenance.

"CLC"	Function
OFF	Customizable logic enabled (according to U00 setting)
ON	Customizable logic disabled

Note: If you turn ON the customizable logic cancellation signal "CLC," a sequence by the customizable logic is cleared, which can suddenly start operation depending on the settings. Ensure the safety and check the operation before switching the signal.

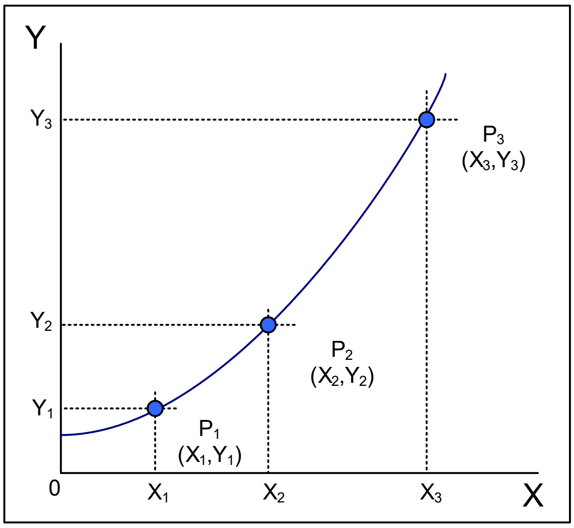
■ **Clear all customizable logic timers "CLTC" (Function codes E01 to E05, data = 81)**

If the "CLTC" terminal function is assigned to a general-purpose input terminal and this input is turned ON, all the general-purpose timers and counters in the customizable logic are reset. It is used to reset and restart the system, when, for example, the timing of external sequence cannot be consistent with internal customizable logic due to a momentary power failure.

"CLTC"	Function
OFF	Normal operation
ON	Resets all the general-purpose timers and counters in the customizable logic. (To reactivate it, turn it OFF again.)

U101 to U106	**Customizable logic (Conversion operation 1 (X1, Y1), Conversion operation 2 (X2, Y2), Conversion operation 3 (X3, Y3))**
U107	**Customizable logic (Automatic conversion coefficient calculation)**

Operation coefficient KA, KB, and KC used with Block 3001: Conversion 1 calculation formula (KA x input 1^2 + KB x input 1 + KC) is calculated automatically. By converting the applicable functions to graphical format, setting the 3 XY points in U101 to U106, and changing U107 from 0 to 1, the exponent part and mantissa for KA, KB, and KC for U92 to U97 are calculated automatically, and data is updated.



Convert the applicable functions to graphical format, and set the 3 XY points as follows.

Function codes	Name	Setting range:
U101	Operating point data P1 (X1)	-999.00 to 9990.00
U102	Operating point data P1 (Y1)	-999.00 to 9990.00
U103	Operating point data P2 (X2)	-999.00 to 9990.00
U104	Operating point data P2 (Y2)	-999.00 to 9990.00
U105	Operating point data P3 (X3)	-999.00 to 9990.00
U106	Operating point data P3 (Y3)	-999.00 to 9990.00

U107 data	Function
0	Disable
1	U92 to U97 automatic calculation (Returns to 0 after automatic calculation)

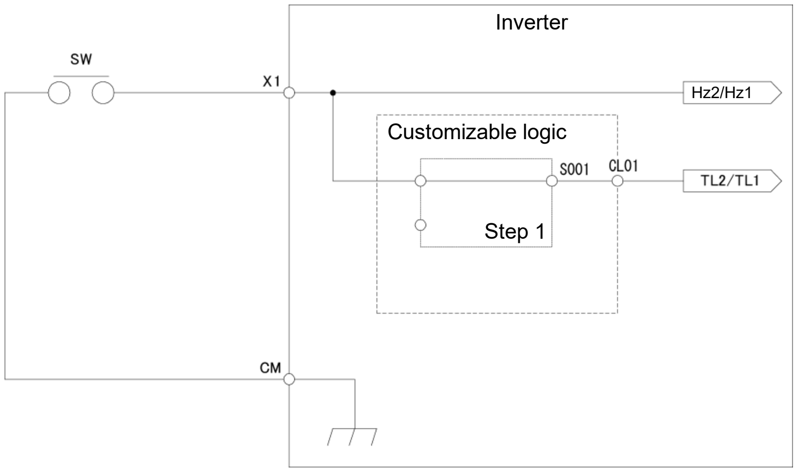
The following operation coefficients are automatically calculated, and then stored in each function code.

Function codes	Name	Setting range:
U92	Coefficient KA mantissa portion	-9.999 to 9.999
U93	Coefficient KA exponent portion	-5 to 5
U94	Coefficient KB mantissa portion	-9.999 to 9.999
U95	Coefficient KB exponent portion	-5 to 5
U96	Coefficient KC mantissa portion	-9.999 to 9.999
U97	Coefficient KC exponent portion	-5 to 5

■ Setting examples of customizable logic

<u>Setting example 1: Use one switch to change multiple signals</u>

If you use one switch to change the frequency setting 2/frequency setting 1 and torque limit 2/torque limit 1 simultaneously, replace an external circuit that is conventionally needed with a customizable logic reducing the digital input terminals used to a single terminal.

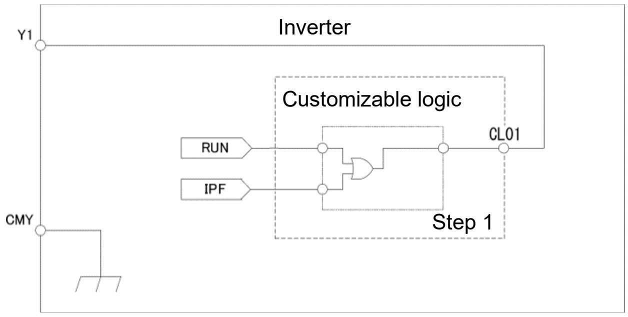


To configure this customizable logic, set the function codes as follows. (Timer selection) and (Timer setting) do not need to be modified if no change is made.

Function codes			Setting value	Setting contents	Remarks
E01	Terminal [X1] (Function selection)		11	Select frequency command 2/1 “Hz2/Hz1”	Can be used in parallel as general-purpose input terminals
U00	Customizable Logic (Operation selection)		1	Enable	
U01	Customizable logic: Step 1	(Block selection)	10	Through output + General-purpose timer	Operation selection
U02		(Input 1)	4001	Terminal [X1] input signal “X1”	
U71	Customizable logic: Output signal 1	(Output selection)	1	Output of step 1, “SO01”	
U81		(Function selection)	14	Select torque limiter level 2/1 “TL2/TL1”	

Setting example 2: Consolidating multiple output signals into one

If also outputting a momentary power failure restart “IPF” signal to an Inverter running “RUN” signal, replace an external circuit that is conventionally needed with a customizable logic sequence to reduce the digital output terminals and external relays.

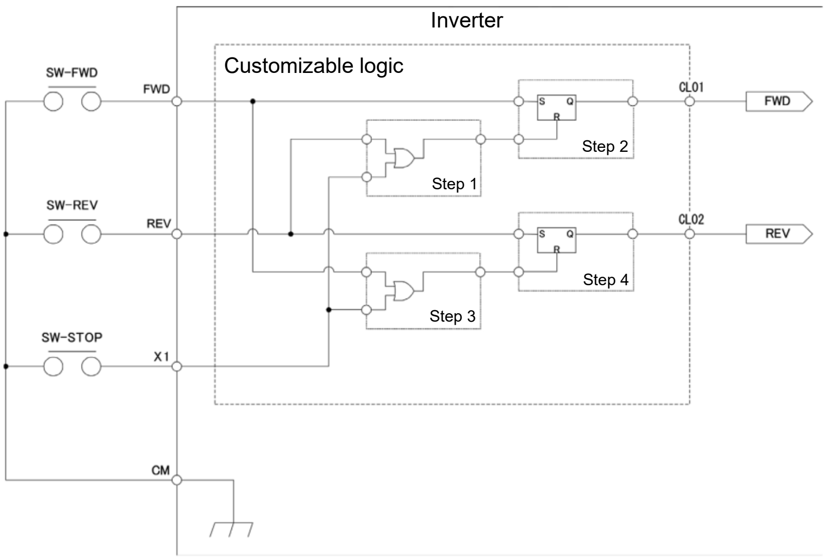


To configure this customizable logic, set the function codes as follows. (Timer selection) and (Timer setting) do not need to be modified if no change is made.

Function codes			Setting value	Setting contents	Remarks
E20	Terminal [Y1] (Function selection)		111	Customizable logic output signal 1 “CL01”	
U00	Customizable Logic (Operation selection)		1	Enable	
U01	Customizable logic: Step 1	(Block selection)	30	Logical OR + general-purpose timer	Operation selection
U02		(Input 1)	0	Inverter running “RUN”	
U03		(Input 2)	6	Momentary power failure restart “IPF”	
U71	Customizable logic: Output signal 1	(Output selection)	1	Output of step 1, “SO01”	
U81		(Function selection)	100	No assignment “NONE”	

Setting example 3: One-shot operation

If starting operation by shorting the SW-FWD switch or SW-REV switch, or stopping operation by shorting the SW-STOP switch (same as multi-function keypad FWD/REV key /STOP key), the previously required external circuit can be replaced with customizable logic.



To configure this customizable logic, set the function codes as follows. (Timer selection) and (Timer setting) do not need to be modified if no change is made.

Function codes			Setting value	Setting contents	Remarks
F02	Operation method		1	External signal	
E01	Terminal [X1] (Function selection)		100	No assignment “NONE”	
E98	Terminal [FWD] (Function selection)		100	No assignment “NONE”	
E99	Terminal [REV] (Function selection)		100	No assignment “NONE”	
U00	Customizable Logic (Operation selection)		1	Enable	
U01	Customizable logic: Step 1	(Block selection)	30	Logical OR + general-purpose timer	Operation selection
U02		(Input 1)	4011	Terminal [REV] input signal “REV”	
U03		(Input 2)	4001	Terminal [X1] input signal “X1”	
U06	Customizable logic: Step 2	(Block selection)	60	Reset priority flip-flop + general-purpose timer	Operation selection
U07		(Input 1)	4010	Terminal [FWD] input signal “FWD”	
U08		(Input 2)	2001	Output of step 1, “SO01”	
U11	Customizable logic: Step 3	(Block selection)	30	Logical OR + general-purpose timer	Operation selection
U12		(Input 1)	4010	Terminal [FWD] input signal “FWD”	
U13		(Input 2)	4001	Terminal [X1] input signal “X1”	
U16	Customizable logic: Step 4	(Block selection)	60	Reset priority flip-flop + general-purpose timer	Operation selection
U17		(Input 1)	4011	Terminal [REV] input signal “REV”	
U18		(Input 2)	2003	Output of step 3, “SO03”	
U71	Customizable logic output signal 1	(Output selection)	2	Output of step 2, “SO02”	“FWD” command
U72	Customizable logic output signal 2		4	Output of step 4, “SO04”	“REV” command
U81	Customizable logic output signal 1	(Function selection)	98	Run forward/stop command “FWD”	
U82	Customizable logic output signal 2		99	Run reverse/stop command “REV”	

5.3.16 y codes (Link Functions)

y01 to y20	RS-485 communication 1, RS-485 communication 2

In the RS-485 communication, two systems can be connected.

System (Communication port)	Connection configuration	Function codes	Equipment that can be connected
System 1 (Port 1)	RJ-45 connector for keypad connection	y01 to y10	(1) Keypad (standard/multi-function) (2) FRENIC-Loader4 (3) Host equipment
System 2 (Port 2)	[Terminal] DX+, DX-, SD	y11 to y20	(2) FRENIC-Loader4 (3) Host equipment

An overview of all compatible devices is given below.

(1) Keypad (standard/multi-function)
The standard keypad or multi-function keypad can be connected to operate and monitor the inverter. The keypad can be used regardless of the y code setting.

(2) FRENIC-Loader4
Inverter support (monitoring, function code editing, test running) can be performed by connecting a PC with the FRENIC-Loader4 installed.

(3) Host equipment
Host equipment such as PLC and controller can be connected to control and monitor the inverter. Modbus RTU* protocol or Fuji general-purpose inverter protocol can be selected for communication.

* Modbus RTU is a protocol stipulated by Modicon.

For details, refer to the "RS-485 Communications User's Manual."

■ Station addresses (y01, y11)

Sets the station address for RS-485 communication. The setting range differs for each protocol.

Protocol	Range	Broadcast
Modbus RTU	1 to 247	0
Fuji general-purpose inverter	1 to 31	99
BACnet MS/TP	0 to 255	255

- When specifying a value outside the range, no response is returned.
- If using FRENIC-Loader4, set the station specified with FRENIC-Loader4.
- BACnet MS/TP can be used with only one system.
  For details, refer to protocol selection (y10, y20).
- “0” is treated as “1” with other than BACnet MS/TP.

■ Operation selection when error occurs (y02, y12)

Selects the operation when an error occurs during RS-485 communication.

RS-485 errors are logical errors such as address errors, parity errors and framing errors, as well as transmission errors and disconnection errors set with y08/y18. These errors occur only when the inverter is configured to receive the operation command or frequency command via the RS-485 communication. If the operation command or frequency command is not issued via the RS-485 communication, or when the inverter is stopped, the system does not determine an error.

y02, y12 data	Function
0	Displays the RS-485 communication error (Er8 for y02, ErP for y12), and immediately stops the operation (trip by alarm).
1	Operates for a period specified in the error process timer (y03, y13), and then displays the RS-485 communication error (Er8 for y02, ErP for y12), and stops the operation (trip by alarm).
2	Retries the communication for a period specified in the error process timer (y03, y13), and if the communication is recovered, the operation continues. Displays the RS-485 communication error (Er8 for y02, ErP for y12) if the communication is not recovered, and immediately stops the operation (trip by alarm).
3	Continues the operation if a communication error occurs.

For details, refer to the "RS-485 Communications User's Manual."

■ Timer (y03, y13)

Sets the error process timer. An error is judged to have occurred when the timer value set at the time a response is required elapses due to non-response from the other end or other reasons. Refer to the "Communication time-out detection timer (y08, y18)" section also.

- Data setting range: 0.0 to 60.0 (s)

■ Baud rate (y04, y14)

Sets the Baud rate.

y04, y14 data	Function
0	2400 bps
1	4800 bps
2	9600 bps
3	19200 bps
4	38400 bps
5	57600 bps
6	76800 bps
7	115200 bps

■ Data length selection (y05, y15)

Sets the character length.

- For Modbus RTU:
  The value does not need to be set since it automatically becomes 8 bits.

y05, y15 data	Function
0	8 bits
1	7 bits

■ Parity selection (y06, y16)

Sets the parity bit.

y06, y16 data	Function
0	No parity bit (2 bits of stop bit for Modbus RTU)
1	Even parity (1 bit of stop bit for Modbus RTU)
2	Odd parity (1 bit of stop bit for Modbus RTU)
3	No parity bit (1 bit of stop bit for Modbus RTU)

■ Stop bit selection (y07, y17)

Sets the stop bit.

- For Modbus RTU:
  The value does not need to be set since it is automatically determined in conjunction with the parity bit.

y07, y17 data	Function
0	2 bits
1	1 bit

■ Communication time-out detection timer (y08, y18)

Sets the period from the time the system detects a communication time-out (for any reason such as disconnection in equipment that periodically accesses the station within a specific time) during operation using RS-485 communication, until the time the system processes communication errors.

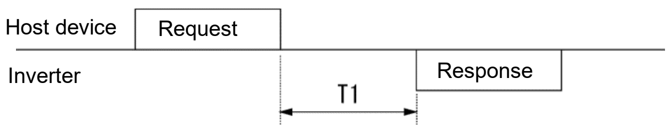
Refer to y02, y12 for details on communication error processing.

y08, y18 data	Function
0	Disconnection is not detected.
1 to 60	Detection time from 1 to 60 (s)

■ Response interval time (y09, y19)

Sets the period from the time the system receives a request from host equipment (PC or PLC, etc.) until the time that a response is returned after receipt of the request is complete. Even with host devices for which processing from the completion of transmission to the completion of receipt preparation is delayed, the timing can be aligned by setting the response interval time.

- Data setting range: 0.00 to 1.00 (s)



T1 = Response interval time + α

α: Processing time inside the inverter. This differs based on the timing and command.

For details, refer to the "RS-485 Communications User's Manual."

Note　If specifying inverter settings from FRENIC-Loader4 via RS-485 communication, set based on the performance and conditions for the PC or converter (USB-RS-485 converter, etc.) (Some converters monitor communication status and switch transmission and reception with timer.)

■ Protocol selection (y10, y20)

Selects the communication protocol.

y10, y20 Data	Function
0	Modbus RTU protocol
2	Fuji general-purpose inverter Protocol
5	BACnet MS/TP protocol

Note　Data 5: BACnet MS/TP protocol can be used with only one system.
If either of the above is assigned to both port 1 and port 2, the port 1 communication protocol in the inverter will be “0: Modbus RTU protocol.”

y60, y61	BACnet MS/TP device instance (high order digits, low order digits)

These function codes set the device instance used for identification at the BACnet MS/TP protocol application layer.
The setting method differs as follows depending on the y16 setting value.

y61 data	Device instance	Settable range *1
0	(y60 data x 1000) + MAC address *2	(y60 data x 1000) + (0 to 127)
128 to 999	(y60 data x 1000) + y61 data	(y60 data x 1000) + (128 to 999)

*1 The maximum device instance setting range is 0 to 4194302.

*2 Set the MAC address to y01 or y11.

y62, y63	BACnet MS/TP Network Number (ch1, ch2)

These function codes set the BACnet MS/TP network numbers for RS-485 communication Ch1/Ch2.
The setting range for each network number is 0 to 65534.

y85 to y88	For adjustment by manufacturer

These function codes are for adjustment by the manufacturer. Unless otherwise specified, do not access these function codes.

y93	RTU current format switching

It is possible to switch the format of the current data which can be monitored by Modbus RTU protocol with RS-485 communication.

If switching from the E1 or E2 series, and inheriting the customer's controller program (using without changes), set "1: Format 19."

y93 data	Function
0	Format 24
1	Format 19 (E1, E2 compatible)

For details on applicable function codes, refer to the "RS-485 Communication User's Manual."

Data format [24] floating point data

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Exponent part		Mantissa													

Exponent part : 0～3 Mantissa : 1～9999

Numerical value expressed with this format = Mantissa x (Exponent - 2) to the 10th power

Numerical value (current value)	Mantissa	Exponent	(Exponent part-2) to the 10th power
0.00 to 99.99	0 to 9999	0	0.01
100.0 to 999.9	1000 to 9999	1	0.1
1000 to 9999	1000 to 9999	2	1
10000 to 99990	1000 to 9999	3	10

Data format [19] current value

The current value is decimal point data (positive). The increment is 0.01.

It is not possible to write data that exceeds 655 A. When reading after a data write instruction that exceeds 655 A, positive values are not read.

Furthermore, current value data from the 5th digit is rounded down inside the inverter.

(Example: After submitting a write instruction of 107.54 A, 107.5 A is written.)

(Example) If F11 (electronic thermal overload relay operation level) = 107.0 A

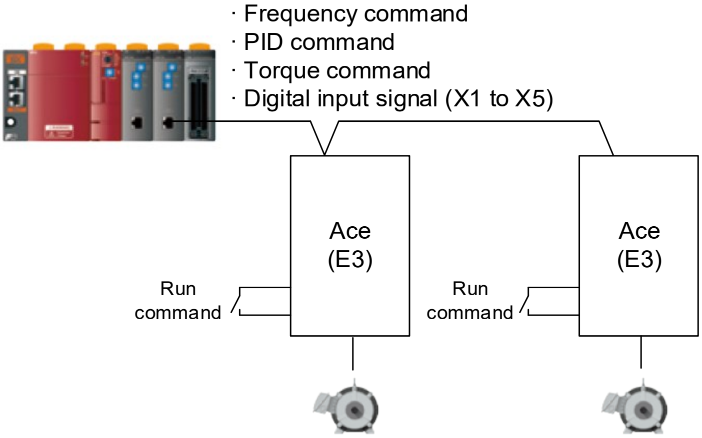
107.00 x 100 = 10700 = 29CCH → 29H CHH

y94	Link function (X terminal operation selection) Related function codes y98: Bus function (Operation selection) H30: Link function (Operation selection)

When running and operating the inverter via field bus communication, this function is used if issuing run commands only with inverter unit digital input terminals [FWD] and [REV]. When doing so, set the following values for y98, H30, and F02.

Refer to the H30 section for details on operation if y94 is set to "1," and y98, H30, and F02 are set to other than the following, and if y94 is set to "0."

y94	y98	H30	F02	Frequency commands, PID commands, etc.	Run command	Other than run commands (input terminal [X1 to X5])
1	1	0	1	Commands through field bus communication	Inverter unit Terminal [FWD], [REV]	Commands via field bus communication



y95	Data clear processing for communications error

If any of the communication error alarms (Er8, ErP, Er4, Er5) occurs in RS-485, or bus option, the data of communication command function codes (S codes) can automatically be cleared.

Since the frequency and operation commands are also disabled when the data is cleared, the inverter does not start unintentionally when an alarm is released.

y95 data	Function
0	Do not clear the data of function codes Sxx when a communications error occurs. (compatible with the conventional inverters)
1	Clear the data of function codes S01/S05/S19 when a communications error occurs.
2	Clear the bit assigned to run command of function code S06 when a communications error occurs.
3	Clear operations for 1 and 2 above are performed.
4	Clear operations for 1 and 2 above and S02, S03, S13, S15, S20, S21

y96	Communication compatibility mode (E1, E2 compatibility mode)

When reading or writing inverter function code setting data via RS-485 communication or field bus communication, it is possible to select a compatibility mode that permits communication with the same function code and data format as the FRENIC-Multi (E1) and FRENIC-Ace (E2) series. By using this function, it is possible to keep customer controller program changes to a minimum when replacing inverters.

y96 data	Function
0	Disable
6	Enable (E1 compatibility)
7	Enable (E2 compatibility)

Only when y96 = 2 or 3, and the communication command source is RS-485 communication or field bus communication, the following function codes are replaced with the equivalent of those for the E1 and E2 series. Function codes that are not listed below are interchangeable, and therefore E1 and E2 series settings can be replaced as is.

E1 function codes → E3 replace destination function codes

Number	E1 function codes				Replaced	Replace destination E3 function codes		Replace-enabled conditions	Remarks
	Code	Name	R/W	Communication data format (*1)	O: Yes —: No	Code	Communication data format (*1)	Function code conditions	
1	F51	Electronic thermal (Braking resistors protection)	R/W	[7]	O	F51	[45]	y96=6	—
2	E39	Constant feed time coefficient	R/W	[7]	O	E39	[45]	y96=6	
3	E40	PID display coefficient A	R/W	[12]	O	J106	[12]	y96=6	—
4	E41	PID display coefficient A	R/W	[12]	O	J107	[12]	y96=6	—
5	E45	LCD monitor (Item selection)	R/W	[1]	O	K15	[1]	y96=6	—
6	E46	LCD monitor (Language selection)	R/W	[1]	O	K01	[1]	y96=6	—
7	E47	LCD monitor (Contrast adjustment)	R/W	[1]	O	K04	[1]	y96=6	—
8	E59	Terminal function selection (C1 function/V2 function)	R/W	[1]	-			y96=6	
9	C21	Timed operation	R/W	[1]	O	C21	[1]	y96=6	—
10	H54	Acceleration/deceleration time (Jogging operation)	R/W	[12]	O	H54	[12]	y96=6	—
11						H55	[12]	y96=6	—
13	H94	Cumulative motor run time 1	R/W	[1]	O	H94	[74]	y96=6	—
14	H98	Protection/maintenance functions	R/W	[1]	O	H98	[1]	y96=6	Only for bits 0 to 4.
15	A45	Cumulative motor run time 2	R/W	[1]	O	A51	[74]	y96=6	—
16	A46	Startup count 2	R/W	[1]	O	A52	[1]	y96=6	—
18	J68	Brake control signal (Brake-release current)	R/W	[1]	O	J68	[5]	y96=6	—
19	J70	(Brake-release timer)	R/W	[3]	O	J70	[5]	y96=6	—
20	J72	(Brake-apply timer)	R/W	[3]	O	J72	[5]	y96=6	—
44	o01	Command/feedback input – Input format selection	R/W	[3]	-			y96=6	—
45	o02	Speed control (P)	R/W	[3]	-			y96=6	—
46	o03	Speed control (I)	R/W	[3]	-			y96=6	—
47	o04	Speed command filter	R/W	[3]	-			y96=6	—
48	o05	Command pulse – Encoder pulse	R/W	[3]	-			y96=6	—
49	o06	Command pulse – Filter time constant	R/W	[3]	-			y96=6	—
50	o07	Command pulse – Compensation coefficient 1	R/W	[3]	-			y96=6	—
51	o08	Command pulse – Compensation coefficient 2	R/W	[3]	-			y96=6	—
52	o09	Feedback pulse – Encoder pulse	R/W	[3]	-			y96=6	—
53	o10	Feedback pulse – Filter time constant	R/W	[3]	-			y96=6	—
54	o11	Feedback pulse – Compensation coefficient 1	R/W	[3]	-			y96=6	—
55	o12	Feedback pulse – Compensation coefficient 2	R/W	[3]	-			y96=6	—
56	o13	PG output limiter (for speed control)	R/W	[3]	-			y96=6	—

E2S function codes → E3S replace destination function codes

Number	E1 function codes				Replaced	Replace destination E3 function codes		Replace-enabled conditions	Remarks
	Code	Name	R/W	Communication data format (*1)	O: Yes —: No	Code	Communication data format (*1)	Function code conditions	
1	E39	Constant feed time coefficient	R/W	[7]	O	E39	[45]	y96=7	—
2	E59	Terminal function selection (C1 function/V2 function)	R/W	[1]	-			y96=7	—
3	H90	Auto search method selection	R/W	[1]	-			y96=7	—
4	J56	Speed command filter for PID-PID	R/W	[5]	-			y96=7	—
5	J70	(Brake-release timer)	R/W	[3]	O	J70	[5]	y96=7	—
6	J72	(Brake-apply timer)	R/W	[3]	O	J72	[5]	y96=7	—
7	d92	- PM - auto search frequency hold (Current draw)	R/W	[5]	O	d192	[5]	y96=7	—
8	y21	For adjustment by manufacturer	R/W	[1]	-			y96=7	—
9	y24	For adjustment by manufacturer	R/W	[1]	-			y96=7	—
10	y25	For adjustment by manufacturer	R/W	[1]	-			y96=7	—
11	y26	For adjustment by manufacturer	R/W	[1]	-			y96=7	—
12	y27	For adjustment by manufacturer	R/W	[1]	-			y96=7	—
13	y28	For adjustment by manufacturer	R/W	[1]	-			y96=7	—
14	y29	For adjustment by manufacturer	R/W	[1]	-			y96=7	—
15	y30	For adjustment by manufacturer	R/W	[1]	-			y96=7	—
16	y31	For adjustment by manufacturer	R/W	[1]	-			y96=7	—
17	y32	For adjustment by manufacturer	R/W	[1]	-			y96=7	—
18	y33	For adjustment by manufacturer	R/W	[1]	-			y96=7	—
19	y34	For adjustment by manufacturer	R/W	[1]	-			y96=7	—
20	y35	For adjustment by manufacturer	R/W	[1]	-			y96=7	—
21	y36	For adjustment by manufacturer	R/W	[1]	-			y96=7	—
22	o01	Terminal O1 (Function selection)	R/W	[1]	O	o121	[1]	y96=7	—
23	o02	Terminal O2 (Function selection)	R/W	[1]	O	o122	[1]	y96=7	—
24	o03	Terminal O3 (Function selection)	R/W	[1]	O	o123	[1]	y96=7	—
25	o04	Terminal O4 (Function selection)	R/W	[1]	O	o124	[1]	y96=7	—
26	o05	Terminal O5 (Function selection)	R/W	[1]	O	o125	[1]	y96=7	—
27	o06	Terminal O6 (Function selection)	R/W	[1]	O	o126	[1]	y96=7	—
28	o07	Terminal O7 (Function selection)	R/W	[1]	O	o127	[1]	y96=7	—
29	o08	Terminal O8 (Function selection)	R/W	[1]	O	o128	[1]	y96=7	—
30	W150	Y2/SRCF switching SW8 status	R	[1]	-			y96=7	—
31	W192	For adjustment by manufacturer	R	[1]	-			y96=7	—

y97	Communication data storage selection

The inverter memory (non-volatile memory) has a limited number of rewritable times (100 thousand to 1 million times). If the count immoderately increases, the data cannot be modified or saved, causing a memory error.

If frequently rewriting data through communication, data can be stored to the temporary memory instead of writing it to the nonvolatile memory. By doing so, the number of times that data is written to the nonvolatile memory is suppressed, preventing memory errors.

If y97 is set to “2,” the data written in the temporary memory is stored (All Saved) in the non-volatile memory.

To change the y97 data, it is necessary to press the STOP + ▲/▼ keys (simultaneous keying).

y97 data	Function
0	Store into nonvolatile memory (Rewritable times are limited)
1	Write into temporary memory (Rewritable times are unlimited)
2	Save all data from temporary memory to nonvolatile memory (After All Save, the y97 data returns to 1)

y98	Bus function (Operation selection) (Refer to H30)

For details on setting the y98 bus function (mode selection), refer to the description of H30.

y99	Loader link function (Operation selection)

Function code to switch the links to the inverter supporting loader software (FRENIC-Loader4). Rewriting y99 with the inverter supporting loader software (FRENIC-Loader4) enables the set frequency and run command from the inverter supporting loader software (FRENIC-Loader4). You do not need to use the keypad since the data is rewritten from the inverter supporting loader.

If the operation command is configured to be given from the inverter supporting loader software, and if the PC starts to go out of control during the operation and a stop command from the loader software is ignored, remove the communication cable connected to the PC that runs the inverter supporting loader software, and connect the keypad to set the y99 data to “0.” The y99 data can also be set to “0” by pressing the STOP key on the keypad.

When y99 data is set to “0,” the operation is isolated from the FRENIC-Loader4 commands and switches to the commands from the inverter settings (such as function code H30).

The y99 data is not saved in the inverter; the setting is lost and returned to “0” when powered OFF.

y99 data	Function	
	Reference frequency	Run command
0	From function codes H30 and y98	From function codes H30 and y98
1	Setting from FRENIC-Loader4	From function codes H30 and y98
2	From function codes H30 and y98	Command issued from FRENIC-Loader4
3	Setting from FRENIC-Loader4	Command issued from FRENIC-Loader4

5.3.17 o/o1/o2 codes (Option Functions)

[E3S]

These codes are set when the inverter is equipped with an option card.

Set the codes after referring to the description in Chapter 11 “11.12 Adapter-equipped Type Option Cards Overview”, ”11.13 Terminal Block Type Options” , and the respective instruction manuals for each option card.

[E3N]

Used for the Ethernet connection settings. Before setting, refer to Chapter 9 ”9.3 Ethernet Communication Overview.”

5.3.18 K codes (Keypad Functions)

The multi-function keypad indicated in the description refers to the TP-A2SW.

For details on the multi-function keypad installation method, separately sold battery/SD card insertion and removal method, screen display and operation methods, and setting method for setting items other than K codes, refer to the TP-A2SW multi-function keypad Instruction Manual (Detailed version) (INR-SI47-2422□-E).

K01	LCD monitor (Language selection)

Select the language displayed on the multi-function keypad LCD monitor.

- Data setting range: 0 to 19

K01 data	Language	K01 data	Language	K01 data	Language
0	Japanese	7	Korean	14	Portuguese
1	English	8	Russian	15	Dutch
2	German	9	Greek	16	Malay
3	French	10	Turkish	17	Vietnamese
4	Spanish	11	Polish	18	Thai
5	Italian	12	Czech	19	Indonesian
6	Chinese	13	Swedish		

K02	Backlight OFF time

Sets the LCD backlight OFF time for the multi-function keypad. Turns the backlight OFF if the time set for K02 has elapsed since stopping multi-function keypad operation.

- Data setting range: 1 to 30 (min), OFF

K02 data	Function
OFF	Always OFF
1 to 30 (min)	Automatically turns OFF after the set time has elapsed if no multi-function keypad operation is performed.

K03 K04	LCD monitor (Brightness adjustment) (Contrast adjustment)

The multi-function keypad LCD brightness and contrast can be adjusted.

- Data setting range: 0 to 10

■ **Brightness adjustment (K03)**

K03 data	0, 1, 2, · · · · · · · · · · · · · · · · · · 8, 9, 10
0	Dark ◄──────────► Bright

■ **Contrast adjustment (K04)**

K04 data	0, 1, 2, · · · · · · · · · · · · · · · · · · 8, 9, 10
0	Low ◄──────────► High

Chap 5 FUNCTION CODES

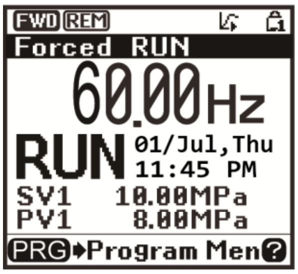
FUNCTION
F Codes
E Codes
C Codes
P Codes
H Codes
A Codes
b Codes
r Codes
J Codes
d Codes
U Codes
y Codes
O Codes
K Codes

K08	Status display

The status message displayed on the multi-function keypad LCD can be hidden or displayed.

- Data setting range: 0, 1

K08 data	Function
0	Hide
1	Show all



Status message
Displays operating statuses that the operator needs to be notified of.

Example
Undervoltage
Performing forced stoppage
Restarting after momentary power failure
Awaiting retry
Performing forced operation
Performing commercial operation, etc.

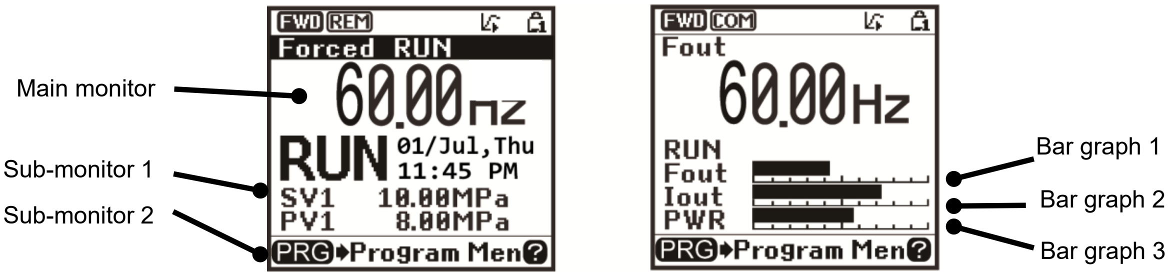
K15	Screen selection

The multi-function keypad LCD sub-monitor display type can be selected.

- Data setting range: 0, 1

K15 data	Function
0	Operation guide display
1	Bar graph display

<Sub-monitor: Operation guide display> <Sub-monitor: Bar graph display>



K16	**Sub-monitor 1 display content**
K17	**Sub-monitor 2 display content**
K20	**Bar graph 1 display content**
K21	**Bar graph 2 display content**
K22	**Bar graph 3 display content**

The displayed content can be selected from the following function codes based on the display type selected with K15.

For details of the display content, refer to the description for function code E43, and "3.3.1 Operating Status Main Monitor and Sub-monitor" in the multi-function keypad Instruction Manual (Detailed version) (INR-SI47-2422☐-E), and set for the following function codes.

Display location	Description
Main monitor	E43 data
Sub-monitor 1	K16 data
Sub-monitor 2	K17 data
Bar graph 1	K20 data
Bar graph 2	K21 data
Bar graph 3	K22 data

K25	**Display Unit for Load speed**

Selects the unit when the load rotation speed is displayed (E48 = 4)

K40	**For manufacturer**

Do not change.

K51	**Traceback (Data overwrite selection)**

It is possible to set whether to allow or prohibit overwriting if the maximum number of data items that can be saved is reached.

0: Allow (factory default), 1: Prohibit

Maximum number of data items that can be saved

When multi-function keypad TP-A2SW (option) connected: max. 100 items (when microSD card inserted) (Note)
When Remote keypad TP-E2 (option) connected: 1 item (stored in the TP-E2 nonvolatile memory)
When the standard keypad (TP-M3) or no keypad is connected: 1 item (stored in the inverter nonvolatile memory)

Note: Data cannot be saved when a microSD card has not been inserted.

K52	**Traceback (Sampling cycle)**

Sets the analog input/output signal or digital input/output signal waveform sampling cycle when an event occurs. There are 500 samples (fixed).

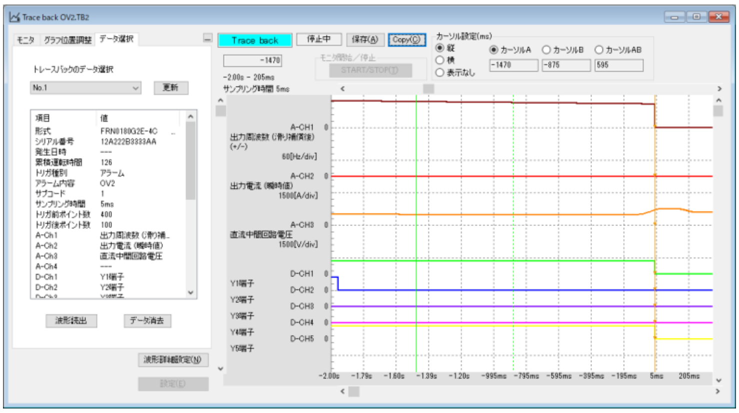
The following table shows the relationship between sampling cycle and the length of time that sampling is possible.

Sampling cycle	500 [μs] (Setting value: 8)	· · · ·	200 [ms] (Setting value: 7)
Sampling possible time	250 [ms]	· · · ·	100 [s]

K53	**Traceback (CH4 operation selection)**
K54 to K57	**Traceback (Analog Ch1 to 4 source selection)**
K58 to K65	**Traceback (Digital Ch1 to 8 source selection)**

By selecting the analog input/output signal or digital input/output signal to be saved when an event occurs using the FRENIC-Loader4 inverter support software and setting it to the inverter, setting information is saved to this function code.

By factory default, events are set for when “alarms” occur.



Traceback data display example

For details on traceback, refer to the Instruction Manual (INR-SI47-2104☐) for the FRENIC-Loader4 inverter support software.

K91 K92	Multi-function keypad TP-A2SW ◄ key shortcut selection Multi-function keypad TP-A2SW ► key shortcut selection

By pressing the multi-function keypad TP-A2SW (option) ◄ or ► keys while in Running mode, it is possible to jump to the Programming mode (PRG) menu screen set beforehand.

- Data setting range: 0 (disable), 11 to 99
  The left data setting digit indicates the menu number, and the right digit indicates the sub-menu number.

Example: If K91 = 21, by pressing the ◄ key, the display jumps to the PRG>2>1 function code data setting screen.

K91, K92 Data	Setting screen display	Jump destination	
		Menu	Sub-menu
0	OFF	Disable	-
11	Language	Start-up	Language
12	ApplInit		Application selection
13	Date/Time		Clock settings (Date/Time)
14	Display		Display settings
15	Bluetooth		Bluetooth
21	DataSet	Function codes	Data Setting
22	DataCheck		Data Checking
23	ChgData		Change Data Checking
24	DataCopy		Data Copying
25	Schedule		Disable (Scheduled operation)
26	Initial		Data initialization
31	EnergyMon	Inverter Information	Disable (Energy monitor)
32	OprMon		Drive Monitoring
33	I/O Check		I/O Checking
34	Mainte		Maintenance Information
35	UnitInfo		Unit Information
36	Dest.		Destination
41	AlarmHist	"Alarm Information"	Alarm history
42	Warn.Hist		Warning History
43	RetryHist		Retry History
51	Q.Setup	User-defined setting	Select Favorites
52	Password		Password
61	PID Mon	Tools	PID monitor
62	M-Op Mon		Disable (Multi-operation monitor)
63	Resonant		Avoid resonance
64	LoadFctr		Load factor measurement
65	COM Debug		Communication debug
70	KP Update	KP Update	-

FUNCTION CODES
Chap 5
FUNCTION
F Codes
E Codes
C Codes
P Codes
H Codes
A Codes
b Codes
r Codes
J Codes
d Codes
U Codes
y Codes
O Codes
K Codes

Chapter 6
TROUBLESHOOTING

This chapter describes troubleshooting procedures to be followed when the inverter malfunctions or an alarm or a warning occurs.

Contents

6.1 Protective Functions

In order to prevent the system going down and to shorten recovery time, FRENIC-Ace is equipped with various protective functions shown in Table 6.1-1 below. The protective functions marked with an asterisk (*) in the table are disabled by factory default.
Enable them according to your needs.

The protective functions include, for example: the “Alarm detection” function which, upon detection of an abnormal state, displays the alarm code on the LED monitor and causes the inverter to trip; the “Warning” function which displays the alarm code but lets the inverter continue the current operation; and other warning functions.

If any problem arises, understand the protective functions listed below and follow the procedures given in section 6.2 and onwards for troubleshooting.

Table 6.1-1 Error detection (Alarms/warnings)

Protective Function	Description	Related function Code
Alarm detection	This function detects an abnormal state, displays the corresponding alarm code on the keypad, and causes the inverter to trip. For details on alarm codes, refer to “6.3.1 Alarm code list” or “6.3.2 Alarm causes, checks and measures.” The inverter is capable of retaining and displaying the cause (alarm code) for the last 10 trips, as well as detailed data for each part for the last 4 trips.	H98
Warning*	This function detects an abnormal state, and if a minor abnormality is detected, a warning code is displayed, and operation continues without tripping the inverter. The warning display operation can be selected with Warning selection (function codes H81, H82, and H83).	H81 H82 H83
Stall prevention	When the output current exceeds the current limiter level (function code F44) during acceleration/deceleration or constant speed running, this function decreases the output frequency to avoid an overcurrent trip.	F44
Overload prevention control*	Before the inverter trips due to a cooling fin overheat (OH1) or inverter overload (OLU), this function decreases the output frequency of the inverter to reduce the load.	H70
Anti-regenerative control*	If regenerative energy returned exceeds the inverter's braking capability, this function automatically increases the deceleration time or controls the output frequency to avoid an overvoltage trip.	H69
Deceleration characteristics* (Improvement of braking performance)	During deceleration, this function increases the motor energy loss and decreases the regenerative energy returned to avoid an overvoltage trip.	H71
Command loss detection*	This function detects a frequency command loss (due to a broken wire, etc.), issues the alarm, and continues the inverter operation at the specified frequency.	E65
Automatic lowering of carrier frequency	Before the inverter trips due to the surrounding temperature or output current, this function automatically lowers the carrier frequency to avoid a trip.	H98
Motor overload early warning*	When the inverter output current has exceeded the specified level, this function issues the “Motor overload early warning” signal before the thermal overload protection function causes the inverter to trip for motor protection (only for motor 1).	E34 E35
Retry*	When the inverter has stopped because of a trip, this function allows the inverter to automatically reset and restart itself. The number of retries and the latency between stop and reset can be specified.	H04 H05

Protective Function	Description	Related function Code
Forced stop*	Upon receipt of the forced stop signal “STOP,” this function interrupts the run command and other functions currently applied in order to forcedly decelerate the inverter to a stop.	H56
Surge protection	This function protects the inverter from a surge voltage between main circuit power lines and the ground.	—
Momentary power failure protection*	• If a momentary power failure for 15 ms or longer occurs, a protective operation (inverter stop) is activated. • When Momentary power failure restart is selected, the inverter restarts automatically after voltage restoration within a set time (momentary power failure permissible time).	F14

6.2 Before Proceeding with Troubleshooting

WARNING

- If any of the protective functions has been activated, first remove the cause. Then, after checking that all run commands are set to OFF, release the alarm. If the alarm is released while any run command is set to ON, the inverter may start supplying power to the motor at that moment. This is very dangerous because the motor may start rotating unintentionally.

Failure to observe this could result in injury.

- Even if the inverter cuts off the supply of power to the motor, if voltage is being applied to main power supply input terminals [L1/R], [L2/S], and [L3/T] or [L1/L] and [L2/N], voltage may be output to inverter output terminals [U], [V] and [W].
- Carry out an inspection after first waiting for at least 5 minutes after turning off the power, ensuring that the LED monitor and charge lamp are off, and using a device such as a tester to ensure that the DC intermediate circuit voltage across main circuit terminals P(+)-N(-) has dropped to a safe level(+25 VDC or less).

Failure to observe this could result in electric shock.

Follow the procedure below to solve problems.

(1) Is wire connection correct?

Refer to Chapter 2 “2.2.1 Basic connection diagrams.”

(2) Check whether an alarm code or warning code is displayed on the LED monitor.

- If an Alarm Code Appears on the LED Monitor — To Section 6.3
- If a Warning Code Appears on the LED Monitor — To Section 6.4
- Other Errors

Abnormal motor operation — To Section 6.5.1

6.5.1 [1] The motor does not rotate
6.5.1 [2] The motor rotates, but the speed does not increase
6.5.1 [3] The motor runs in the opposite direction to the command
6.5.1 [4] Speed fluctuation or current oscillation (e.g., hunting) occurs during running at constant speed
6.5.1 [5] Unpleasant noises are emitted from motor or noises fluctuate
6.5.1 [6] The motor does not accelerate or decelerate according to set acceleration or deceleration times
6.5.1 [7] The motor does not restart even after the power recovers from a momentary power failure
6.5.1 [8] The motor generates an abnormal amount of heat
6.5.1 [9] The motor does not run as expected
6.5.1 [10] The motor stalls during acceleration

Problems with inverter settings — To Section 6.5.2

6.5.2 [1] Nothing appears on the keypad
6.5.2 [2] The desired menu is not displayed
6.5.2 [3] Display of under bars (_ _ _ _)
6.5.2 [4] Display of center bars (- - - -)
6.5.2 [5] Display of parenthesis [ ]
6.5.2 [6] Function code data cannot be changed
6.5.2 [7] Function code data cannot be changed (changed from link functions)

If any problems persist after the above recovery procedure, contact your Fuji Electric representative.

6.3 If an Alarm Code Appears on the LED Monitor

6.3.1 Alarm code list

When an alarm is detected, check the alarm code displayed on the keypad 7-segment LED. With the Ethernet built-in type (E3N), the alarm code is displayed 2 digits at a time alternately (ex. for OC 1: OC ⇔ 1) on the 7-segment LED. Refer to "6.3.2 Alarm causes, checks and measures" and take the appropriate measures.

When one alarm code has more than one cause, alarm subcodes are provided to make it easy to identify the causes. When there is only one cause, the alarm subcode is "-" and displayed as "-."

Furthermore, certain types of alarms can be changed to warnings, allowing inverter operation to continue. (Refer to "Warning selection possible" in Table 6.3-1 below.)

Note: Continuing operation while a warning has occurred may cause damage to devices, and therefore the inverter should be stopped promptly from an external source.

To enter Programming mode while an alarm has occurred, press the PRG/RESET key while holding down the STOP key.

For the method of checking the alarm subcodes, refer to Chapter 3 "3.4.6 Reading alarm information: "Alarm Information: 6.AL"."

Table 6.3-1 Alarm code and subcode list

Alarm code	Alarm code name	Warning selection possible	Retry	Alarm subcode	Alarm subcode name	Reference page
CA1 ~ CA5	User-defined alarm	O	–	0	-	6-7
CoF	Current input terminals [C1], [C2] signal line break	O	–	1	Terminal [C1] wire break	6-7
				2	Terminal [C2] wire break	
				3	Terminals [C1], [C2] wire breaks	
dbA	Braking transistor failure	–	–	0	-	6-7
dbH	Braking resistor overheat	O	O	0	-	6-8
ECF	EN circuit failure	–	–	0	-	6-8
ECL	Customizable logic failure	–	–	0	-	6-9
Er1	Memory error	–	–	1–16	For investigation by manufacturer	6-9
Er2	Keypad communication error	–	–	1–2	For investigation by manufacturer	6-10
Er3	CPU error	–	–	1–9000	For investigation by manufacturer	6-10
Er4	Option error	O	–	1	Reserved for manufacturers	6-11
Er5	Option error	O	–	0	Timeout	6-11
				1–10	For investigation by manufacturer	
Er6	Operation error	–	–	1	STOP key priority/forced stop (STOP terminal)	6-11
				2	Start check function	
				3	Start check function (when operation is permitted)	
				4	Start check function when reset is turned on)	
				5	Start check function (when the power recovers following powering on)	
				6	Start check function (keypad connection)	
				8	Brake signal failure	
				9–16	For investigation by manufacturer	

Table 6.3-1 cont'd

Alarm code	Alarm code name	Warning selection possible	Retry	Alarm subcode	Alarm subcode name	Reference page
Er7	Tuning error	–	–	1 to 4	Abnormal tuning results due to interphase voltage unbalance, output phase loss, etc.	6-12
				6	Abnormal output current	
				7	Run command OFF during motor tuning	
				8	Forced stop during motor tuning	
				9	BX command during motor tuning	
				10	Hardware current limit during motor tuning	
				11	Occurrence of low voltage (LV) during motor tuning	
				12	Failure due to prevention of reverse rotation during motor tuning	
				13	Upper limit frequency exceeded during motor tuning	
				14	Switching to commercial power during motor tuning	
				15	Occurrence of alarm during motor tuning	
				16	Change of run command source during motor tuning	
				18	Acceleration time exceeded during motor tuning	
				24	Terminal [EN1], [EN2] error during motor tuning	
				5000 or higher	Refer to Chapter 4 "4.8.2 [3] PMSM tuning method."	
				Other than above	For investigation by manufacturer	
Er8	RS-485 communication error (Communication port 1)	○	–	0	-	6-13
Erd	Step-out detection/detection failure of magnetic pole position at startup	–	–	5001–5010	For investigation by manufacturer	6-14
ErC	Magnetic pole position detection error	–	–	5002–5008	For investigation by manufacturer	6-15
ErE	Speed inconsistency/ excessive speed deviation	○	–	1	Signs of speed command and speed detection are inconsistent.	6-16
				3	In the case of excessive speed deviation (|detected speed|>|speed command|)	
				5	Detected speed remains 0Hz irrespective of speed command.	
				7	In the case of excessive speed deviation (|detected speed|>|speed command|)	
ErF	Data saving error during undervoltage	–	–	0	-	6-17
ErH	Hardware error	–	–	–	For investigation by manufacturer	6-17
Ero	Positioning control error	○	–	1–5	For investigation by manufacturer	6-17
ErP	RS-485 communication error (Communication port 2)	○	–	0	-	6-13
Err	Simulated failure	–	–	0	-	6-18
Lin	Input phase loss	–	–	1–2	For investigation by manufacturer	6-18
LoK	Password protection	–	–	1	Password 1 protection	6-18
				2	Password 2 protection	

Table 6.3-1 cont'd

Alarm code	Alarm code name	Warning selection possible	Retry	Alarm subcode	Alarm subcode name	Reference page
LU	Undervoltage	–	–	1	Occurrence of low voltage during gate ON (F14=0)	6-19
				2	Run command ON during low voltage (F14=0, 2)	
				3	LV trip during power recovery from a momentary power failure (F14=1)	
				4–5	For investigation by manufacturer	
OC1 OC2 OC3	Instantaneous overcurrent	–	○	1–13 5001	For investigation by manufacturer	6-20
OH1	Cooling fin overheat	○	○	1–14	For investigation by manufacturer	6-21
OH2	External alarm	○	–	0	-	6-21
OH3	Inverter internal overheat	○	○	0	Internal air overheat	6-21
				1	Charging resistor overheat	
				Other than above	For investigation by manufacturer	
OH4	Motor protection (PTC thermistor)	–	○	0	-	6-22
OH6	Charging resistor overheat	○	○	0	-	6-22
OL1 to OL2	Motor overload 1 to 2	○	○	0	-	6-23
OLU	Inverter overload	–	○	1	IGBT protection	6-24
				2	Inverter overload	
				10	For investigation by manufacturer	
OPL	Output phase loss detection	–	–	1–10	For investigation by manufacturer	6-25
OS	Overspeed protection	–	–	0	-	6-25
OU1 OU2 OU3	Overvoltage	–	○	1–12	For investigation by manufacturer	6-26
PbF	Charger circuit fault (FRN0030E3□-2G to FRN0115E3□-2G /FRN0022E3□-4G to FRN0072E3□-4G)	–	–	0–2	For investigation by manufacturer	6-27
PG	PG wire break	–	–	10–20	For investigation by manufacturer	6-27
dO	Excessive positioning deviation	–	–	0	-	6-27
Fod	Forced operation (Fire Mode)	–	–	–	-	6-28

Note)
- All protective functions are automatically reset if the control power voltage drops to a level at which inverter control circuit operation can no longer be sustained.
- The protection stoppage can be canceled by pressing the keypad PRG/RESET key, or turning the [X] (assigned to RST) to [CM] terminals from OFF to ON. However, the reset operation will not be valid until the cause of the alarm has been eliminated.
- If multiple alarms have occurred, the reset operation will not be valid until the cause of all alarms has been eliminated. (The cause of uncleared alarms can be checked on the keypad.)
- When assigned to warnings, terminals [30A/B/C] do not work.

6.3.2 Alarm causes, checks and measures

[1] CA1 to CA5 User-defined alarm

Phenomenon An alarm defined with customizable logic occurred.

Possible Cause	Check and Measures
An error is displayed if the alarm conditions defined by the user with customizable logic are met. (This is not an error in the inverter itself.)	Check the input/output status in accordance with the alarm conditions set with customizable logic.

[2] CoF Current input terminals [C1], [C2] signal line break

Phenomenon A current input signal line break occurred.

Possible Cause	Check and Measures
(1) Current input command wire break [Subcodes: 1, 2, 3]	Check whether current is flowing to current input terminals [C1] and [C2]*. ➔ Terminal [C1] wire break detection [subcode: 1] Terminal [C2]* wire break detection [subcode: 2] Terminals [C1] and [C2]* wire break detection [subcode: 3] *If equipped with OPC-AIO (optional).
(2) The inverter was affected by strong electrical noise.	Check noise countermeasures (grounding condition, signal line and communication cable/main circuit wiring installation method, etc.) ➔ Enhance noise countermeasures. ➔ Keep the main circuit wiring and control circuit wiring as far apart as possible.

[3] dbA Braking transistor failure

Phenomenon Faulty operation of the braking transistor was detected.

Possible Cause	Check and Measures
Braking resistor connection terminal miswiring	Check whether the braking resistor has been correctly wired between main circuit terminals [P+] and [DB]. Check whether the motor wiring has been mistakenly connected to terminal [DB]. ➔ Ask for inverter repair to be carried out if wiring work has been carried out incorrectly.
The braking transistor is broken.	Check whether resistance of the braking resistor is correct or whether there is a misconnection of the resistor. ➔ If there are no problems, ask for inverter repair to be carried out.

[4] dbH Braking resistor overheat

Phenomenon The electronic thermal protection for the braking resistor has been activated.

Possible Cause	Check and Measures
(1) Braking load is too heavy. [Subcode: 0]	Reconsider the relationship between the braking load estimate and the braking capability. ➔ Lower the braking load. ➔ Select another braking resistor which can increase the braking capability. Modification of related function code data (F50, F51, and F52) may be also required.
(2) Specified deceleration time is too short. [Subcode: 0]	Recalculate the deceleration torque and time needed for the load currently applied, based on a moment of inertia for the load and the deceleration time. ➔ Increase the deceleration time (function codes F08, E11, E13, E15, and H56). ➔ Select another braking resistor which can increase the braking capability. Modification of related function code data (F50, F51, and F52) may be also required.
(3) Incorrect setting of function code data F50, F51, and F52. [Subcode: 0]	Recheck the specifications of the braking resistor. ➔ Review data of function codes F50, F51, and F52, then modify them if required.

Note The inverter issues an overheat alarm for the braking resistor by monitoring the magnitude of the braking load, not by measuring its surface temperature.

When the braking resistor is used so frequently as to exceed the settings made by function codes F50, F51, and F52, therefore, the inverter issues an overheat alarm even if the surface temperature of the braking resistor does not rise. To obtain full performance of the braking resistor, configure function codes F50, F51, and F52 while actually measuring the surface temperature of the braking resistor.

[5] ECF EN circuit failure

Phenomenon Enable circuit's status was diagnosed and a circuit failure was detected.

Possible Cause	Check and Measures
(1) Control terminal block PCB contact defect	Confirm that the control terminal block PCB has been firmly mounted in the inverter. ➔ Alarm is released by turning power ON again.
(2) Enable circuit logic failure	• Confirm that outputs from safety switch etc. are inputted by the same logic (High/High or Low/Low) with terminals [EN1] and [EN2]. • Ensure that the 2 poles for the SW9 switch on the control PCB are both ON/ON or OFF/OFF. ➔ The alarm is cleared by pressing the PRG/RESET key, or by turning the power OFF and ON again.
(3) A failure (single failure) of enable circuit (safety stop circuit) was detected.	If the alarm is not released by the procedures above, the inverter is out of order. ➔ Contact your Fuji Electric representative.

[6] ECL Customizable logic failure

Phenomenon Customizable logic error was detected.

Possible Cause	Check and Measures
(1) The settings for customizable logic operation selections were changed during operation.	Check whether the customizable logic operation selections (Function code U00) were changed during operation. ➔ For safety reasons, do not change the customizable logic operation selections during operation.

[7] Er1 Memory error

Phenomenon Error occurred in writing the data to the memory in the inverter.

Possible Cause	Check and Measures
(1) When writing function code data (especially initializing or copying data), the inverter was shut down so that the voltage to the control power supply dropped.	Initialize data by data initialization (H03), and check whether the alarm can be released by PRG/RESET key after finishing the initialization. ➔ Revert the initialized function code data to their previous settings, then restart the operation.
(2) The inverter was affected by strong electrical noise when writing function code data (especially initializing).	Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of control and main circuit wires). Also, perform the same check as described in (1) above. ➔ Implement noise control measures. Revert the initialized function code data to their previous settings, then restart the operation.
(3) The control circuit failed.	Initialize data by data initialization (H03), and check whether an alarm continues even when the release of the alarm is attempted by PRG/RESET key after finishing the initialization. ➔ The PCB (on which the CPU is mounted) is defective. Contact your Fuji Electric representative.
(4) The power was cut and the control power supply dropped while saving user setting values with function code H193.	Save the user setting values with function code H193, and confirm whether the alarm persists even after canceling the alarm with the PRG/RESET key when saving is complete. ➔ The PCB (on which the CPU is mounted) is defective. Contact your Fuji Electric representative.
(5) The inverter was affected by external noise while saving user setting values with function code H193.	Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of control and main circuit wires). Also, perform the same check as described in (4) above. ➔ The PCB (on which the CPU is mounted) is defective. Contact your Fuji Electric representative.

[8] Er2 Keypad communication error

Phenomenon   A communication error occurred between the keypad and the inverter.

Possible Cause	Check and Measures
(1) Broken communication cable or poor contact.	Check continuity of the cable, contacts and connections. ➔ Re-insert the connector firmly. ➔ Replace the cable.
(2) Connecting many control wires hinders the front cover from being mounted, lifting the keypad.	Check the mounting condition of the front cover. ➔ Reduce the wire size. (Recommended wire size (0.3 to 0.75 mm^2)) ➔ Change the wiring layout inside the unit so that the front cover can be mounted firmly.
(3) The inverter was affected by strong electrical noise.	Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of communication cables and main circuit wires). ➔ Take noise countermeasures. For details, refer to Appendix A.
(4) A keypad fault occurred.	Replace the keypad with another one and check whether the Er2 error occurs. ➔ Replace the keypad.

[9] Er3 CPU error

Phenomenon   A CPU error (e.g. erratic CPU operation) occurred.

Possible Cause	Check and Measures
(1) The inverter was affected by strong electrical noise.	Check noise countermeasures (grounding condition, signal line and communication cable/main circuit wiring installation method, etc.) ➔ Implement noise control measures.

[10] Er4 Option communication error

Phenomenon A communication error occurred between the option card and the inverter.

Possible Cause	Check and Measures
(1) There was a problem with the connection between the option card and the inverter.	Check whether the connector on the option card is properly engaged with that of the inverter. ➔ Reinsert the option card into the inverter.
(2) The inverter was affected by strong electrical noise.	Check noise countermeasures (grounding condition, signal line and communication cable/main circuit wiring installation method, etc.) ➔ Implement noise control measures.

[11] Er5 Option error

An error detected by the option card.

Refer to the instruction manual of the option card for details.

[12] Er6 Operation error

Phenomenon An incorrect operation was attempted.

Possible Cause	Check and Measures
(1) STOP key was pressed when the STOP key is active (function code H96=1, 3). [Subcode: 1]	Check whether the STOP key was pressed in a state that a run command is inputted via terminal block or communication. ➔ If this was not intended, check the setting of function code H96.
(2) The start check function was activated when the start check function (function code H96 = 2 or 3) was active. [Subcode: 2 to 6]	Check that any of the following operations have been performed with a run command being entered. • Power on • Release of alarm • Switching to link operation command ➔ Review the sequence, etc. to avoid input of a run command when Er6 error occurs. If this was not intended, check the setting of function code H96. Turn the run command OFF before releasing the alarm.
(3) The forced stop (digital input terminal) “STOP” was turned OFF. [Subcode: 1]	Check that the forced stop “STOP” is turned OFF. ➔ If this was not intended, check the settings of function codes E01 to E05 for terminals [X1] to [X5].
(4) Brake check signal “BRKE” and brake signal “BRKS” mismatch [Subcode: 8]	Check whether the signal input to the [X] terminal to which the brake check signal “BRKE” is assigned matches the brake signal “BRKS” output from the [Y] terminal. • Check for a signal line break. • Check whether the logic is correct. • If there is an operation delay, check the function code H180 (brake signal) time.

[13] Er7 Tuning error

Phenomenon Auto-tuning failed.

Possible Cause	Check and Measures
(1) Motor is not wired correctly	➔ Check whether the motor wiring is causing a phase interruption, and wire all 3 phases correctly. ➔ If there is a contactor connected to the inverter-motor wiring, check for abnormalities in the contacts. ➔ Check whether there is an ammeter, etc., inserted in the inverter-motor wiring and causing an interphase voltage unbalance.
(2) V/f, torque boost, or motor rated values have not been set correctly.	Check whether the data of function codes (F04*, F05*, F09*, H50, H51, H52, H53, H65, H66, P02*, P03*) agree with the motor modes.
(3) Sequence error	If run command OFF, forced stop “STOP,” coast to a stop “BX,” etc., has been input during tuning. ➔ Do not turn run command OFF during tuning.
(4) Rotation tuning (function code P04* = 2) was performed	➔ Check the condition of the mechanical brake. Also check whether the motor is mechanically capable of rotating. ➔ Check whether the acceleration time setting is short and the current limiter is operating.
(5) If the tuning range is exceeded	Tuning may not be possible when the inverter capacity differs greatly from the motor capacity, or when using special motors such as high-speed motors. ➔ Reconsider the inverter capacity. ➔ Do not use auto-tuning, and do not use auto torque boost (set function code F37* = 1).
(6) If undervoltage occurs	If DC intermediate voltage is low and tuning is performed ➔ Check whether the main power is input normally.

The explanations for function codes with an asterisk (*) are limited to motor 1. If using motor 2, replace with the relevant function codes in Chapter 5 "Table 5.3-2 Switching function codes list."

[14] Er8 RS-485 communication error (Communication port 1)/ ErP RS-485 communication error (Communication port 2)

Phenomenon A communication error occurred during RS-485 communication.

Possible Cause	Check and Measures
(1) Communication conditions of the inverter do not match that of the host equipment.	Compare the settings of the function codes (y01 to y10, y11 to y20) with those of the host equipment. ➔ Correct any settings that differ.
(2) Even though no-response error detection time (function codes y08, y18) has been set, communication is not performed within the specified cycle.	Check the host equipment. ➔ Change the settings of host equipment software or disable the no-response error detection (function codes y08, y18 = 0).
(3) The host equipment did not operate due to defective software, settings, or defective hardware.	Check the host equipment (e.g., PLCs and personal computers). ➔ Remove the cause of the equipment error.
(4) The RS-485 converter did not operate due to incorrect connections and settings, or defective hardware.	Check the RS-485 converter (e.g., check for poor contact). ➔ Change the various RS-485 converter settings, reconnect the wires, or replace hardware (with recommended devices) as appropriate.
(5) Broken communication cable or poor contact.	Check the continuity of the cables, contacts and connections. ➔ Replace the cable.
(6) The inverter was affected by strong electrical noise.	Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of communication cables and main circuit wires). ➔ Take noise countermeasures. ➔ Take noise reduction measures at the host side. ➔ Replace the RS-485 converter with a recommended insulated one.
(7) Terminating resistor is not properly configured.	Check that the inverter serves as a terminating device in the network. ➔ Set terminal resistor select switches for RS-485 communication (SW3/SW2) correctly. If the inverter serves as a terminating device in the network, set the switch to ON.

[15] *Erd* Step-out detection/detection failure of magnetic pole position at startup

Phenomenon PMSM (Permanent magnet synchronous motor) step-out was detected. The magnetic pole position at startup failed to be detected.

Possible Cause	Check and Measures
(1) Function code settings do not agree with the motor characteristics.	Check whether function codes F04, F05, P01, P02, P03, P60, P61, P62, P63, P64 agree with the motor constants. ➔ Perform auto-tuning.
(2) Magnetic pole position detection method is not appropriate.	Confirm that the magnetic pole position detection mode matches the motor type. ➔ Match the magnetic pole position detection mode selection (function code P30) to the motor type.
(3) Starting frequency (holding time) (function code F24) is insufficient.	Check whether a starting frequency (holding time) (function code F24) is set optimally, after setting the magnetic pole position detection mode selection (function code P30) to “0” or “3.” ➔ Set a period of time during which the motor can rotate by one or more revolutions. F24 ≥ P01/2/F23 (P01: Number of poles, F23: Starting frequency)
(4) Starting torque is insufficient.	Check the data for acceleration time (function codes F07, E10, E12, E14) and current command value on startup (function code P74). ➔ Change the acceleration time to match the load. ➔ Increase the current command value at startup. ➔ Increase the control switching level (function code P89) setting.
(5) Load is small.	Check the data for current command value at startup (function code P74). ➔ Decrease the current command value at startup. Set it to 80% or lower when running a motor single unit in a test run etc.
(6) Phase loss in the connection between the inverter and the motor.	➔ Properly connect the motor to the inverter.

[16] ErC Magnetic pole position detection error

Phenomenon When performing vector control with sensor (PMSM), an error occurred when performing PMSM magnetic pole position detection.

Possible Cause	Check and Measures
(1) The inverter settings are not appropriate.	Check whether the motor being used, the existence and type of the speed/magnetic pole position sensor, the control method (F42) and feedback pulse input method (d14), and the feedback pulse count (d15) are consistent. ➔ Check the machine configuration (motor speed/magnetic pole position sensor type and specifications), and set F42, d14, and d15 correctly. Ensure that the magnetic pole position detection method selection (P30) has been set to either “0” or “3”, and that the magnetic pole position sensor offset (P95) is not “999 (offset not adjusted)”. ➔ Set P95 correctly. (Auto tuning is also possible). 📖Refer to “4.8.2 [3] PMSM tuning method.”)
(2) There is a problem with the speed/magnetic pole position sensor connection.	Check for speed/magnetic pole position sensor output wiring contact defects, and check the AB phase or UVW phase sequence. ➔ Connect the feedback input option card and speed/magnetic pole position sensor correctly. Check for motor wiring contact defects, and check the phase sequence. ➔ Connect the motor correctly to the inverter.
(3) The motor rotation direction and sensor output do not match.	
(4) There is a problem with the option card connection.	Check whether the connector on the option card is properly engaged with that of the inverter. ➔ Reinsert the option card into the inverter.
(5) The inverter was affected by strong electrical noise.	Check noise countermeasures (grounding condition, signal line and communication cable/main circuit wiring installation method, etc.) ➔ Take noise countermeasures.

[17] ErE Speed inconsistency/excessive speed deviation

Phenomenon An excessive deviation appears between the speed command and the detected speed.

Possible Cause	Check and Measures
(1) Incorrect setting of function codes.	Check the motor “Number of poles” (P01*) settings. ➔ Specify the P01* settings in accordance with the motor to be used.
(2) Overload	Measure the inverter output current. ➔ Reduce the load.
	Check whether any mechanical brake is applied. ➔ Release the mechanical brake.
(3) The motor speed does not increase due to the current limiter operation.	Check the data of function code F44 (Current limiter (Level)). ➔ Change the F44 data correctly. Or, set the F43 data to “0” (Disable) if the current limiter operation is not needed.
	Check the data of the function codes (F04*, F05*, P01* to P12*) to see if V/f is set correctly. ➔ Match the V/f settings with the motor ratings. ➔ Change the function code data in accordance with the motor parameters.
(4) Function code settings do not match the motor characteristics.	Confirm that P01*, P02*, P03*, P06*, P07*, P08*, P09*, P10*, P12* match the motor constants. ➔ Perform auto-tuning of the inverter, using the function code P04*.
(5) Wiring to the motor is incorrect.	Check the wiring to the motor. ➔ Connect the inverter output terminals (U, V, and W) to the motor input terminals (U, V, and W), respectively.
(6) The motor speed does not increase due to the torque limiter operation.	Check the data of F40 (Torque limiter (Level)). ➔ Change the F40 data correctly. Or, set the F40 data to “999” (Disable) if the torque limiter operation is not needed.
(7) The wire between the pulse generator (PG) and the option card is broken or incorrect	Check whether the pulse generator (PG) is correctly connected to the option card or any wire is broken. ➔ Check whether the PG is connected correctly. Or, tighten the related terminal screws. ➔ Check whether any contact part bites into the wire sheath. ➔ Replace the wiring.
(8) Anti-regenerative control occurred during deceleration, causing delayed deceleration.	Check the speed agreement (detection width) (d21), (detection timer) (d22), and PG error selection (d23) data. ➔ Change d21 and d22 to an appropriate value, or disable the speed mismatch/excessive speed deviation alarm by setting d23 to “0”.

📖 The explanations for function codes with an asterisk (*) are limited to motor 1. If using motor 2, replace with the relevant function codes in Chapter 5 "Table 5.3-2 Switching function codes list."

[18] ErF Data saving error during undervoltage

Phenomenon The inverter failed to save data such as the frequency commands and PID commands (which are specified through the keypad), or the output frequencies modified by the UP/DOWN signal commands when the power was turned OFF.

Possible Cause	Check and Measures
(1) During data saving performed when the power was turned OFF, the voltage fed to the control power supply dropped in an abnormally short period due to the rapid discharge of the DC intermediate circuit.	Check how long it takes for the DC intermediate circuit voltage to drop to the preset voltage when the power is turned OFF. ➔ Remove whatever is causing the rapid discharge of the DC intermediate circuit voltage. After pressing the PRG/RESET key and releasing the alarm, return the data of the relevant function codes (such as the frequency commands and PID commands (specified with the keypad) or the output frequencies modified by the UP/DOWN signal commands) back to the original values and then restart the operation.
(2) The inverter operation was affected by strong electrical noise during data saving performed when the power was turned OFF.	Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of control and main circuit wires). ➔ Take noise countermeasures. After pressing the PRG/RESET key and releasing the alarm, return the data of the relevant function codes (such as the frequency commands and PID commands (specified with the keypad) or the output frequencies modified by the UP/DOWN signal commands) back to the original values and then restart the operation.
(3) The control circuit failed.	Check if ErF occurs each time the power is turned ON. ➔ The PCB (on which the CPU is mounted) is defective. Contact your Fuji Electric representative.

[19] ErH Hardware error

Phenomenon The combination of PCBs is abnormal.

Possible Cause	Check and Measures
(1) Control PCB and power supply PCB combination abnormality	It is necessary to replace the control PCB or power supply PCB. ➔ Contact your Fuji Electric representative.

[20] Ero Positioning control error

Phenomenon Excessive position deviation occurred on servo lock/master-follower operation/position control.

Possible Cause	Check and Measures
(1) Insufficient gain in positioning control system (servo lock)	Readjust the settings of J97 (Servo lock (Gain)) and d03 (Speed control 1 P (Gain)).
(2) Position deviation is excessive. (master-follower operation)	Check whether the excessive error detection level (d78) is set up properly.
(3) Position deviation is excessive. (Position control)	Position pulse has not been input. ➔ Check if the PG has been installed correctly. Tighten the screws on the terminal block. ➔ Check whether any contact part bites into the wire sheath. Replace the wiring or the PG.

[21] Err Simulated failure

Phenomenon The LED displays the alarm Err.

Possible Cause	Check and Measures
(1) Keep STOP key + FUNC/DATA key pressed for five seconds or longer.	➔ To escape from this alarm state, press the PRG/RESET key.
(2) Function code H45 (simulation fault) is set to “1”.	

[22] Lin Input phase loss

Phenomenon Input phase loss occurred, or interphase voltage unbalance rate was large.

Possible Cause	Check and Measures
(1) Breaks in wiring to the main power supply input terminals.	Measure the input voltage. ➔ Repair or replace the main power supply input wires or input devices (MCCB, MC, etc.).
(2) The screws on the main power supply input terminals are loose.	Check if the screws on the main power supply input terminals have become loose. ➔ Tighten the terminal screws to the recommended torque.
(3) Interphase voltage unbalance among three phases was too large.	Measure the input voltage. ➔ Connect an AC reactor (ACR) to lower the voltage unbalance between input phases. ➔ Increase the inverter capacity.
(4) Overload cyclically occurred.	Measure the ripple wave of the DC intermediate circuit voltage. ➔ If the ripple is large, increase the inverter capacity.
(5) A three-phase inverter was connected to a single-phase power supply.	Check the inverter type. ➔ Select an inverter that matches the specifications of the power supply.

Note The purpose of this function is to protect the inverter. Even with input phase loss, if the motor load is light, the motor may continue to run without the loss being detected.
The input phase loss protection can be disabled with the function code H98.

[23] LoK Password protection

Phenomenon The wrong user password was entered more than the prescribed number of times.

Possible Cause	Check and Measures
(1) User password 1 or 2 was entered incorrectly more than the prescribed number of times.	Clear the alarm. ➔ Turn OFF the inverter power, and then turn it back ON again. If you have forgotten your password: ➔ Contact the distributer or machine set manufacturer.

[24] LU Undervoltage

Phenomenon DC intermediate circuit voltage has dropped below the undervoltage detection level.

Possible Cause	Check and Measures
(1) A momentary power failure occurred. [Subcode: 1] [Subcode: 3]	➔ Clear the alarm. ➔ If you want to restart running the motor without treating this condition as an alarm, set Momentary power failure restart (F14) to “3,” “4,” or “5,” depending on the load type.
(2) The power to the inverter was switched back to ON too soon (when F14 = 1). [Subcode: 2]	Check if the power to the inverter was switched back to ON while the control power supply was still active. Check whether the LEDs on the keypad are lit. ➔ Turn the power ON again after all LEDs on the keypad turn OFF.
(3) The power supply voltage did not reach the inverter's specified range.	Measure the input voltage. ➔ Increase the voltage to within the specified range.
(4) Peripheral equipment for the power supply circuit malfunctioned, or the connection was incorrect.	Measure the input voltage to find which peripheral equipment malfunctioned or which connection is incorrect. ➔ Replace any faulty peripheral equipment or correct any incorrect connections.
(5) Another load connected to the same power supply system has required a large starting current, causing a temporary power supply voltage drop.	Measure the input voltage and check the voltage fluctuation. ➔ Reconsider the power supply system configuration.
(6) Inverter's inrush current caused a temporary power supply voltage drop because the power supply transformer capacity was insufficient.	Check if the alarm occurs when a molded case circuit breaker (MCCB), earth leakage circuit breaker (ELCB) (with overcurrent protection) or magnetic contactor (MC) is turned ON. ➔ Check the capacity of the power supply transformer.

[25] OCn Instantaneous overcurrent

Phenomenon The inverter momentary output current exceeded the overcurrent level.

OC1 Overcurrent occurred during acceleration.
OC2 Overcurrent occurred during deceleration.
OC3 Overcurrent occurred immediately after startup, or at a specific time.

Possible Cause	Check and Measures
(1) The inverter output lines were short-circuited.	Disconnect the wiring from the inverter output terminals [U], [V] and [W] and measure the interphase resistance of the motor wiring. Check if the resistance is too low. ➔ Remove the short-circuited parts (including replacement of the wires, relay terminals and motor). If overcurrent is displayed when the inverter is run with the wiring disconnected from the inverter output terminals [U], [V], and [W]): ➔ The inverter may be defective. Contact your Fuji Electric representative.
(2) Ground faults have occurred on the inverter output lines.	Disconnect the wiring from the output terminals [U], [V], and [W]) and perform a Megger test. ➔ Remove the grounded parts (including replacement of the wires, relay terminals and motor). If overcurrent is displayed when the inverter is run with the wiring disconnected from the inverter output terminals [U], [V], and [W]: ➔ The inverter may be defective. Contact your Fuji Electric representative.
(3) Overload	Measure the motor current with a measuring device to trace the current trend. Then, use this data to judge if the trend is over the calculated load value for your system design. ➔ If the load is too heavy, reduce it or increase the inverter capacity.
	Trace the current trend and check if there are any sudden changes in the current. ➔ If there are any sudden changes, make the load fluctuation smaller or increase the inverter capacity. ➔ Enable instantaneous overcurrent limiting (H12 = 1).
(4) Excessive torque boost specified. (When manual torque boost F37* = 0, 1, 3, or 4.)	Check whether decreasing the torque boost (F09*) decreases the output current but does not stall the motor. ➔ If no stall occurs, decrease the torque boost (F09*).
(5) The specified acceleration/deceleration time was too short.	Check that the motor generates enough torque required during acceleration/deceleration. That torque is calculated from the moment of inertia of the load and the acceleration/deceleration times. ➔ Increase the acceleration/deceleration times (F07, F08, E10 to E15, and H56). ➔ Enable the current limiter (F43) and torque limiter (F40, F41, E16, and E17). ➔ Increase the inverter capacity.
(6) Built-in braking transistor short circuit detection was activated	Check whether the braking resistor connection terminals [P+], [DB] have shorted. Check whether the resistance of the connected braking resistance is excessively low. ➔ Connect an appropriate braking resistor.
(7) Malfunction caused by noise.	Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of control and main circuit wires). ➔ Take noise countermeasures. For details, refer to Appendix A. ➔ Enable the retry function (H04). ➔ Connect a surge absorber to magnetic contactor's coils or other solenoids (if any) causing noise.

📖 The explanations for function codes with an asterisk (*) are limited to motor 1. If using motor 2, replace with the relevant function codes in Chapter 5 "Table 5.3-2 Switching function codes list."

[26] OH1 Cooling fin overheat

Phenomenon Temperature around the cooling fins has risen abnormally.

Possible Cause	Check and Measures
(1) The surrounding temperature exceeded the inverter's specified limit.	Measure the surrounding temperature. ➔ Lower the temperature (e.g., ventilate the paneling where the inverter is mounted).
(2) Ventilation paths are blocked.	Check if there is sufficient clearance around the inverter. ➔ Change the mounting place to ensure the clearance.
	Check if the fins are clogged. ➔ Clean the fins.
(3) Cooling fan's airflow volume decreased due to service life expiration or failure.	Check the cumulative run time of the cooling fan. (refer to Chapter 3 "3.4.5 Reading maintenance information: "Maintenance Information: 5.CHE".") ➔ Replace the cooling fan.
	Visually check that the cooling fan rotates normally. ➔ Replace the cooling fan.
(4) Overload	Measure the inverter output current. ➔ Reduce the load (Reduce the load before reaching an overload using Cooling fin overheat forecast (E020-E24, E27)/Overload forecast (E34)). ➔ Decrease the motor sound (Carrier frequency (F26)). ➔ Enable overload prevention control (H70).

[27] OH2 External alarm

Phenomenon External alarm ("THR") was input.
(When the "Enable external alarm" signal "THR" has been assigned to any of digital input terminals)

Possible Cause	Check and Measures
(1) An alarm function of external equipment was activated.	Check the operation of external equipment. ➔ Remove the cause of the alarm that occurred.
(2) Wrong connection or poor contact in external alarm wiring.	Check if the external alarm signal wiring is correctly connected to the terminal to which the "external alarm" has been assigned (Any of E01 to E05, E98, and E99 should be set to "9."). ➔ Connect the external alarm signal wire correctly.
(3) Incorrect setting of function code data.	Check whether an "external alarm" is assigned to a terminal not used among E01 to E05, E98, E99. ➔ Correct the assignment.
	Check whether the logic of "THR" set for E01 to E05, E98, E99 agrees with that (positive/negative) of external signals. ➔ Set the logic correctly.

[28] OH3 Inverter internal overheat

Phenomenon Temperature inside the inverter has exceeded the allowable limit.

Possible Cause	Check and Measures
(1) The surrounding temperature exceeded the inverter's specified limit. [Subcode: 0]	Measure the surrounding temperature. ➔ Lower the temperature around the inverter (e.g., ventilate the paneling where the inverter is mounted).

[29] 0H4 Motor protection (PTC thermistor)

Phenomenon　Temperature of the motor has risen abnormally.

Possible Cause	Check and Measures
(1) The temperature around the motor exceeded the motor's specified range.	Measure the surrounding temperature. ➔ Lower the temperature around the motor.
(2) Cooling system for the motor is defective.	Check if the cooling system of the motor is operating normally. ➔ Repair or replace the cooling system of the motor.
(3) Overload	Measure the inverter output current. ➔ Reduce the load (e.g., Use the overload early warning (E34) and reduce the load before the overload protection is activated.) (In winter, the load tends to increase.) ➔ Lower the temperature around the motor. ➔ Increase the motor sound (Carrier frequency (F26).
(4) The operation level (H27*) of the PTC thermistor for motor overheat protection is not adequate.	Check the PTC thermistor specifications and recalculate the detection voltage. ➔ Modify the data of function code.
(5) The setting of the PTC thermistor is not adequate.	Check thermistor (operation selection) (H26*) and the function selection switches (SW5) of terminal [V2]. ➔ Set an appropriate value for H26* for the thermistor being used, and set SW5 to the PTC side.
(6) Excessive torque boost specified (F09*)	Check whether decreasing the torque boost (F09*) does not stall the motor. ➔ If no stall occurs, decrease the F09* data.
(7) The V/f settings did not match the motor.	Check if the base frequency (F04*) and the rated voltage at base frequency (F05*) match the rated values on the motor's Main nameplate. ➔ Match the function code data with the values on the motor's Main nameplate.
(8) Incorrect setting of function code data.	Although PTC thermistor is not used, the thermistor (operation selection) (H26*) is operating. ➔ Set the H26* data to “0” (Disable).

📖 The explanations for function codes with an asterisk (*) are limited to motor 1. If using motor 2, replace with the relevant function codes in Chapter 5 "Table 5.3-2 Switching function codes list."

[30] 0H6 Charging resistor overheat

Phenomenon　Temperature of the charging resistor inside the inverter has risen abnormally.

Possible Cause	Check and Measures
(1) The inverter power is turned ON/OFF frequently.	Decrease the inverter power ON/OFF cycles. ➔ Turn ON/OFF the inverter power once or less per 30 min.
(2) The inverter power is not turned ON/OFF frequently.	Check that this alarm always occurs when the inverter power is turned ON/OFF. ➔ The charging circuit of the inverter is defective. Consult your Fuji Electric representative for repair.

[31] OLn Motor overloads 1 to 2

Phenomenon Thermal overload protection function for motor overload detection of motors 1-2 is operating.

OL1 Motor 1 overload
OL2 Motor 2 overload

Possible Cause	Check and Measures
(1) The thermal protection characteristics do not match the motor's overload characteristics.	Check the motor characteristics. ➔ Review the data of related function codes P99*, F10*, F12*. ➔ Use an external thermal relay.
(2) Operation level for the thermal protection was inadequate.	Check the continuous allowable current of the motor. ➔ Reconsider and, if necessary, change the data of function code F11*.
(3) The specified acceleration/deceleration time was too short.	Recalculate the acceleration/deceleration torque and time needed for the load, based on the moment of inertia of the load and the acceleration/deceleration times. ➔ Increase the acceleration/deceleration times (F07, F08, E10 to E15, and H56).
(4) Overload	Measure the inverter output current. ➔ Reduce the load (e.g., Use the overload early warning (E34) and reduce the load before the overload protection is activated.) (In winter, the load tends to increase.)
(5) Excessive torque boost specified (F09*)	Check whether decreasing the torque boost (F09*) does not stall the motor. ➔ If no stall occurs, decrease the F09* data.

The explanations for function codes with an asterisk (*) are limited to motor 1. If using motor 2, replace with the relevant function codes in Chapter 5 "Table 5.3-2 Switching function codes list."

[32] OLU Inverter overload

Phenomenon   Temperature inside the inverter has risen abnormally.

Possible Cause	Check and Measures
(1) The surrounding temperature exceeded the inverter's specified limit.	Measure the surrounding temperature. ➔ Lower the temperature (e.g., ventilate the paneling where the inverter is mounted).
(2) Excessive torque boost specified (F09*)	Check whether decreasing the torque boost (F09*) does not stall the motor. ➔ If no stall occurs, decrease the F09* data.
(3) The specified acceleration/deceleration time was too short.	Recalculate the acceleration/deceleration torque and time needed for the load, based on the moment of inertia of the load and the acceleration/deceleration times. ➔ Increase the acceleration/deceleration times (F07, F08, E10 to E15, and H56).
(4) Overload	Measure the inverter output current. ➔ Reduce the load (e.g. Use the overload early warning (E34) and reduce the load before the overload protection is activated.) (In winter, the load tends to increase.) ➔ Decrease the motor sound (Carrier frequency (F26)). ➔ Enable overload prevention control (H70).
(5) Ventilation paths are blocked.	Check if there is sufficient clearance around the inverter. ➔ Change the mounting place to ensure the clearance.
	Check if the fins are clogged. ➔ Clean the fins.
(6) Cooling fan's airflow volume decreased due to the service life expiration or failure.	Check the cumulative run time of the cooling fan. (refer to Chapter 3 “3.4.5 Reading maintenance information: “Maintenance Information: 5.CHE””.) ➔ Replace the cooling fan.
	Visually check that the cooling fan rotates normally. ➔ Replace the cooling fan.
(7) The wires to the motor are too long, causing a large leakage current from them.	Measure the leakage current. ➔ Insert an output circuit filter (OFL).

📖 The explanations for function codes with an asterisk (*) are limited to motor 1. If using motor 2, replace with the relevant function codes in Chapter 5 "Table 5.3-2 Switching function codes list."

[33] OPL Output phase loss detection

Phenomenon Output phase loss occurred.

Possible Cause	Check and Measures
(1) Inverter output wires are broken.	Measure the inverter output current. ➔ Replace the output wires.
(2) The motor winding is broken.	Measure the inverter output current. ➔ Replace the motor.
(3) The screws for the inverter output terminal were not tight enough.	Check if any screws on the inverter output terminals have become loose. ➔ Tighten the terminal screws to the recommended torque.
(4) A single-phase motor has been connected.	➔ The inverter cannot be used. FRENIC-Ace has been designed for driving three-phase induction motors and PMSMs.

[34] OS Overspeed protection

Phenomenon Motor rotated at excessive speed (When motor speed ≥ (F03 x 1.2))

Possible Cause	Check and Measures
(1) Incorrect setting of function code data.	Check the motor "Number of poles" (P01*) settings. ➔ Specify the P01* data in accordance with the motor to be used.
	Check the maximum frequency setting (F03*). ➔ Specify the F03* data in accordance with the output frequency.
	Check the speed limiting function (d32, d33) setting. ➔ Disable the speed limiting function (d32, d33).
	Check the overspeed detection level (d35) setting. ➔ Set the overspeed detection level (d35) to 120%.
(2) The speed regulator gain is insufficient.	Check whether the speed has overshot when performing high-speed operation. ➔ Increase the speed regulator gain (d03*). (Depending on the situation, it may be necessary to change the filters or adjust the integral time.)
(3) Noise is superimposed on the PG signal.	Check the PG signal input monitor, and check noise countermeasures (grounding condition, signal line/main circuit wiring installation method, etc.) ➔ Take noise countermeasures. For details, refer to Appendix A.
(4) The output frequency and motor rotation speed exceeded 599 Hz.	If running the motor near 599 Hz, check whether the acceleration time is too short, whether there are any load fluctuations, and whether the speed regulator gain (d03*) and integral time (d04*) are appropriate. ➔ Reduce the operating frequency.

📖 The explanations for function codes with an asterisk (*) are limited to motor 1. If using motor 2, replace with the relevant function codes in Chapter 5 "Table 5.3-2 Switching function codes list."

TROUBLESHOOOTING

Chap 6

[35] 0Un Overvoltage

Phenomenon The DC intermediate circuit voltage was over the overvoltage detection level.

0U1 Overvoltage occurred during acceleration.
0U2 Overvoltage occurred during deceleration.
0U3 Overvoltage occurred during running at constant speed.

Possible Cause	Check and Measures
(1) The power supply voltage exceeded the inverter's specified range.	Measure the input voltage. ➔ Decrease the voltage to within the specified range. ➔ If the power supply voltage is within the specified range, the inverter may be defective. Contact your Fuji Electric representative.
(2) A surge current entered the input power supply.	In the same power line, if a phase-advancing capacitor is turned ON/OFF or a thyristor converter is activated, a surge (momentary large increase in the voltage or current) may be caused in the input power. ➔ Install a DC reactor.
(3) The deceleration time was too short for the moment of inertia of the load.	Recalculate the deceleration torque based on the moment of inertia of the load and the deceleration time. ➔ Increase the deceleration time (F08, E11, E13, E15, and H56). ➔ Enable the anti-regenerative control (H69), or deceleration characteristics (H71). ➔ Enable torque limit (F40, F41, E16, E17). ➔ Set the rated voltage at base frequency (F05*) to “0” to improve the braking capability. ➔ Consider the use of a braking resistor.
(4) The acceleration time was too short.	Check if the overvoltage alarm occurs after rapid acceleration. ➔ Increase the acceleration time (F07, E10, E12, and E14). ➔ Select the Curve acceleration/deceleration (H07). ➔ Consider the use of a braking resistor.
(5) Braking load is too heavy.	Compare the braking torque of the load with that of the inverter. ➔ Set the rated voltage at base frequency (F05*) to “0” to improve the braking capability. ➔ Consider the use of a braking resistor.
(6) A ground fault occurred on the output side.	If the motor runs normally with the wiring disconnected from the inverter output terminals [U], [V], [W]: ➔ Check whether a ground fault has occurred on the output wiring or motor. If overvoltage is displayed when the inverter is run with the wiring disconnected from the inverter output terminals [U], [V], and [W]: ➔ The inverter may be defective. Contact your Fuji Electric representative.
(7) Malfunction caused by noise.	Check if the DC intermediate circuit voltage was below the overvoltage level when the overvoltage alarm occurred. ➔ Take noise countermeasures. For details, refer to Appendix A. ➔ Enable the retry function (H04). ➔ Connect a surge absorber to magnetic contactor's coils or other solenoids (if any) causing noise.

📖 The explanations for function codes with an asterisk (*) are limited to motor 1. If using motor 2, replace with the relevant function codes in Chapter 5 "Table 5.3-2 Switching function codes list."

[36] PbF Charger circuit fault (FRN0030E3□-2G to FRN0115E3□-2G /FRN0022E3□-4G to FRN0072E3□-4G)

Phenomenon Charge circuit fault was detected.

Possible Cause	Check and Measures
(1) The charging circuit is defective.	Inverter repair is necessary ➔ Contact your Fuji Electric representative.

[37] PG PG wire break

Phenomenon The pulse generator (PG) wire has been broken somewhere in the circuit.

Possible Cause	Check and Measures
(1) [PIN] has not been set on the input terminal (Position control)	Check if pulse input [PIN] has been assigned to E05. ➔ Confirm assignment.
(2) The wire between the pulse generator (PG) and the option card is broken.	Check whether the pulse generator (PG) is correctly connected or whether any wire is broken. ➔ Check whether the PG is connected correctly, or tighten the related terminal screws. ➔ Check whether any contact part bites into the wire sheath. ➔ Replace the wire(s).
(3) The inverter was affected by strong electrical noise.	Check noise countermeasures (grounding condition, signal line and communication cable/main circuit wiring installation method, etc.) ➔ Take noise countermeasures. ➔ Keep the main circuit wiring and control circuit wiring as far apart as possible.

[38] dO Excessive positioning deviation

Phenomenon The position deviation during position control was excessive.

Possible Cause	Check and Measures
(1) Encoder wire break	Check whether an encoder wire break has occurred.
(2) Encoder rotation direction (wiring phase sequence), motor rotation direction (inverter output wiring phase sequence) mismatch	Connect and set so that all directions match. Review the setting values for d14 to d17 and H190.
(3) The deviation overflow setting value is too small.	Review the setting values for d223 and d224. Increase the setting value if too small.
(4) The position control gain is too small.	Review the setting values for d203 and d204. Increase the setting value if too small.
(5) The speed control gain is too small.	Review the setting values for d03 (A45, b45, r45). Increase the setting value if too small.
(6) Torque limiting has been applied.	If torque limiting is active, it will not be possible to perform position control or speed control correctly. Take the following countermeasures to prevent torque limiting from being applied. •Reduce the load. •Review the acceleration/deceleration time. •Review the machine configurations such as the deceleration rate and motor capacity to reduce the load.

[39] Fod Forced operation (Fire Mode)

Phenomenon Displayed in the alarm history when forced operation (Fire Mode) is performed. Operation continues without a trip occurring even if another alarm occurs during forced operation.

Possible Cause	Check and Measures
(1) The “FMS” forced operation command was turned ON.	If the operation is unintended, turn OFF the “FMS” forced operation command, or change function code H116 to “0”.

While in forced operation, the running status (frequency, etc.) and “F irE” are displayed alternatively on the LED monitor. For details, refer to Chapter 3 “3.3.2 Monitoring warnings.”

For details on forced operation settings and operation, refer to H116 to H121 in Chapter 5 “5.3.6 H1 codes (High-performance Functions)”, and to ■ Forced operation command “FMS” assignment in Chapter 5 “5.3.2 E codes (Extension terminal functions)” for details on “FMS” forced operation command assignment.

6.4 If a Warning Code Appears on the LED Monitor

6.4.1 Warning code list

It is possible to display a warning cause code while the inverter continues to run, and output a warning signal from the [Y] terminal. To display the warning, select with function codes H81, H82, or H83. (refer to Chapter 5 “FUNCTION CODES.”)

If outputting warning signals from the [Y] terminal, set 98 “L-ALM” for the function codes corresponding to E20 to E21 and E27.

Table 6.4-1 Warning code list

Warning Code	Warning name	Operation selection function codes	Setting method	Related page
Cnt	Machine life (Number of startups)	H82 Bit 13	For details, refer to “5.3.5 H codes (High-performance functions)” in Chapter 5 “FUNCTION CODES.”	-
iGb	IGBT lifetime early warning	H83 Bit 13		
LiF	Lifetime early warning	H82 Bit 7		
OH	Cooling fin overheat early warning	H82 Bit 6		
OL	Motor overload early warning	H82 Bit 5		
Pid	PID alarm output	H82 Bit 9		
PTC	PTC thermistor activate	H82 Bit 11		
rEF	Reference loss	H82 Bit 8		
rTE	Machine life (Cumulative motor run time)	H82 Bit 12		
UTL	Low torque detection	H82 Bit 10		
Lob	Low battery warning	H82 Bit 15		

6.4.2 Warning cause and check

[1] Cnt Machine life (Number of startups)

Possible Cause	Check and Measures
(1) Machine life (Number of startups)	This is displayed when the number of times that the motor is started reaches the number of times set with function code H79 (maintenance setting startup count). Furthermore, the current startup count can be checked with function code H44 (startup count), and therefore the H44 data should be set to “0000” to reset the count.

[2] iGb IGBT lifetime early warning

Possible Cause	Check and Measures
(1) IGBT power cycle life	The power cycle life for the element temperature of the main circuit semiconductor IGBT due to frequent acceleration/deceleration/stoppage is estimated, and this is displayed before the design life is reached.

[3] LiF Lifetime early warning

Possible Cause	Check and Measures
(1) Lifetime early warning	It is judged that the service life of any one of the capacitors (DC link bus capacitors or electrolytic capacitors on PCBs), the cooling fan, or the IGBT has expired. Refer to Chapter 7 “7.4.1 Judgment on service life,” and check the part service life status from the maintenance information on the keypad.

[4] OH Cooling fin overheat early warning

Possible Cause	Check and Measures
(1) Cooling fin overheat early warning	This is displayed as a warning before cooling fin overheating trip OH1 occurs. For details on countermeasures, refer to 6.3.2 “[26] OH1 Cooling fin overheat.”

[5] OL Motor overload early warning

Possible Cause	Check and Measures
(1) Motor overload early warning	This is displayed as a warning before the motor overload OL1 alarm occurs. Set the current at which this is triggered with Overload early warning operation level (E34). Check whether the actual motor current is greater than the current set with E34.

[6] PID PID alarm output

Possible Cause	Check and Measures
(1) PID alarm output	This is displayed if a PID control warning (absolute value warning, deviation warning) occurs. For details, refer to Chapter 5 "FUNCTION CODES " - "5.3.9 J1 codes (Application Functions)" (J11 to J13 PID Control (Select warning output)).

[7] PTC PTC thermistor activate

Possible Cause	Check and Measures
(1) Thermistor detection (PTC)	This warning is displayed when the temperature detected with the motor PTC thermistor exceeds the operation level (H27) threshold value. For details on countermeasures, refer to “6.3.2 [29] OH4 Motor protection (PTC thermistor).”

[8] rEF Reference loss

Possible Cause	Check and Measures
(1) Reference loss	If the analog frequency setting (terminals [12], [C1], [V2]) reference drops rapidly to 10% or lower, a wire break is determined, and “rEF” is displayed. Check the wiring.

[9] rTE Machine life (Cumulative motor run time)

Possible Cause	Check and Measures
(1) Inverter life (Cumulative run time)	This is displayed when the motor cumulative run time reaches the time set with function code H78 (maintenance setting time). The motor cumulative run time can be checked with H94* (motor cumulative run time). Furthermore, the time can be reset by setting the H94* value to “0.”

[10] UTL Low torque detection

Possible Cause	Check and Measures
(1) Low torque detection	This is displayed when the output torque drops to the low torque detection level (E80) or below, and persists for the time set with the timer (E81) or longer.

[11] Lob Low battery warning (for Multi-function Keypad)

Possible Cause	Check and Measures
(1) The TP-A2SW multi-function keypad (option) remaining battery capacity is insufficient.	Check whether the trip history date and time information has been lost. Refer to the TP-A2SW multi-function keypad instruction manual, and replace the battery (sold separately) and set the date and time information again.

6.5 Other Errors

6.5.1 Abnormal motor operation

[1] The motor does not rotate

Possible Cause	Check and Measures
(1) The main power supply is not being input correctly.	Check the input voltage, presence of interphase voltage unbalance, etc. ➔ Switch ON a molded-case circuit breaker, an earth-leakage circuit breaker (with overcurrent protective function) or a magnetic contactor. ➔ Check for voltage drop, phase loss, poor connections, or poor contacts, and fix them if necessary. ➔ If only the control power auxiliary input is supplied, also supply the main power to the inverter.
(2) No forward/reverse operation command was inputted, or both the commands were inputted simultaneously (terminal block operation).	Check the input status of the forward/reverse command by using "I/O Checking" on the keypad menu. ➔ Input a run command. ➔ Set either the forward or reverse operation command to OFF. ➔ Correct the run command input method. (Set F02 data to "1.") ➔ Correct the assignment error of terminals [FWD], [REV]. (E98, E99) ➔ Connect the external circuit wires to control circuit terminals [FWD] and [REV] correctly. ➔ Make sure that the SINK/SOURCE switch (SW1) on the PCB is properly configured.
(3) No rotational direction is instructed. (Keypad operation)	Check the forward/reverse rotation direction command by using "I/O Checking" on the keypad menu. ➔ Input the rotation direction (F02 = 0), or select the keypad operation with which the rotation direction is fixed (F02 = 2 or 3).
(4) The inverter could not accept any run commands from the keypad since it was in Programming mode.	Check which operation mode the inverter is in using the keypad. ➔ Shift the operation mode to Running mode and enter a run command.
(5) A run command with higher priority than the one attempted was active, and the run command was stopped.	Based on the run command block diagram (refer to "Figure 8.2-4" (for E3S/E3E) and "Figure 8.3-4" (for E3N) in Chapter 8), check the priority of the run commands by Function code data check and I/O checking from the keypad menu. ➔ Correct any incorrect function code data settings such as Link function (Operation selection) (H30) and Bus link function (Operation selection) (y98), or cancel the higher priority run command.
(6) No analog frequency command input.	Check that a reference frequency has been entered correctly by using "I/O Checking" on the keypad menu. ➔ Connect external circuit wirings of terminals [13], [12], [11] and [C1], and correctly. ➔ If using terminal [C1], check the terminal [C1] function selection switches (SW3, SW4), and the thermistor (operation selection) (H26) setting.

Possible Cause	Check and Measures
(7) The reference frequency was below the starting or stop frequency.	Check that a reference frequency has been entered correctly by using "I/O Checking" on the keypad menu. ➔ Set the reference frequency at the same or higher value than that of the starting (F23*) and stop (F25*) frequencies. ➔ Reconsider the starting (F23*) and stop (F25*) frequencies, and if necessary, change them to lower values. ➔ Inspect the external frequency command potentiometers, signal converters, switches, and relay contacts. Replace any that are faulty. ➔ Connect external circuit wirings of terminals [13], [12], [11] and [C1] correctly.
(8) A frequency command with higher priority than the one attempted was active.	Based on the frequency setting block diagram (refer to "Figure 8.2-1" (for E3S/E3E) and "Figure 8.3-1" (for E3N) in Chapter 8), check the data by Function code data check and I/O checking from the keypad menu. ➔ Correct any incorrect function code data (e.g. cancel the higher priority run command).
(9) The upper and lower frequencies for the frequency limiters were set incorrectly.	Check the data of function codes F15 (Frequency limiter (High)) and F16 (Frequency limiter (Low)). ➔ Change the settings of F15 and F16 to the correct ones.
(10) The coast-to-stop command was active.	Check the data of the function codes (E01 to E05, E98, E99), and check the input state by using "I/O Checking" on the keypad menu. ➔ Release the coast-to-stop command setting.
(11) Broken wires, incorrect connection or poor contact with the motor.	Check the wiring (Measure the output current). ➔ Repair or replace the wires to the motor.
(12) Overload	Measure the inverter output current. ➔ Reduce the load (In winter, the load tends to increase.)
	Check whether any mechanical brake is applied. ➔ Release the mechanical brake.
(13) Torque generated by the motor was insufficient.	Check that the motor starts running if the value of the torque boost (F09*) is increased. ➔ Increase the value of torque boost (F09*).
	Check the data of function codes (F04*, F05*, H50, H51, H52, H53, H65, and H66). ➔ Change the V/f pattern to match the motor's characteristics.
	Check that the motor switching signal (selecting motor 1 or 2) is correct and the function code data matches each motor. ➔ Correct the motor switching signal. ➔ Modify the function code data to match the connected motor.
	Check whether the reference frequency is below the slip frequency of the motor. ➔ Change the reference frequency so that it becomes higher than the slip frequency of the motor.
(14) Wrong connection or poor contact with DC reactor.	Check the wiring. ➔ Connect the DCR correctly. Repair or replace DCR wires.

The explanations for function codes with an asterisk (*) are limited to motor 1. If using motor 2, replace with the relevant function codes in Chapter 5 "Table 5.3.2 Switching function codes list."

[2] The motor rotates, but the speed does not increase

Possible Cause	Check and Measures
(1) The specified maximum output frequency was too low.	Check the data of function code F03* (Maximum output frequency 1). ➔ Correct the F03* data.
(2) The specified Frequency limiter (Upper limit) was too low.	Check the data of function code F15 (Frequency limiter (Upper limit)). ➔ Correct the F15 data. The factory default is set to 70 Hz. If running the motor with maximum output frequency 1 (F03*) set to 70 Hz or higher, it will also be necessary to increase the F15 value.
(3) The reference frequency was too low.	Check that the reference frequency has been entered properly by using “I/O Checking” on the keypad menu. ➔ Increase the reference frequency. ➔ Inspect the external frequency command potentiometers, signal converters, switches, and relay contacts. Replace any that are defective. ➔ Connect external circuit wirings of terminals [13], [12], [11] and [C1] correctly.
(4) A frequency command (e.g., multi-frequency or via communication) with higher priority than the one attempted was active and its reference frequency was too low.	Based on the frequency setting block diagram (refer to ”Figure 8.2-1” (for E3S/E3E) and “Figure 8.3-1” (for E3N) in Chapter 8), check the function code data using the keypad menu, and perform an I/O check to check the input frequency command. ➔ Correct any incorrect data of function codes (e.g. cancel the higher priority frequency command)
(5) The acceleration time was too long or too short.	Check the data of acceleration times (F07, E10, E12, E14, H54). ➔ Change the acceleration time to match the load.
(6) Overload	Measure the inverter output current. ➔ Reduce the load.
	Check whether any mechanical brake is applied. ➔ Release the mechanical brake.
(7) Function code settings do not agree with the motor characteristics.	When automatic torque boost and automatic energy-saving operations are performed, confirm that P02*, P03*, P06*, P07*, P08* agree with motor constants. ➔ Perform auto-tuning.
(8) The output frequency does not increase due to the current limiter operation.	Make sure that F43 (Current limiter (Operation selection)) is set to “2” and check the data of F44 (Current limiter (Level)). ➔ Correct the F44 data, or set the F43 data to “0” (Disable) if the current limiter operation is not needed.
	Decrease the value of torque boost (F09*), then run the motor again and check if the speed increases. ➔ Adjust the F09* data.
	Check the data of function codes (F04*, F05*, H50, H51, H52, H53, H65, and H66) to ensure that the V/f settings are correct. ➔ Match the V/f settings with the motor ratings.
(9) The output frequency does not increase due to the torque limiter operation.	Check whether the data of torque control levels (F40, F41, E16, E17) are set to appropriate values. Also, check whether Torque limit 2/1 switching signal “TL2/TL1” is correct. ➔ Correct the data of F40, F41, E16 and E17 or disable. ➔ Set the Torque limit 2/1 switching signal “TL2/TL1” correctly.
(10) Bias and gain incorrectly specified.	Check the data of function codes (F18, C50, C32, C34, C37, C39, C42, and C44). ➔ Readjust the bias and gain to appropriate values.

Possible Cause	Check and Measures
(11) When performing vector control with sensor, the motor rotates slowly, and is unable to run at the specified speed.	Check whether the encoder wiring/rotation direction and motor wiring/rotation direction match the function code settings. ➔ Wire the encoder and motor correctly, and set the correct rotation directions.

The explanations for function codes with an asterisk (*) are limited to motor 1. If using motor 2, replace with the relevant function codes in Chapter 5 "Table 5.3.2 Switching function codes list."

[3] The motor runs in the opposite direction to the command

Possible Cause	Check and Measures
(1) Wiring to the motor is incorrect.	Check the wiring to the motor. ➔ Connect terminals [U], [V], and [W] of the inverter to the [U], [V], and [W] terminals of the motor, respectively.
(2) Incorrect settings and wiring for run commands and rotation direction commands (FWD and REV).	Check the data of function codes (E98 and E99) and the wiring. ➔ Correct the data of the function codes and the wiring.
(3) A run command (with fixed rotation direction) from the keypad is active, but the rotation direction settings are incorrect.	Check the data of function code F02 (Operation method). ➔ Change the data of function code F02 to “2: / Keypad operation (Forward rotation)” or “3: / Keypad operation (Reverse rotation)”.
(4) The rotation direction of the motor is opposite to that of the inverter.	The rotation direction of IEC-compliant motors is opposite to that of non-compliant motors. ➔ Switch the “FWD”/”REV” signal setting.
(5) The function code data related to the speed command is incorrect.	Check the function code data. Refer to Chapter 8 “BLOCK DIAGRAMS FORCONTROL LOGIC.” ➔ Set correct data.

[4] Speed fluctuation or current oscillation (e.g., hunting) occurs during running at constant speed

Possible Cause	Check and Measures
(1) The frequency setting is fluctuating.	Check the signals for the frequency command with "I/O Checking" using the keypad menu. ➔ Increase the filter constants (C33, C38, and C43) in the frequency settings.
(2) An external frequency command potentiometer is used for frequency setting.	Check that there is no noise in the control signal wires from external sources. ➔ Keep the main circuit wiring and control circuit wiring as far apart as possible. ➔ Use shielded or twisted wires for control signals.
	Check whether the external frequency command potentiometer is malfunctioning due to noise from the inverter. ➔ Connect a capacitor to the output terminal of the potentiometer or insert a ferrite core on the signal wire. (Refer to Chapter 2.)
(3) Frequency switching or multi-frequency command was enabled.	Check whether the relay signal for switching the frequency command is chattering. ➔ If the relay contact is defective, replace the relay.
(4) The wiring length between the inverter and the motor is too long.	Check whether auto-torque boost, auto-energy saving operation, or dynamic torque vector control is enabled. ➔ Perform auto-tuning. ➔ Disable the automatic control systems by setting F37* (Constant torque load) to "1" and F42* (V/f control) to "0", then check if the motor vibration stops. ➔ Make the output wires as short as possible.
(5) The machinery is hunting due to vibration caused by low rigidity of the load. Or the current is irregularly oscillating due to special motor parameters.	After disabling all the automatic control systems such as auto torque boost, auto energy saving operation, overload prevention control, current limiter, torque limiter, anti-regenerative control, auto search for idling motor speed, slip compensation, dynamic torque vector control, droop control, overload stop function, speed control, online tuning, notch filter, and observer, check that the motor vibration disappears. ➔ Disable the functions causing the vibration. ➔ Readjust the output current fluctuation damping gain (H80*). ➔ Readjust the speed control system. (d01* to d06*)
	Check that the motor vibration is suppressed if you decrease the value of F26 (Motor sound (Carrier frequency)) or set F27 (Motor sound (Tone)) to "0." ➔ Decrease the carrier frequency (F26) or set the tone to "0" (F27 = 0).

📖 The explanations for function codes with an asterisk (*) are limited to motor 1. If using motor 2, replace with the relevant function codes in Chapter 5 "Table 5.3.2 Switching function codes list."

[5] Unpleasant noises are emitted from motor or noises fluctuate

Possible Cause	Check and Measures
(1) The specified carrier frequency is too low.	Check the data of Motor sound (Carrier frequency) (F26) and Motor sound (Tone) (F27). ➔ Increase the carrier frequency (F26). ➔ Correct the F27 data.
(2) Ambient temperature of inverter is high. (When selecting carrier frequency automatic reduction function (H98))	Measure the temperature inside the paneling where the inverter is mounted. ➔ If it is over 40°C (104°F), lower it by improving the ventilation. ➔ Reduce the load to lower the inverter temperature (for fans or pumps, decrease the Frequency limiter (upper limit) (F15)). Note) By canceling H98, alarm OH1, OH3, or OLU may occur.
(3) Resonance with the load.	Check the machinery mounting precision or check whether there is resonance with the mounting base. ➔ Run the motor alone to isolate the cause of the resonance, and improve the load characteristics. ➔ Avoid continuous running at the frequency range where the resonance occurs by setting the jump frequency (C01-C04) ➔ Set Speed control (Notch filter) (d07*, d08*) and Observer (d18, d19, d20) to suppress vibrations. (Depending on the load characteristics, this may not be effective.)

The explanations for function codes with an asterisk (*) are limited to motor 1. If using motor 2, replace with the relevant function codes in Chapter 5 "Table 5.3.2 Switching function codes list."

[6] The motor does not accelerate or decelerate according to set acceleration or deceleration times

Possible Cause	Check and Measures
(1) The inverter runs the motor with S-curve or curvilinear acceleration/deceleration.	Check the data of function code H07 (Curvilinear acceleration/ deceleration). ➔ Set linear acceleration/deceleration. (H07=0) ➔ Shorten the acceleration/deceleration times (F07, F08, E10 through E15).
(2) The current limiting operation prevented the output frequency from increasing (during acceleration).	Make sure that F43 (Current limiter (Operation selection)) is set to 2, then check that the setting of F44 (Current limiter (Level)) is appropriate. ➔ Readjust the setting of F44 to appropriate value, or disable the function of current limiter with F43. ➔ Increase the acceleration/deceleration times (F07, F08, E10 through E15).
(3) The anti-regenerative control is enabled (during deceleration).	Check the data of function code H69 (Anti-regenerative control (Operation selection)). ➔ Increase the deceleration time (F08, E11, E13, and E15).
(4) Overload	Measure the inverter output current. ➔ Reduce the load. In the case of fans/pumps, lower the setting value of F15 (Frequency limiter (Upper limit)). (In winter, the load tends to increase.)
(5) Torque generated by the motor was insufficient.	Check that the motor starts running if the value of the torque boost (F09*) is increased. ➔ Increase the value of the torque boost (F09*).
(6) An external frequency command potentiometer is used for frequency setting.	Check that there is no noise in the control signal wires from external sources. ➔ Keep the main circuit wiring and control circuit wiring as far apart as possible. ➔ Use shielded or twisted wires for control signals. ➔ Connect a capacitor to the output terminal of the potentiometer or insert a ferrite core on the signal wire. (Refer to Chapter 2.)
(7) The output frequency is limited by the torque limiter.	Check whether the data of torque control levels (F40, F41, E16, E17) are set to appropriate values. Also, check whether Torque limit 2/1 switching signal “TL2/TL1” is correct. ➔ Correct the data of F40, F41, E16 and E17 or disable them. ➔ Set the Torque limit 2/1 switching signal “TL2/TL1” correctly. ➔ Increase the acceleration/deceleration times (F07, F08, E10 through E15).
(8) The specified acceleration or deceleration time was incorrect.	Check the terminal commands “RT1” and “RT2” for acceleration/ deceleration times. ➔ Correct the “RT1” and “RT2” settings.

📖 The explanations for function codes with an asterisk (*) are limited to motor 1. If using motor 2, replace with the relevant function codes in Chapter 5 "Table 5.3.2 Switching function codes list."

[7] The motor does not restart even after the power recovers from a momentary power failure

Possible Cause	Check and Measures
(1) The data of function code F14 is either “0,” “1,” or “2.”	Check if an undervoltage trip LU occurs. ➔ Change the data of function code F14 (Momentary power failure restart (Operation selection)) to “3,” “4,” or “5.”
(2) The run command remains OFF even after the power has been restored.	Check the input status with “I/O Checking” using the keypad menu. (Refer to Chapter 3 “3.4.4 Checking I/O signal status: “I/O Checking: 4. I_o”.”) ➔ Check the power recovery sequence with an external circuit. If necessary, consider the use of a relay that can keep the run command ON.
	In 3-wire operation, momentary power failure duration is so long that the control circuit power supply of the inverter is shut off once, or “Select self hold” signal “HLD” is switched OFF once. ➔ Change the design or the setting so that a run command can be issued again within 2 seconds after the power has been restored.

[8] The motor generates an abnormal amount of heat

Possible Cause	Check and Measures
(1) Excessive torque boost specified.	Check whether decreasing the torque boost (F09*) decreases the output current but does not stall the motor. ➔ If no stall occurs, decrease the torque boost (F09*).
(2) Continuous running in extremely slow speed.	Check the running speed of the inverter. ➔ Change the speed setting or replace the motor with a motor exclusively designed for inverters.
(3) Overload	Measure the inverter output current. ➔ Reduce the load. In the case of fans/pumps, lower the setting value of F15 (Frequency limiter (Upper limit)). (In winter, the load tends to increase.)

📖 The explanations for function codes with an asterisk (*) are limited to motor 1. If using motor 2, replace with the relevant function codes in Chapter 5 "Table 5.3.2 Switching function codes list."

[9] The motor does not run as expected

Possible Cause	Check and Measures
(1) Incorrect setting of function code data.	Check that function codes are correctly configured, and that no unnecessary configuration has been done. ➔ Configure all the function codes correctly.
	Make a note of function code data currently configured and then initialize all function code data using H03. ➔ After the above process, reconfigure function codes one by one, checking the running status of the motor.
(2) The Forced operation function (Fire Mode) is being used.	Check that function codes are correctly configured, and that no unnecessary configuration has been done. ➔ Check the operation selection (H116) settings for forced operation. ➔ Check digital input terminal forced operation command “FMS.”

[10] The motor stalls during acceleration

Possible Cause	Check and Measures
(1) The acceleration time was too short.	Check the data of acceleration time (F07, E10, E12, E14, H57, H58). ➔ Extend the acceleration time.
(2) Moment of inertia of load is large.	Measure the inverter output current. ➔ Reduce the moment of inertia of the load. ➔ Increase the inverter capacity.
(3) Voltage drop of wiring is large.	Check the terminal voltage of the motor. ➔ Increase the diameter or shorten the distance of wirings between the inverter and the motor.
(4) Load torque is large.	Measure the inverter output current. ➔ Reduce the load torque. ➔ Increase the inverter capacity.
(5) Torque generated by the motor was insufficient.	Check whether the motor starts when torque boost (F09*, F37*, H51) is increased. ➔ Increase F09, F37, and H51.

The explanations for function codes with an asterisk (*) are limited to motor 1. If using motor 2, replace with the relevant function codes in Chapter 5 "Table 5.3.2 Switching function codes list."

6.5.2 Problems with inverter settings

[1] Nothing appears on the keypad

Possible Cause	Check and Measures
(1) No power (neither main power nor auxiliary control power) is supplied to the inverter.	Check the input voltage and interphase voltage unbalance. ➔ Switch on a molded-case circuit breaker, an earth-leakage circuit breaker (with overcurrent protective function) or a magnetic contactor. ➔ Check for voltage drop, phase loss, poor connections, or poor contacts and fix them if necessary.
(2) The power for the control power supply did not reach a sufficiently high level.	Check if the shorting bar has been removed between terminals [P1] and [P(+)] or if there is a poor contact between the shorting bar and those terminals. ➔ Mount a shorting bar or a DC reactor between terminals [P1] and [P(+)]. In case of poor contact, tighten the screws.
(3) The keypad was not properly connected to the inverter.	Check whether the keypad is properly connected to the inverter. ➔ Remove and then reattach the keypad. ➔ Replace the keypad with another one and check whether the problem recurs.
	When running the inverter remotely, ensure that the extension cable is securely connected both to the keypad and to the inverter. ➔ Disconnect the cable, reconnect it, and see whether the problem recurs. ➔ Replace the keypad with another one and check whether the problem recurs.

[2] The desired menu is not displayed

Possible Cause	Check and Measures
(1) The menu display mode is not selected appropriately.	Check the data of function code E52 (keypad menu selection). ➔ Change the E52 data so that the desired menu appears.

[3] Display of under bars (_ _ _ _)

Phenomenon Although RUN key (FWD/REV keys for the Multi-function keypad), run forward command "FWD", or run reverse command "REV" was pressed, the motor did not rotate and under bars were displayed.

Possible Cause	Check and Measures
(1) The voltage of the DC intermediate circuit was low.	Select 5_01 from menu number 5 "Maintenance Information" in keypad Program mode, and check the DC intermediate circuit voltage. (For three-phase 200 V: 200 VDC or less; for three-phase 400 V: 400 VDC or less; for single-phase 200 V: 200 VDC or less) ➔ Connect the inverter to a power supply that meets its voltage supply range.
(2) The main power is not ON, while only the control power auxiliary input is supplied.	Check whether the main power supply is turned ON. ➔ Turn ON the main power supply. Check if the shorting bar has been removed between terminals [P1] and [P(+)] or if there is a poor contact between the shorting bar and those terminals. ➔ Mount a shorting bar or a DC reactor between terminals [P1] and [P(+)]. In case of poor contact, tighten the screws.
(3) AC power supply is not connected due to the connection of DC power supply, but the main power supply interruption detection is activated (H72=1).	Check the connection to the main power supply and check if the H72 data is set to "1" (factory default). ➔ Review the data of H72.
(4) Breaks in wiring to the main power supply input terminals.	Measure the input voltage. ➔ Repair or replace the main power supply input wires or input devices (MCCB, MC, etc.).

[4] Display of center bars (- - - -)

Phenomenon Center bars (- - - -) appeared on the LED monitor.

Possible Cause	Check and Measures
(1) When PID control had been disabled, E43 (LED Monitor (Item selection)) is set to 10 (PID command value) or 12 (PID feedback). During PID control operation, PID control has been disabled when the LED monitor had been set to display the PID command value, PID feedback value or PID output value by pressing the FUNC/DATA key.	Make sure that when you wish to view other monitor items, E43 is not set to "10: PID command value" or "12: PID feedback value." ➔ Set E43 to a value other than "10" or "12." Make sure that when you wish to view a PID command value or a PID feedback value, J01 (PID control) is not set to "0: Disable."
(2) The keypad was poorly connected.	Prior check: Even when FUNC/DATA key is pressed, the display is not switched. Check continuity of the extension cable used in remote operation. ➔ Replace the cable.

[5] Display of parenthesis [ ]

Phenomenon [ ] was displayed during speed monitoring by keypad.

Possible Cause	Check and Measures
(1) The display data overflows the LED monitor.	Check whether the product of the output frequency and the display coefficient (E50) exceeds 100,000. ➔ Review the data of E50.

[6] Function code data cannot be changed

Possible Cause	Check and Measures
(1) An attempt was made to change function code data that cannot be changed when the inverter is running.	Check if the inverter is running with “Drive Monitoring” using the keypad menu, and then confirm whether the data of the function codes can be changed when the motor is running by referring to the function code tables. ➔ Stop operation, and then change the function code data.
(2) The data of the function codes is protected.	Check the data of function code F00 (Data protection). ➔ Change the data of F00 from a data protection state (F00 = 1 or 3) to a data changeable state (F00 = 0 or 2).
(3) The “WE-KP” terminal command (“Enable data change with keypad”) is not entered, though it has been assigned to a digital input terminal.	Check the data of the function codes (E01 to E05, E98, E99), and check the input state by using “I/O Checking” on the keypad menu. ➔ Input a “WE-KP” command through a digital input terminal.
(4) The FUNC/DATA key was not pressed.	Check whether the FUNC/DATA key was pressed after changing the function code data. ➔ Press the FUNC/DATA key after changing data. Ensure that SAVE is displayed.
(5) The data of the function codes F02, E01 to E05, E98, E99 are not changeable.	Either one of the “FWD” and “REV” terminal commands is turned ON. ➔ Turn OFF both “FWD” and “REV”.
(6) The function code(s) to be changed do(es) not appear.	Only the function codes registered in favorites (0.Fnc) appear. ➔ Call up the menus of 1.F_ _ to 1.P_ _ by pressing the ∧ key from Favorites (0.Fnc) on the Menu to display the intended function code and to change the value. (For details, refer to Chapter 3, section 3.4 “Table 3.4-1 Menus Available in Programming Mode.”)
(7) The user password is protected.	Check the decimal point “.” at the end of the displayed function code number. ➔ Check user password protective functions 1, 2 (function codes H99 and H197 to H199), and disable password protection. (If user password 1 or 2 is input incorrectly over a set number of times, the LoP alarm is displayed.)

[7] Function code data cannot be changed (changed from link functions)

Possible Cause	Check and Measures
(1) An attempt was made to change function code data that cannot be changed when the inverter is running.	Check if the inverter is running with “Drive Monitoring” using the keypad menu, and then confirm whether the data of the function codes can be changed when the motor is running by referring to the function code tables. ➔ Stop operation, and then change the function code data.
(2) The data of the function code F02 is not changeable.	Either one of the “FWD” and “REV” terminal commands is turned ON. ➔ Turn OFF both “FWD” and “REV”.

[8] _ _En appears

Phenomenon Even when keys and “FWD”/”REV” signals are input, the motor did not rotate, and _ _En was displayed.

Possible Cause	Check and Measures
(1) EN terminals are OFF.	Check whether terminals [EN1] and [EN2] are ON. ➔ Turn those terminals ON. ① When the EN terminal function is not used: Check whether the 2 poles on the SW9 switch on the PCB are both ON (factory default). ② When the EN terminal function is used: Check whether the safety relay EMERGENCY STOP button is open (OFF) (turn terminals [EN1] and [EN2] ON).

Chapter 7
MAINTENANCE AND INSPECTION

This chapter describes the maintenance and inspection items of the inverter.

Contents

Perform daily and periodic inspections to avoid trouble and keep reliable operation of the inverter for a long time. When performing inspections, follow the instructions given in this chapter.

⚠WARNING⚠
• Carry out inspection **after waiting 5 minutes or longer** after shutting off the power supply. Furthermore, ensure that the LED monitor or charge lamp are OFF, and use a device such as a tester to ensure that the DC intermediate circuit voltage across main circuit terminals [P(+)] and [N(-)] has dropped to a safe level (+25 VDC or less). **Failure to observe this could result in electric shock.** • Maintenance, inspection and part replacement should only be carried out by the authorized personnel. • Remove all metal objects (watches, rings, etc.) before beginning work. • Be sure to use insulated tools. • Never modify the product. **Failure to observe this could result in electric shock or injury.**

7.1 Inspection Interval

Table 7.1-1 lists the inspection intervals and check items as a guide.

Table 7.1-1 List of inspections

Inspection type	Inspection interval	Inspection details
Daily inspection	Every day	Refer to 7.2
Periodic inspection	Every year	Refer to 7.3
10-year inspection *1	10th year *3	Replacement of cooling fans *2 Replacement of smoothing capacitors and close checks

*1 The 10-year inspection should be performed only by the persons who have finished the Fuji Electric training course.
Contact the sales agent where you purchased the product or your nearest Fuji Electric representative. (Excl. cooling fan replacement.)

*2 For the number of years for standard replacement of cooling fans, refer to “7.4 List of Periodic Replacement Parts.”

*3 Carry out this inspection in the 7th year when using these models in the following modes:

- FRN0012, 0020E3☐-2G and FRN0007, 0012E3☐-4G in HND mode
- FRN****E3☐-4G in ND mode
- FRN****E3☐-7G in HND mode

Note The replacement intervals are based on the inverter’s service life estimated at an ambient temperature of 40°C (104°F) at 100% (FRN0030 to 0115E3☐-2G / FRN0022 to 0072E3☐-4G in HHD mode) or 80% (FRN0020E3☐-2/7G / FRN0012E3☐-4G and below in HHD/HND/HD/ND mode) of full load. In environments with an ambient temperature above 40°C (104°F) or a large amount of dust or dirt, the replacement intervals may be shorter.

The standard replacement frequency is merely a guide, and the life expectancy indicated is not guaranteed. For details, refer to “7.4 List of Periodic Replacement Parts.”

7.2 Daily Inspection

Visually inspect the inverter for operation errors from the outside without removing the covers when the inverter is running or the power is ON. Table 7.2-1 lists daily inspection items.

Table 7.2-1 Daily inspection list

Inspection location	Inspection item(s)	Inspection method	Criteria
Ambient environment	1) Check the ambient temperature, humidity, vibrations, and atmosphere (presence of dust, gas, oil mist, water droplets, etc.) 2) Have any foreign objects such as tools or dangerous objects been left in the surrounding area?	1) Perform a visual inspection, and perform measurement with the respective measuring instruments. 2) Visual inspection	1) Contents of Chapter 1 “1.3.1 Operating environment” must be satisfied. 2) No tools or dangerous objects should have been left in the surrounding area.
External appearance, other	1) Are the bolts securing the wires to the main circuit terminals and control circuit terminals loose? (* Carry out inspection before turning ON the power.) 2) Are there any abnormalities such as signs of overheating or discoloration? 3) Are there any abnormal noises, abnormal vibrations, or abnormal odors, etc.?	1) Retighten (* Do so before turning ON the power.) 2) Visual inspection 3) Auditory, visual, and olfactory inspection	1) There should be no looseness. If loose, retighten the screws. 2), 3) There should be no abnormalities.
Cooling fans	Is there any abnormal noise or excessive vibration when the cooling fans are in operation?	Auditory and visual inspections	There should be no abnormalities.
Keypad display	Are there any alarm indicators?	Visual inspection	If any alarm is displayed, refer to Chapter 6 “6.3. If an Alarm Code Appears on the LED Monitor.”
Performance	Is the unit performing as expected (does it satisfy standard specifications)?	Check the keypad monitor.	There should be no abnormalities in the output speed, current and voltage or other operation data.

7.3 Periodic Inspection

7.3.1 Periodic inspection 1 (Before the inverter is powered ON or after it stops running)

Perform periodic inspection 1 according to the items listed in Table 7.3-1 Periodic inspection list 1. When performing periodic inspection 1 after stopping the inverter, first shut down the power and then remove the front cover before performing the inspection.

It takes time for the main circuit DC parts' smoothing capacitors to dissipate even after turning OFF the power. To eliminate any danger, wait until the LED monitor or the charge lamp "CHARGE" has turned OFF, and use a device such as a tester to ensure that the DC voltage has dropped to a safe level (25 VDC or less) before carrying out work.

Table 7.3-1 Periodic inspection list 1

Inspection location		Inspection item	Inspection method	Criteria
Structural parts such as frames, covers		1) Is there any bolt looseness (tightening parts)? 2) Is there any deformation or damage? 3) Is there any discoloration due to overheating? 4) Is there any staining or dust adhesion?	1) Retighten 2), 3), 4) Visual inspection	1), 2), 3), 4) There should be no abnormalities. (If any section is stained, clean it with a soft cloth.)
Main circuit	Common	1) Are there any loose or missing bolts? 2) Is there any device or insulating material deformation, cracking, damage, or any discoloration due to degradation or overheating? 3) Is there any staining or dust adhesion?	1) Retighten 2), 3) Visual inspection	1, 2), 3) There should be no abnormalities. (If any section is stained, clean it with a soft cloth.)
	Conductors, wires	1) Is there any discoloration or distortion of conductors due to overheating? 2) Are there any wire coating tears, cracks, or discoloration?	1), 2) Visual inspection	1), 2) There should be no abnormalities.
	Terminal blocks	Is there any damage?	Visual inspection	There should be no abnormalities.
	Smoothing capacitors	1) Is there any electrolyte leakage, discoloration, cracks, or case expansion? 2) Is there any safety valve protrusion, and are there any smoothing capacitors with significant valve expansion?	1), 2) Visual inspection	1), 2) There should be no abnormalities.
	Braking resistors	1) Is there an abnormal odor due to overheating, or insulating material cracks? 2) Are any resistors disconnected?	1) Olfactory and visual inspection 2) Check the wires visually, or disconnect either one of the wires and measure the conductivity with a tester.	1) There should be no abnormalities. 2) Within ±10 % of the resistance of the braking resistor

Inspection location		Inspection item	Inspection method	Criteria
Control circuit	PCBs	1) Are there any loose screws or connectors? 2) Are there any abnormal odors or discoloration? 3) Are there any cracks, damage, deformation, or significant rust? 4) Is there any electrolyte leakage or signs of deformation in the capacitors?	1) Retighten 2) Olfactory and visual inspection 3), 4) Visual inspection * Judgment on service life using “Menu number 5 Maintenance Information” in Chapter 3, Section 3.4.5.	1), 2), 3), 4) There should be no abnormalities.
Cooling system	Cooling fans	1) Is there any catching or abnormal vibration? 2) Is there any bolt looseness? 3) Is there any discoloration due to overheating?	1) Turn by hand. (Be sure to turn the power OFF beforehand.) 2) Retighten 3) Visual inspection * Judgment on service life using “Menu number 5 Maintenance Information” in Chapter 3, Section 3.4.5.	1) The fan should rotate smoothly. 2), 3) There should be no abnormalities.
	Ventilation route	Is there any cooling fin, air intake, or exhaust port clogging or foreign material adhesion?	Visual inspection	There should be no clogging or accumulation of dust, dirt or foreign materials. Clean it, if any, with a brush or air gun.

7.3.2 Periodic inspection 2 (When the inverter is ON or it is running)

Visually inspect the inverter for operation errors from the outside without removing the covers when the inverter is running or the power is ON.
Perform periodic inspections according to the items listed in Table 7.3-2 Periodic inspection list 2.

Table 7.3-2 Periodic inspection list 2

Inspection location		Inspection item	Inspection method	Criteria
Voltage		Is the main circuit and control circuit voltage normal?	Measure with a device such as a tester.	The standard specifications should be satisfied.
Structural parts such as frames, covers		Is there any abnormal noise or excessive vibration when the inverter is in operation?	Auditory and visual inspections.	There should be no abnormalities.
Main circuit	Transformers, reactor	Are there any abnormal buzzing sounds or abnormal odors when the inverter is in operation?	Auditory, visual, and olfactory inspection	There should be no abnormalities.
Main circuit	Magnetic contactors, relays	Are there any chattering sounds when the inverter is r in operation?	Auditory inspection	There should be no abnormalities.
Main circuit	Smoothing capacitors	Measure the capacitance if necessary.	* Judgment on service life using “Menu number 5 Maintenance Information” in Chapter 3, Section 3.4.5.	Capacitance ≥ Initial value x 0.85
Cooling fans		Is there any abnormal noise or excessive vibration when the cooling fans are in operation?	Auditory and visual inspections	There should be no abnormalities.

* For details, refer to Chapter 3 “3.4.5 Reading maintenance information: “Maintenance Information: 5.CHE”.”

[Supplementary information]

(1) The inspection interval (every year) of check items given in Table 7.3-1 and Table 7.3-2 is merely a guide. Make the interval shorter depending on the usage environment.

(2) Store and organize the inspection results to utilize them as a guide for operation and maintenance of the equipment and service life estimation.

(3) At the time of an inspection, check the cumulative run times on the keypad to utilize them as a guide for replacement of parts.
(For details, refer to “7.4.1 Judgment on service life.”)

(4) The inverter has cooling fans inside to ventilate itself for discharging the heat generated by the power converter section. This will accumulate dust or dirt on the heat sink depending on the ambient environment.

In a dusty environment, the heat sink requires cleaning in a shorter interval than that specified for periodic inspections. Neglecting cleaning of the heat sink can raise its temperature, activating protective circuits and leading to an abrupt shutdown or causing the temperature rise of the surrounding electronic devices to adversely affect their service life.

7.4 List of Periodic Replacement Parts

Each part of the inverter has its own service life that will vary according to the environmental and operating conditions. It is recommended that the following parts be replaced at the specified intervals indicated in Table 7.4-1. When the replacement is necessary, consult your Fuji Electric representative.

Table 7.4-1 Replacement parts

Part name	Standard replacement intervals (Note 1)	Replacement method, other
	HHD/HND/HD/ND modes	
DC link bus capacitor	10 years (Note 2)	-
Electrolytic capacitors on PCBs	10 years (Note 2)	PCB replacement
Cooling fans	10 years (Note 2)	—
Waterproof gasket	10 years (Note 2)	—
Contact output [30 A/B/C]	—	200,000 times (250 VAC, 0.3 A COSφ = 0.3 or, 48 VDC, 0.5 A (with resistive load))
Charging resistance short circuit 73X	—	100,000 times (if power turned ON within once an hour)
IGBT	—	For details, refer to “7.4.1 Judgment on service life.”

(Note 1) The estimated life expectancy is calculated based on the following conditions for each inverter specification. In environments with an ambient temperature above 40 °C (104 °F) or a large amount of dust or dirt, the standard replacement interval may be shorter.

HHD mode: Inverter ambient temperature: 40 °C (104 °F), load factor: 100% (For models up to FRN0020E3☐-2G/7G capacity, and models up to FRN0012E3☐-4G capacity: 80%)

HND/HD/ND mode: Inverter ambient temperature: 40 °C (104 °F), load factor: 80%

(Note 2) Replace every 7 years when using these models in the following modes:

- FRN0012, 0020E3☐-2G and FRN0007, 0012E3☐-4G in HND mode
- FRN****E3☐-4G in ND mode
- FRN****E3☐-7G in HND mode.

Pay attention to the following items.

(1) The replacement intervals listed above are a guide for preventing parts from most failures if those parts are replaced with new ones at the listed intervals. They do not guarantee completely fault-free operation.

(2) Table 7.4-1 does not apply to unused spare parts being kept in storage.
It applies only when they are stored under the temporary and long-term storage conditions given in Chapter 1 “1.3.2 Storage environment” and energized approximately once a year.

(3) Cooling fans and waterproof gaskets can be replaced by users. For details, refer to the maintenance-related documents (not included in this Manual). As for other parts, only the persons who have finished the Fuji Electric training course can replace them. For the purchase of spare cooling fans and the request for replacement of other parts, contact the sales agent where you purchased the product or your nearest Fuji Electric representative.

7.4.1 Judgment on service life

The inverter has a life prediction function for some parts which predicts the service life of those parts based on their usage, and judges whether those parts are approaching the end of their service life. The predicted values should be used only as a guide since the part life is influenced by the surrounding temperature and its usage environment. (For details, refer to Chapter 3 "3.4.5 Reading maintenance information: "Maintenance Information: 5.CHE ".")

In the case of the Ethernet built-in type (E3N), you can get the predicted values with the function codes for communication.

Table 7.4-2 Life prediction

Part	Prediction method	End-of-life criteria	Prediction timing	Keypad "5: MAINTENANCE" on the LED monitor
DC link bus capacitor	Measurement of discharging time The discharging time of the DC link bus capacitor when the main power is turned OFF is measured, and the capacity is calculated.	85% or lower than initial capacitance at time of shipping	At periodic inspection H98: bit 3 = 0	5_05 (Rated capacity)
		85% or lower than DC link bus capacitor capacitance (necessary to measure at startup) under normal user operating conditions.	During ordinary operation H98: bit 3 = 1	5_05 (Rated capacity)
	Main power supply ON time count The time elapsed when the voltage is applied to the DC link bus capacitor (the time that the main power supply is ON) is counted. Furthermore, the time is corrected based on the capacity measurement.	When 87,600 hours (10 years) or 61,320 hours (7 years) of operation has been exceeded (Note 1: Based on replacement intervals listed in Table 7.4-1)	During ordinary operation	5_26 (Elapsed time) 5_27 (Remaining time)
Electrolytic capacitors on PCBs	The time elapsed when the voltage is applied to the capacitors is counted. Furthermore, the time is corrected based on the ambient temperature.	When 87,600 hours (10 years) or 61,320 hours (7 years) of operation has been exceeded (Note 1: Based on replacement intervals listed in Table 7.4-1)	During ordinary operation	5_06 (Run time)
Cooling fans	The cooling fan run time is counted.	When 87,600 hours (10 years) or 61,320 hours (7 years) of operation has been exceeded (Note 1: Based on replacement intervals listed in Table 7.4-1)	During ordinary operation	5_07 (Run time)
IGBT	The IGBT life expectancy is estimated based on changes in IGBT temperature.	The system determines that the end-of-life has been reached when the estimated IGBT life expectancy drops to below 10% of the designed service life.	During ordinary operation H83: bit 13 = 1	5_58 (Estimated IGBT life expectancy)

The service life of the DC link bus capacitor can be judged by "**(1) Measurement of discharging time**" or "**(2) Main power supply ON time count**."

(1) Measurement of discharging time

- The discharging time of the DC link bus capacitor depends largely on the inverter's internal load conditions, e.g., options installed or ON/OFF of digital I/O signals. If different from the initial values of the load conditions subject to comparison (excl. terminals [EN1], [EN2]), it will not be possible to obtain accurate measurements, and therefore measurement is not performed.
- When connecting a converter, or when connecting a DC common to another inverter, measurement is not performed.
- The capacitance measuring conditions at shipment are limited to the conditions that stabilize the load. Those conditions are, therefore, different from the actual operating conditions in almost all cases. If conditions are the same as the factory default conditions (excl. terminals [EN1], [EN2]), the discharge time is automatically measured when the power is turned OFF. However, the time will not be automatically measured if the conditions are different. In such a case, during periodic inspections, return the conditions to the factory default values, then turn OFF the inverter. Measurement is then performed automatically.

  For details, refer to "[1] Measuring the capacitance of the DC link bus capacitor in comparison with the initial value at the time of shipment."

Note When the inverter uses a control power auxiliary input (including the "external 24 V power supply input" for the E3N type), the load conditions widely differ so that the discharging time cannot be accurately measured.

In this case, measurement of the discharging time can be disabled with function code H98 (bit 4 = 0) for preventing unintended measurement.

- To measure the capacitance of the DC link bus capacitor under ordinary operating conditions when the power is turned OFF, it is necessary to match the DC link bus capacitor measurement conditions to the load conditions for ordinary operation when the power is OFF, and measure the reference capacitance (initial setting).

  For details, refer to "[2] Measuring the capacitance of the DC link bus capacitor under ordinary operating conditions."

  However, even with the above settings, setting bit 3 of H98 data to "0" restores the settings to compare with the capacitance at the time of shipment.

(2) Main power supply ON time count

- In a machine system where the inverter main power is rarely shut down, the inverter does not measure the discharging time. For this reason, a function is also provided to count the length of time that voltage is applied to the DC link bus capacitors (main power supply ON time) in order to determine the capacitor life expectancy. (The display shows the elapsed time "5_26" and lifetime remaining "5_27." For details, refer to the "DC link bus capacitor" field in Table 7.4-2.)

[1] Measuring the capacitance of the DC link bus capacitor in comparison with the initial value at the time of shipment

The measuring procedure given below measures the capacitance of the DC link bus capacitor in comparison with the initial value at the time of shipment. The measurement result is displayed on the keypad as a ratio (%) of the initial capacitance.

---------------- Capacitance measuring procedure (Measurement conditions at the time of shipment) -----------------

Note: For the Ethernet built-in type (E3N), please replace all parts marked by (*) in the following explanation with the content in the table below. (This is because the conditions for measurement of discharging time of the DC link bus capacitor differ from other types.)

Differences in measurement conditions/items

Condition/item	Basic type/EMC filter built-in type (E3S/E3E)	Ethernet built-in type (E3N)
Control circuit terminal input/output	[FWD], [REV], [X1] to [X5]/[Y1], [Y2]	[FWD], [REV], [X1] to [X3]/[Y1]
Auxiliary control power input terminals	[R0], [T0] (only for FRN0088/0115E3☐-2G and FRN0059/0072E3☐-4G)	[P24], [N24] (all capacities) [R0], [T0] (only for FRN0088/0115E3☐ -2G and FRN0059/0072E3☐-4G)
Keypad	Keypad (TP-M3)	Replacement not required (no keypad)
Option cards	Remove before measuring	Removal not required (not installed)
LED display during measurement	Displays 4 dots [....]	Displays 2 dots [..]

1) To ensure validity in the comparative measurement, put the condition of the inverter back to the values at the time of shipment.
   - Remove the option card (if using) from the inverter. (*)
   - In case another inverter is connected via the DC link bus to the main circuit terminals [P(+)] and [N(-)], disconnect the wires.
     It is not required to disconnect the DC reactor (optional), if any.
   - Disconnect the control power auxiliary input terminals ([R0], [T0]). (*)
   - Disconnect the USB cable.
   - Install the keypad (TP-M3). (*)
     If the keypad has been replaced with the remote keypad (TP-E2) or the multi-function keypad (TP-A2SW) (option) after purchasing the inverter, reconnect the TP-M3.
   - Turn OFF all the digital input terminals [FWD], [REV], and [X1] to [X5] (for Ethernet built-in type: [FWD], [REV], and [X1] to [X3]) of the control circuit terminal. (*)
   - If a potentiometer is connected to terminal [13], disconnect it.
   - If an external apparatus is attached to terminal [PLC], disconnect it.
   - Set transistor output terminals [Y1] to [Y2] (*) (for Ethernet built-in type: [Y1] only) and relay output terminals [30 A/B/C] so that they do not turn ON.

   Note: If negative logic is specified for the transistor output and relay output signals, output is considered ON even when the inverter is not running. Specify positive logic for them.

   - Keep the ambient temperature within 25 °C ±10 °C.
2) Turn ON the main power supply.
3) Confirm that the cooling fan is rotating and the inverter is stopped. Disable the cooling fan ON/OFF control (H06 = 0).
4) Turn OFF the main power supply.
5) The inverter automatically starts the measurement of the capacitance of the DC link bus capacitor. Make sure that “. . . . ” (*) appears on the LED monitor.

   Note: If “ . . . . . ” (*) does not appear on the LED monitor, the measurement has not started. Check the conditions listed in 1).

6) After “. . . . ” has disappeared from the LED monitor, turn ON the main power supply again.
7) Select Menu number 5 “Maintenance Information” in Programming mode and note the reading (relative capacitance (%) of the DC link bus capacitor). (For the Ethernet built-in type (E3N), check function code W75 via Ethernet communication.)

----

[2] Measuring the capacitance of the DC link bus capacitor under ordinary operating conditions

In order to measure the capacitance of the DC link bus capacitor under ordinary operating conditions when the power is turned OFF, set the measurement conditions and measure the reference capacitance (initial value) using the procedure below.

Perform measurement immediately after purchasing the inverter (after test run), or immediately after replacing the DC link bus capacitor.

------------------------------------- Measurement procedure under ordinary operating conditions -----------------------------

Note For the Ethernet built-in type (E3N), please replace all parts marked by (*) in the following explanation with the content in the table below. (This is because the conditions for measurement of discharging time of the DC link bus capacitor differ from other types.)

Differences in measurement conditions/items

Condition/item	Basic type/EMC filter built-in type type (E3S/E3E)	Ethernet built-in type (E3N)
Control circuit terminal input/output	[FWD], [REV], [X1] to [X5]/[Y1], [Y2]	[FWD], [REV], [X1] to [X3]/[Y1]
LED display during measurement	Displays 4 dots [....]	Displays 2 dots [..]

1) Set function code H98 (Judgment criteria for the service life of the DC link bus capacitor) to user settings (bit 3 = 1).
2) Stop running the inverter.
3) Make the inverter ready to be turned OFF under ordinary operating conditions.
4) Set both function codes H42 (Capacitance of DC link bus capacitor) and H47 (Initial capacitance of DC link bus capacitor) to "0."
5) Turn OFF the inverter, and the following operations are automatically performed.

   The inverter measures the discharging time of the DC link bus capacitor and saves the result in function code H47 (Initial capacitance of DC link bus capacitor).

   DC link bus capacitor measurement conditions (ON/OFF status of terminals [X1 to X5], [Y1 to Y2] (*) (For Ethernet built-in type: [X1 to X5], [Y1]), whether inverter is equipped with option card or keypad) are automatically detected and saved.
   During measurement, "....." (*) appears on the LED monitor.
6) Turn ON the inverter again.

   Ensure that function code H42 (Capacitance of DC link bus capacitor) and H47 (Initial capacitance of DC link bus capacitor) values are appropriate.
   In Programming Mode, move to Menu number 5 "Maintenance Information," and ensure that the electrostatic capacity ratio (%) of the DC link bus capacitor is 100%. (For the Ethernet built-in type (E3N), check function code W75 via Ethernet communication.)

Note If the measurement has failed, "1" is set for both H42 and H47. Eliminate the cause of the failure and conduct the measurement again.

Hereafter, each time the inverter is turned OFF, the DC link bus capacitor discharge time is automatically measured if the above conditions are met. Periodically check the electrostatic capacity ratio (%) of the DC link bus capacitor with Menu number 5 "Maintenance Information" in Programming mode.

Note The measurement procedure given above tends to produce a rather large measurement error. If this mode gives you a Lifetime early warning, revert H98 (Judgment criteria for the service life of the DC link bus capacitor) to the default setting (bit 3 = 0) and conduct the measurement again under the conditions at the time of factory shipment.

[3] Lifetime early warning output function

For the components listed in Table 7.4-2, the inverter can issue a lifetime early warning output signal from the transistor output terminals [Y1] to [Y2] (For Ethernet built-in type: [Y1] only) and relay output terminals [30 A/B/C] as soon as their respective end-of-life criteria have been met. If even one of these components exceeds the criteria, an ON signal is output.

7.5 Measuring the Amount of Electricity in the Main Circuit

Because the voltage and current of the input (primary) circuit and output (secondary) circuit of the inverter's main circuit contain harmonic components, the readings may vary with the type of the meter. Use meters indicated in Table 7.5-1 when measuring with instruments for commercial frequencies.

The power factor cannot be measured by a commercially available power factor meter that measures the phase difference between the voltage and current. To obtain the power factor, measure the power, voltage and current on each of the input and output sides and use the following formula.

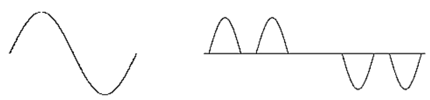
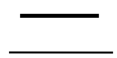
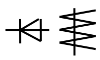
■ Three-phase input

$$\text{Power factor} = \frac{\text{Power (W)}}{\sqrt{3} \times \text{voltage (V)} \times \text{current (A)}} \times 100\ (\%)$$

■ Single-phase input

$$\text{Power factor} = \frac{\text{Power (W)}}{\text{Voltage (V)} \times \text{current (A)}} \times 100\ (\%)$$

Table 7.5-1 Meters for main circuit measurement

Item	Input (primary) side			Output (secondary) side			DC link bus voltage (between P(+) and N(-))
Waveform	Voltage Current 			Voltage Current 			
Name of meter	Ammeter AR, AS, AT	Voltmeter VR, VS, VT	Wattmeter WR, WT	Ammeter AU, AV, AW	Voltmeter VU, VV, VW	Wattmeter WU, WW	DC voltmeter V
Type of meter	Moving iron type	Rectifier or moving iron type	Digital AC power meter	Digital AC power meter	Digital AC power meter	Digital AC power meter	Moving coil type
Symbol of meter			—	—	—	—	

Note If measuring the output current with a moving iron type meter, and the output voltage with a rectifier type meter, an error may occur. Furthermore, there is also a risk of meter burnout. To measure with greater accuracy, the use of a digital AC power meter is recommended.

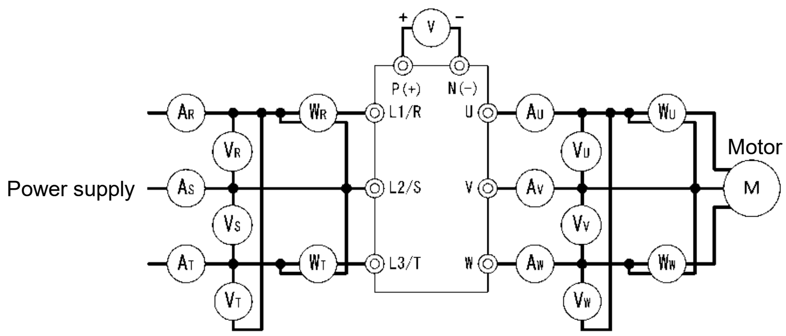


Fig. 7.5-1 Connection of meters

7.6 Insulation Test

Since the inverter has undergone an insulation test before shipment, avoid making a Megger test.

If a Megger test is unavoidable for the main circuit, observe the following instructions; otherwise, the inverter may be damaged.

As with the Megger test, performing a withstand voltage test incorrectly may damage the product. When the withstand voltage test is necessary, consult your Fuji Electric representative.

7.6.1 Megger test of main circuit

1) Use a 500 VDC megohmmeter, and be sure to measure with the main power turned OFF.
2) If the test voltage will also apply to the control circuit due to the way in which the system is wired, disconnect all connections to the control circuit.
3) Connect the main circuit terminals with the common wire as shown in Fig. 7.6-1. (terminals [R0], [T0] are only for FRN0088/0115E3☐-2G and FRN0059/0072E3☐-4G)
4) Perform the Megger test only across the main circuit common wire and the ground (⏚).
5) The result is normal if the megohmmeter reads 5 MΩ or higher. (The value is measured on the inverter alone.)

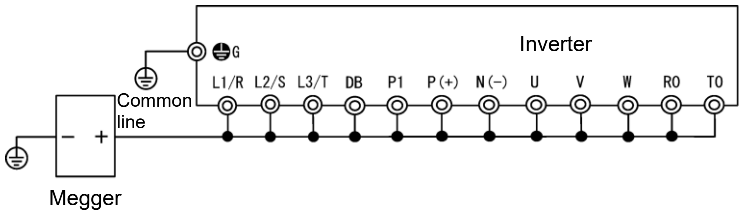


Fig. 7.6-1 Main circuit terminal connection for Megger test

7.6.2 Insulation test of control circuit

Do not conduct a Megger test or withstand voltage test for the control circuit. Use a high resistance range tester for the control circuit.

1) Disconnect all wiring from the control circuit terminals.
2) Perform a continuity test to the ground. The result is normal if the reading is 1 MΩ or higher.

7.6.3 Insulation test of external main circuit and sequence control circuit

Disconnect all the wiring connected to the inverter so that the test voltage is not applied to the inverter.

7.7 Product Inquiries and Warranty

7.7.1 Inquiry request

If necessary to make an inquiry relating to such aspects as product failure or damage, or anything that is in doubt, please notify Fuji Electric of the following.

(1) Inverter type. (For details, refer to Chapter 1 "1.1 Acceptance Inspection (Nameplates and Inverter Type).")

(2) SER No. (serial number of equipment). (For details, refer to Chapter 1 "1.1 Acceptance Inspection (Nameplates and Inverter Type).")

(3) Function codes data that has been changed from factory defaults. (For details, refer to Chapter 3 "3.4.2 Checking changed function codes: "Data Checking: 2.rEP"." However, for the Ethernet built-in type (E3N), use the inverter support software "FRENIC-Loader" to check.)

(4) ROM version. (For details, refer to the maintenance item 5_14 in Chapter 3 "3.4.5 Reading maintenance information: "Maintenance Information: 5.CHE"." However, for the Ethernet built-in type (E3N), check function code W87 via Ethernet communication.)

(5) Date of purchase

(6) Details of inquiry (for example, point and extent of breakage, uncertainties, defects, and other circumstances)

7.7.2 Product warranty

To all our customers who purchase the Fuji Electric products included in this documentation:

<u>Please take the following items into consideration when placing your order.</u>

When requesting an estimate and placing your orders for the products included in these materials, please be aware that unless otherwise specified in the estimate, contract, catalog, specifications or other materials, the following will apply.

In addition, the products included in these materials are limited in their application, the places where they can be used, etc., and may require periodic inspection. Please confirm these points with your sales representative or directly with Fuji Electric.

Furthermore, regarding purchased products and delivered products, we request that you take adequate consideration of the necessity of prompt inspection upon reception, and of product management and maintenance even before receiving your products.

[1] Free of charge warranty period and warranty range

(1) Free of charge warranty period

1) The product warranty period is "1 year from the date of purchase" or 24 months from the manufacturing date imprinted on the Main nameplate, whichever date is earlier.
2) However, in cases where the usage environment, conditions of use, frequency and times used, etc., have an effect on product life, this warranty period may not apply.
3) Furthermore, the warranty period for parts restored by Fuji Electric's Service Department is "6 months from the date that repairs are completed."

(2) Warranty range

1) In the event that a breakdown which is the responsibility of Fuji Electric occurs during the product's warranty period, Fuji Electric will replace or repair the part of the product that has broken down free of charge at the place where the product was purchased or where it was delivered. However, in the following cases, the terms of this warranty may not apply.
   (i) The failure was caused by inappropriate conditions, environment, handling, usage methods, etc., which are not specified in the catalog, instruction manual, specifications, or other relevant documents.
   (ii) The failure was caused by some reason other than the purchased or delivered Fuji Electric product.
   (iii) The failure was unrelated to a Fuji Electric product, such as a problem with the design of the customer's equipment or software.
   (iv) The failure was caused by running a program other than that supplied by Fuji Electric for a programmable Fuji Electric product, or as a result of using such a program.

(v) The failure was caused by disassembly, modifications, or repairs carried out by a party other than Fuji Electric.

(vi) The failure was caused by a failure to properly maintain or replace the consumable parts, etc. specified in the instruction manual or catalog, etc.

(vii) The failure was caused by a reason that could not be foreseen given the science or technology in practical application at the time the product was purchased or delivered.

(viii) The product was not used in the manner in which it was originally intended to be used.

(ix) The failure was caused by a reason for which Fuji Electric holds no responsibility, such as natural or other disaster.

2) Furthermore, the warranty specified herein shall be limited solely to the purchased or delivered product.

3) The upper limit for the warranty scope shall be as specified in item 1) above, and any damages (damage to or loss of machinery or equipment, or lost profits from the same, etc.) consequent to or resulting from a failure of the purchased or delivered product shall be excluded from coverage by this warranty.

(3) Trouble diagnosis

As a rule, the customer is requested to carry out a preliminary trouble diagnosis. However, at the customer's request, Fuji Electric or its service network can perform the trouble diagnosis for a fee. In this case, the customer is asked to assume the burden for charges levied in accordance with Fuji Electric's fee regulations.

[2] Exclusion of liability for loss of opportunity, etc.

Regardless of whether a failure occurs during or after the free of charge warranty period, Fuji Electric shall not be liable for any loss of opportunity, loss of profits, or damages arising from special circumstances, secondary damages, accident compensation to another company, or damages to products other than Fuji Electric's products, whether foreseen or not, which Fuji Electric is not responsible for causing.

[3] Repair period after production stoppage, spare parts supply period (maintenance period)

With regards to models (products) which have gone out of production, Fuji Electric shall carry out repairs for a period of 7 years following production stoppage, from the month and year when the production stoppage occurs. In addition, Fuji Electric shall continue to supply the spare parts required for repairs for a period of 7 years, from the month and year when the production stoppage occurs. However, if it is estimated that the life cycle of certain electronic and other parts is short and it will be difficult to procure or produce those parts, there may be cases where it is difficult to provide repairs or supply spare parts even within this 7-year period. For details, please confirm with the Fuji Electric business office or our service office.

[4] Delivery conditions

The product delivered and handed over to the customer shall be the standard product for which no application configurations or adjustments have been made, and Fuji Electric accepts no responsibility for any on-site adjustments or test runs.

[5] Service description

The price of the purchased or delivered product does not include service costs such as those required for dispatching technicians and so on. Fuji Electric will be more than happy to discuss this further upon request.

[6] Applicable scope of service

Above contents shall be assumed to apply to transactions and use of the country where you purchased the products.

Consult the local supplier or Fuji for details separately.

Chapter 8
BLOCK DIAGRAMS FOR CONTROL LOGIC

This chapter describes the main block diagrams of the control section.

The main block diagrams of the control section are divided into 2 groups: the Basic type/EMC filter built-in type (E3S/E3E), and the Ethernet built-in type (E3N).

Contents

The high-performance, standard inverter FRENIC-Ace is provided with various functions that allow operations to meet the application requirements. For details of each function code, refer to Chapter 5 “FUNCTION CODES.”

Function codes are mutually related and priority order is given depending on the function codes and data thereof.

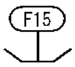
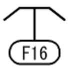
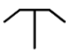
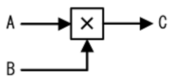
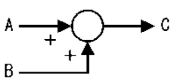
This chapter shows major internal control block diagrams. Understand the diagrams together with the explanation of each function code to correctly set up each function code.

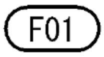
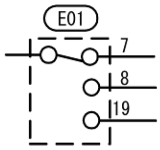
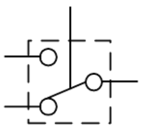
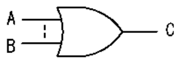
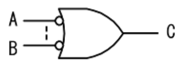
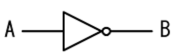
Note that the internal control block diagrams show only the function codes mutually related. For function codes which operate individually and explanations of each function code, refer to Chapter 5 “FUNCTION CODES.”

8.1 Meanings of Symbols Used in the Control Block Diagrams

This section explains major codes, with examples, used in the block diagrams shown in the sections that follow.

Table 8.1-1 Codes and meanings

Symbol	Meaning
[FWD], [Y1], etc.	These symbols denote general-purpose input/output terminals of the inverter control circuit terminal blocks.
“FWD”, “REV”, etc.	These symbols denote control signals (input) or status signals (output) allocated to the control circuit terminals.
	This is a low-pass filter. Time constant is changeable based on function code data.
SET FREQUENCY	This symbol denotes control command used inside the inverter.
	This indicates upper limiter. This limits an upper limit value by function code setting or a constant.
	This indicates lower limiter. This limits a lower limit value by function code setting or a constant.
 “0”	This is a 0 (zero) limiter. This prevents data from becoming negative.
	This denotes a gain multiplier for a reference frequency, analog output signal, etc., given by a current or a voltage, calculated by C = A x B.
	This denotes an adder of two signals or amounts, calculated by C = A + B. This becomes a subtracter when B is a minus sign, calculated by C = A - B.

Symbol	Meaning
	This denotes a function code.
	This indicates a switch controlled by a function code. Numbers of switch terminals indicate function code data.
LINK OPERATION SELECTION [LE] 	This indicates a switch controlled by an internal function control command. The example on the left indicates a link operation selection command “LE” allocated to a digital input terminal.
	This denotes a logical sum (OR) circuit. In the case of positive logic, when any one of inputs is ON, C=ON, and when all inputs are OFF, C=OFF.
	This denotes an NOR (NOR-OR) circuit. In the case of positive logic, when any one of inputs is OFF, C=ON, and when all inputs are ON, C=OFF.
	This denotes a conjunction (AND) circuit. In the case of positive logic, C=ON only when A=ON and B=ON, ; under other conditions, C=OFF.
	This denotes a logical negation (NOT) circuit. In the case of positive logic, when A = ON, B = OFF, and when A = OFF, B = ON.

8.2 Basic type/EMC filter built-in type (E3S/E3E)

8.2.1 Frequency Setting Section

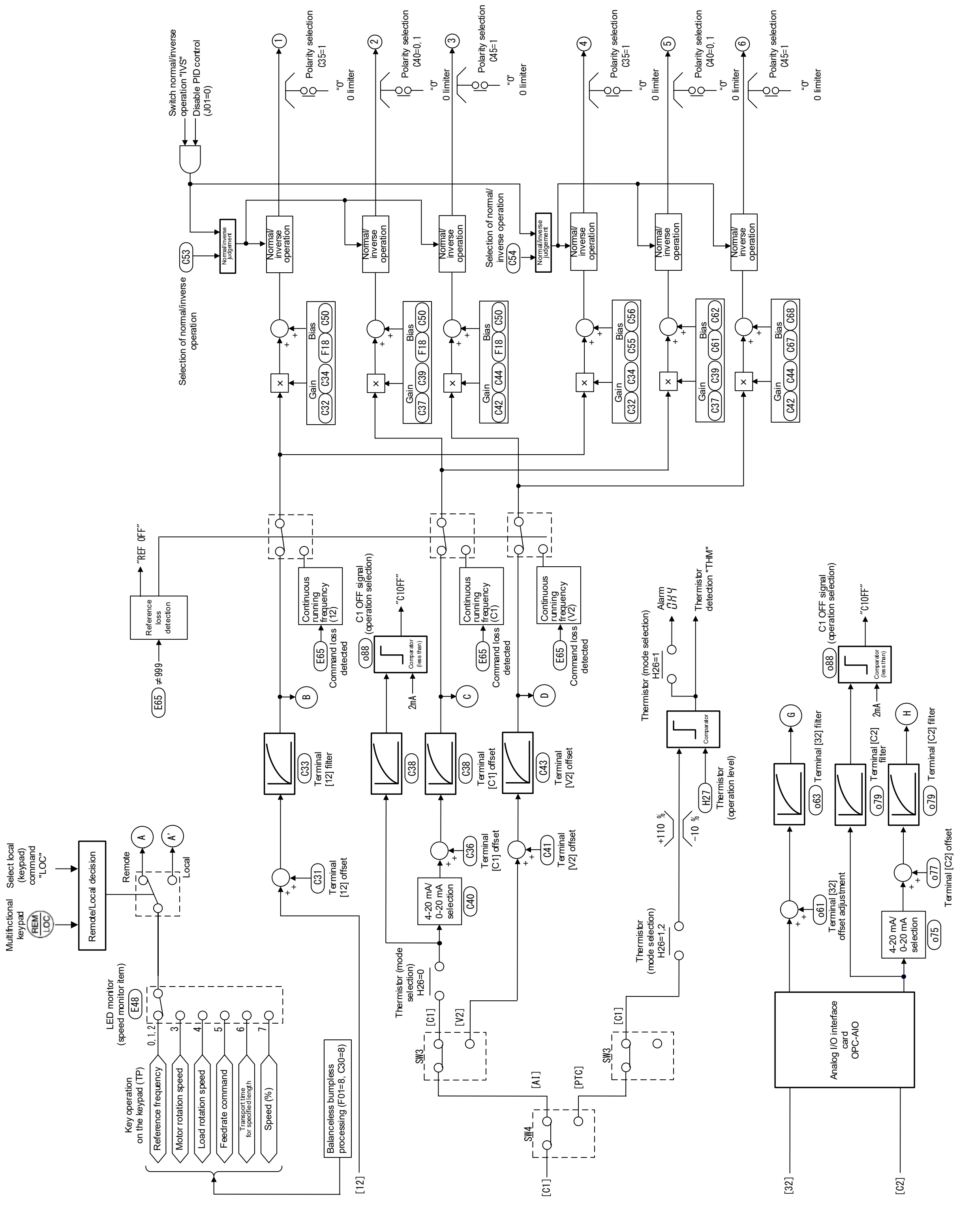
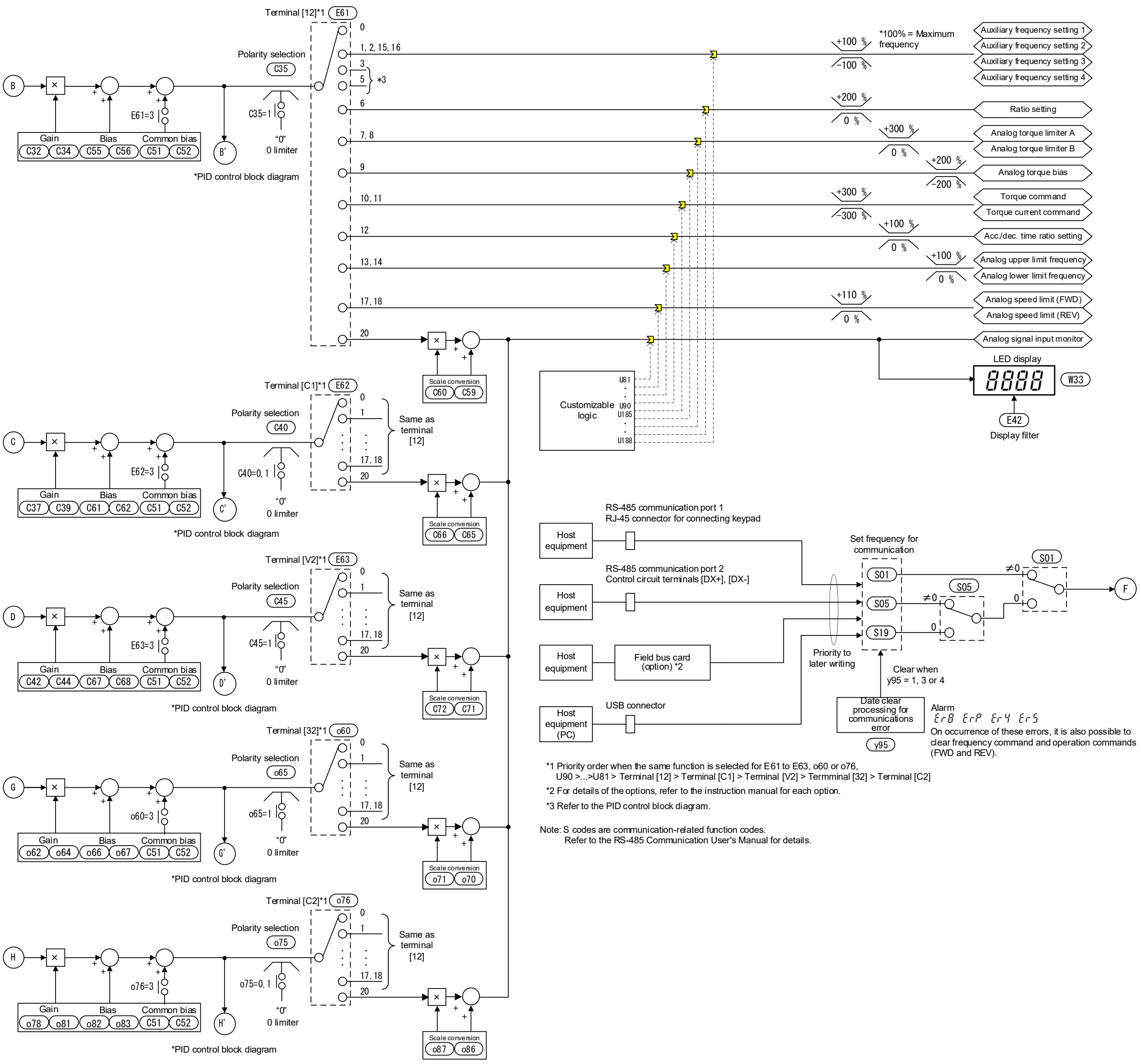


Fig. 8.2-1 Frequency setting section block diagram



*1 Priority order when the same function is selected for E61 to E63, o60 or o76, U90 >...>U81 > Terminal [12] > Terminal [C1] > Terminal [V2] > Termminal [32] > Terminal [C2]

*2 For details of the options, refer to the instruction manual for each option.

*3 Refer to the PID control block diagram.

Note: S codes are communication-related function codes.
Refer to the RS-485 Communication User's Manual for details.

Fig. 8.2-2 Frequency setting section block diagram

Chap 8 BLOCK DIAGRAMS FOR CONTROL LOGIC

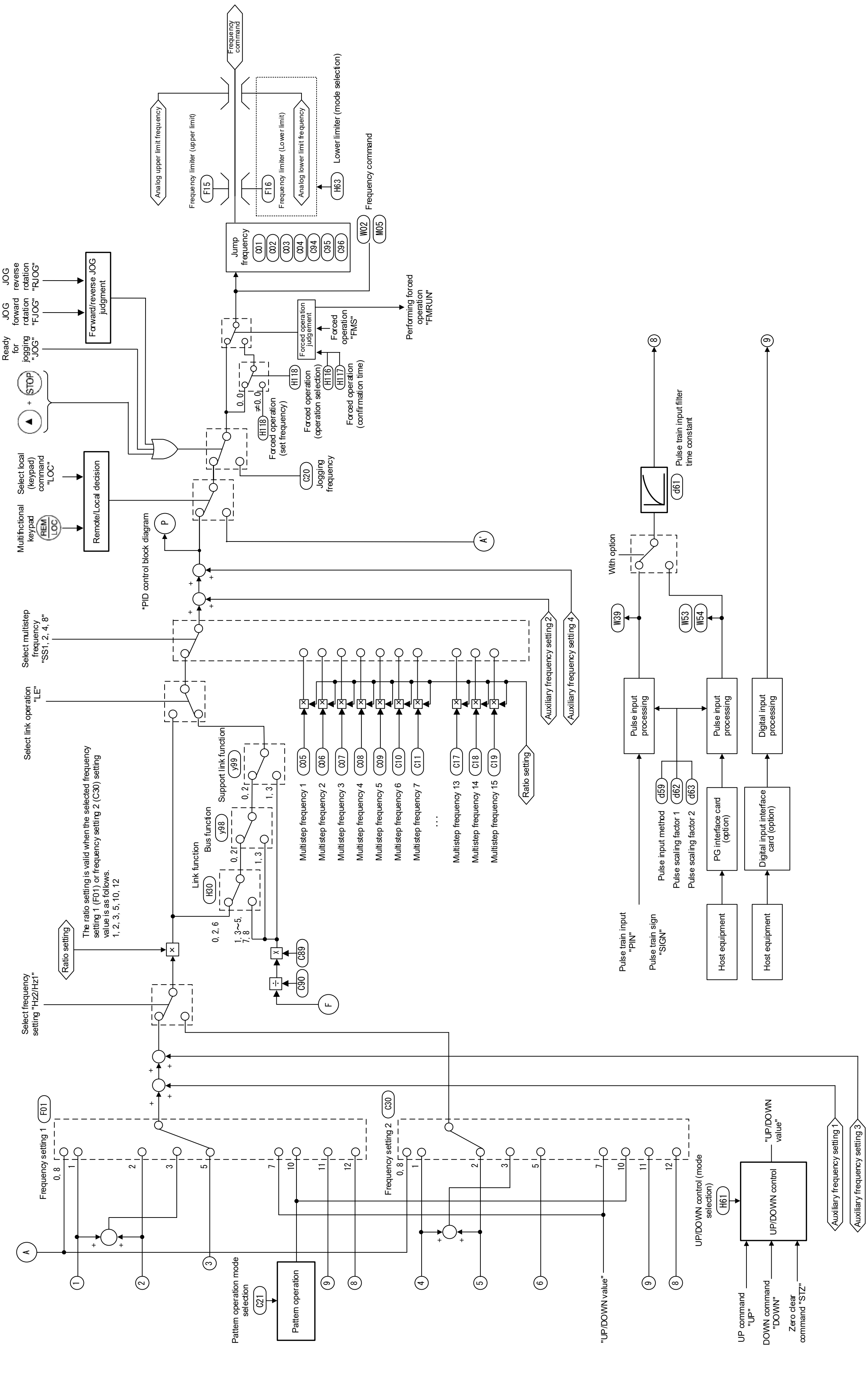
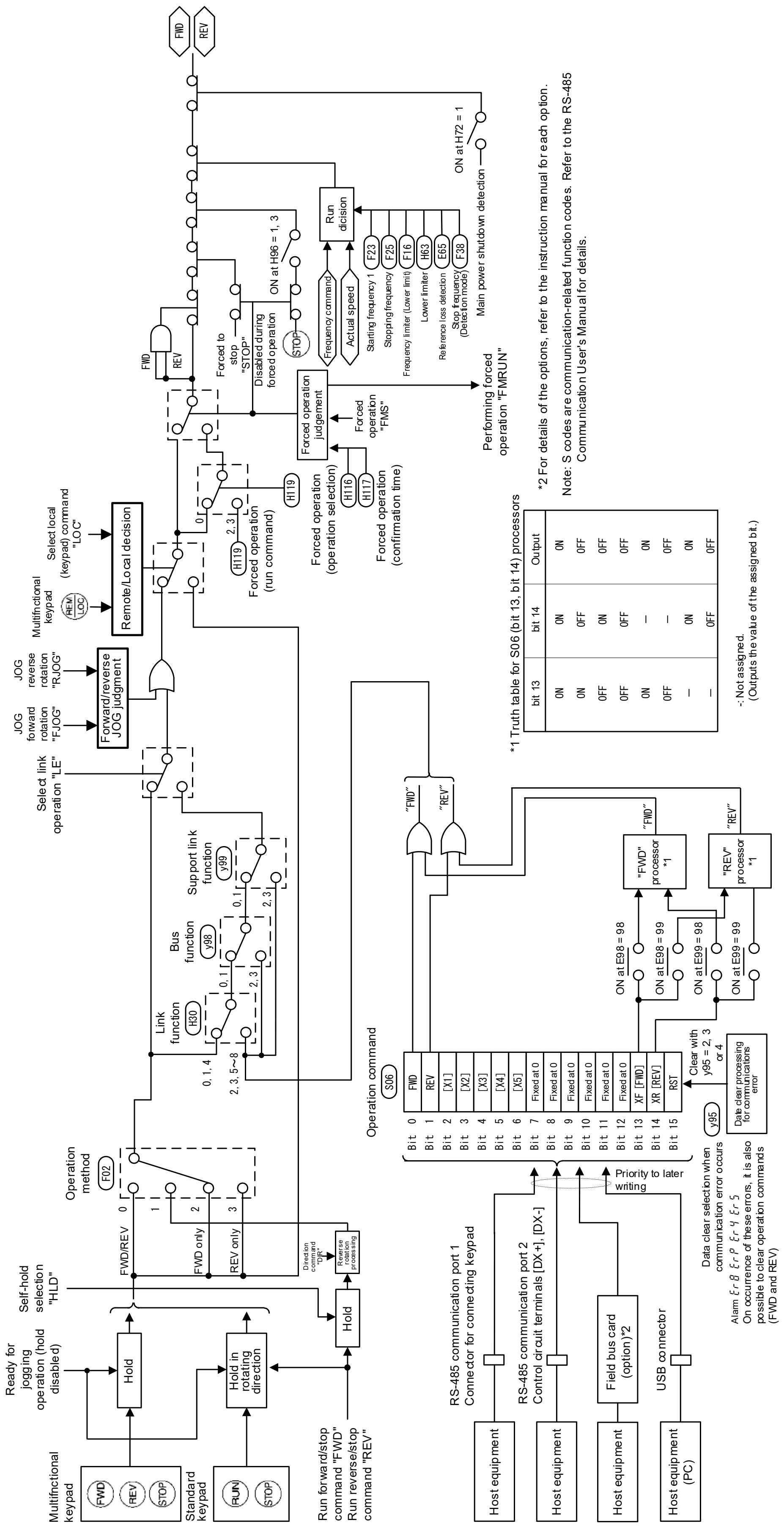


Fig. 8.2-3 Frequency setting section block diagram

8.2.2 Operation Command Section



bit 13	bit 14	Output
ON	ON	ON
ON	OFF	OFF
OFF	ON	OFF
OFF	OFF	OFF
ON	–	ON
OFF	–	OFF
–	ON	ON
–	OFF	OFF

-: Not assigned. (Outputs the value of the assigned bit.)

*2 For details of the options, refer to the instruction manual for each option.

Note: S codes are communication-related function codes. Refer to the RS-485 Communication User's Manual for details.

Fig. 8.2-4 Operation command section block diagram

Chap 8 BLOCK DIAGRAMS FOR CONTROL LOGIC

8.2.3 PID Control Section (for Processing)

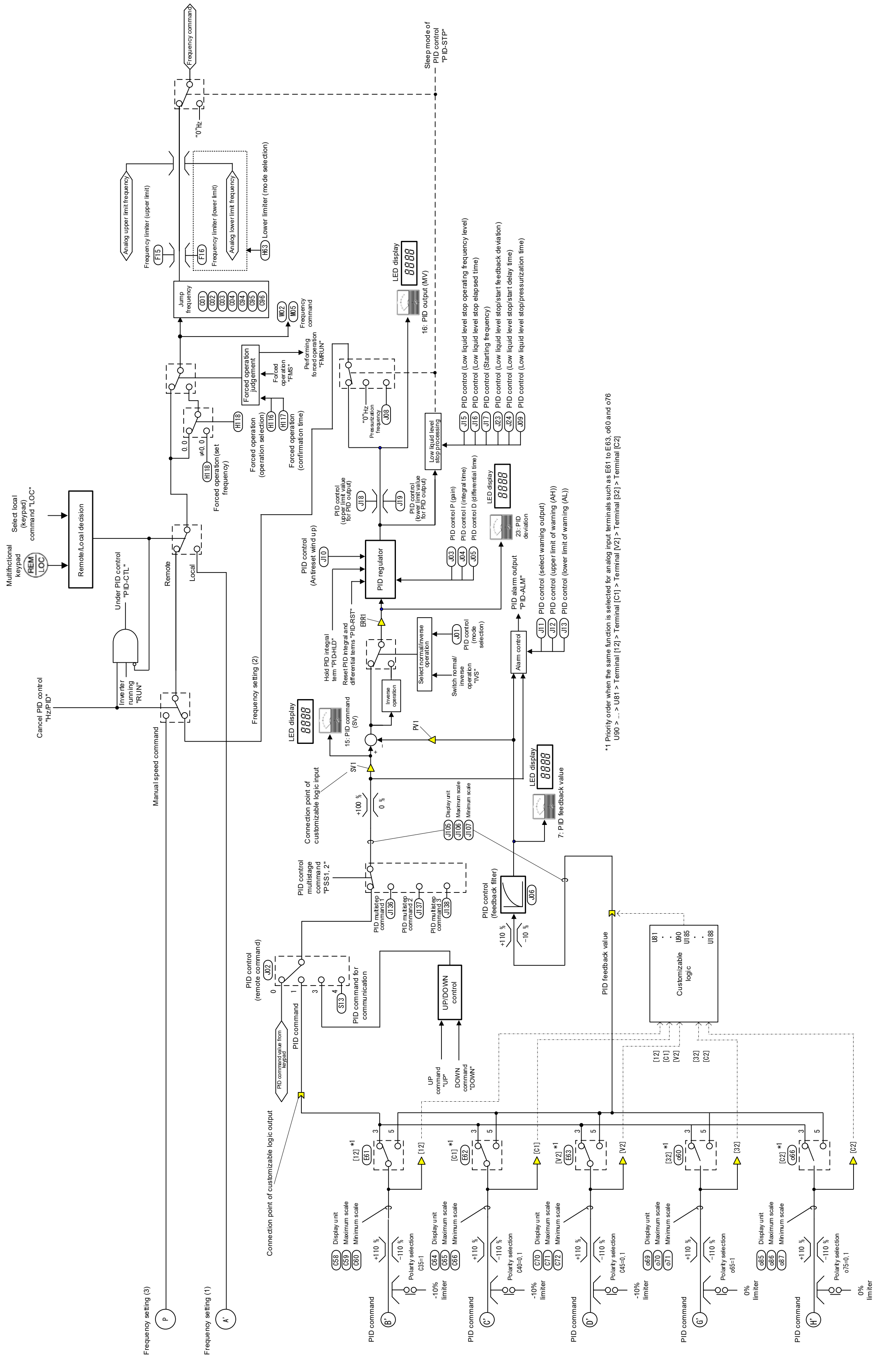


Fig. 8.2-5 PID control section (for processing) block diagram

8.2.4 PID Control Section (for Dancer)

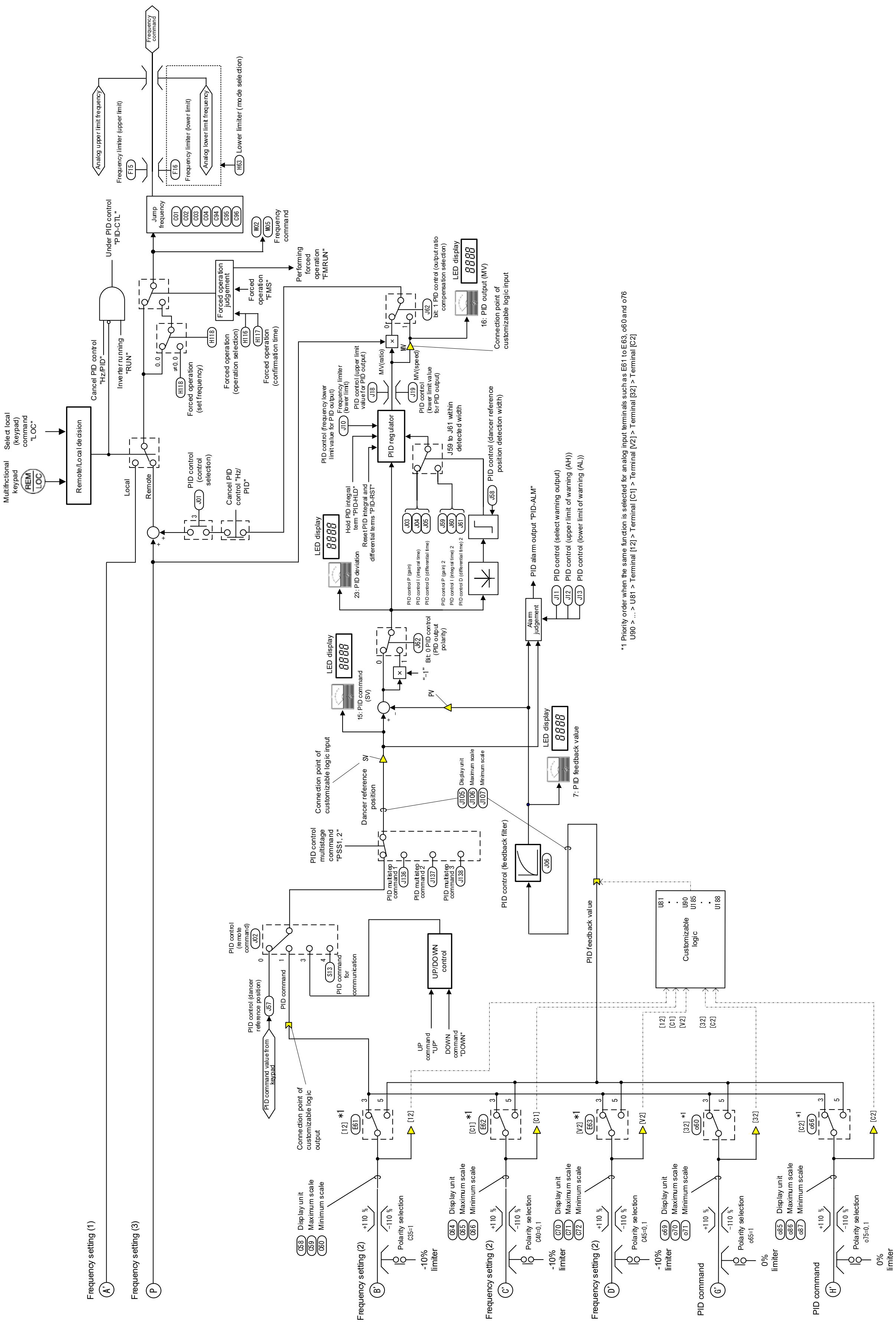


Fig. 8.2-6 PID control section (for dancer) block diagram

8.2.5 V/f Control Section

[1] V/f control : Common

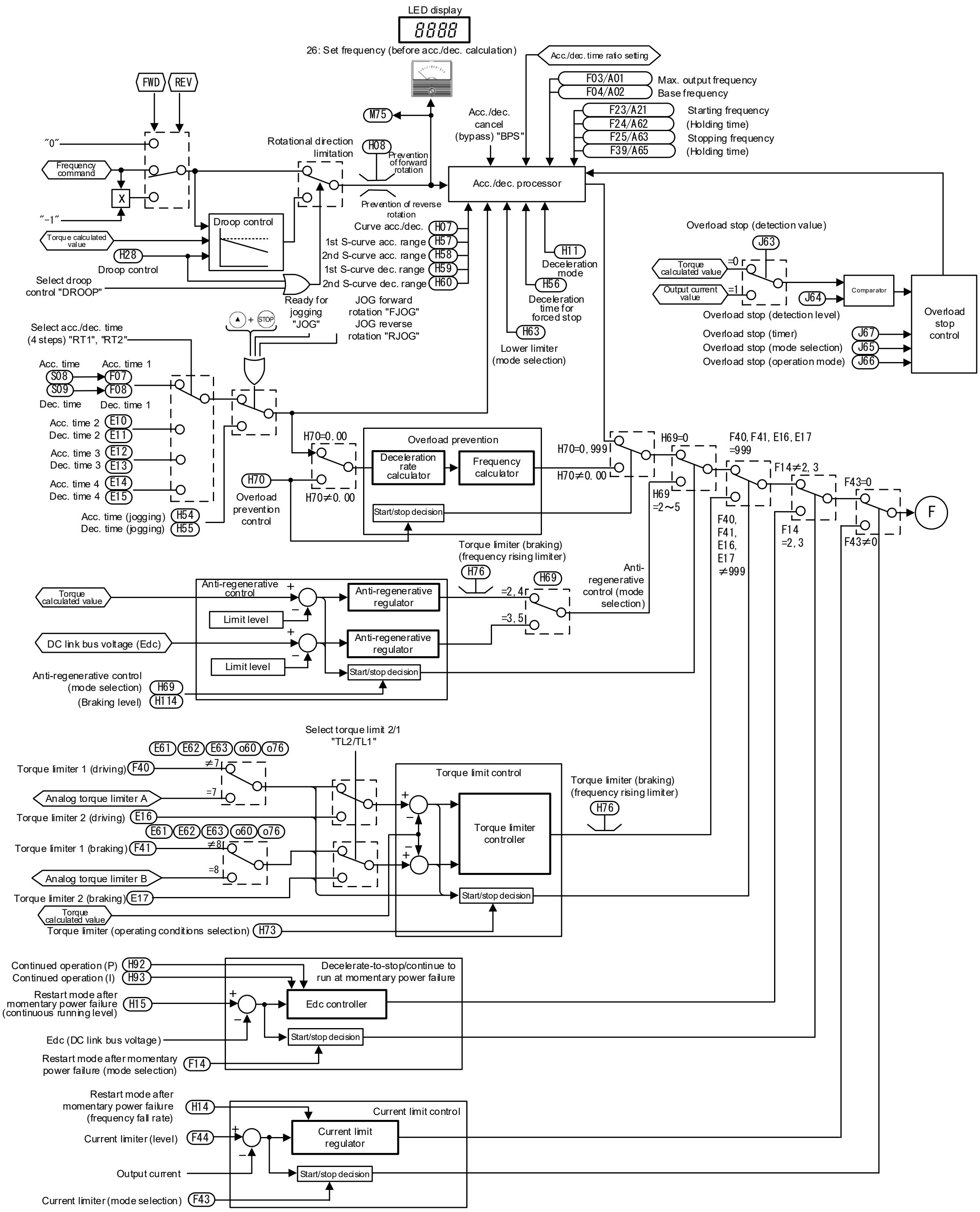


Fig. 8.2-7 V/f control section (common) block diagram

[2] V/f control : Without speed feedback

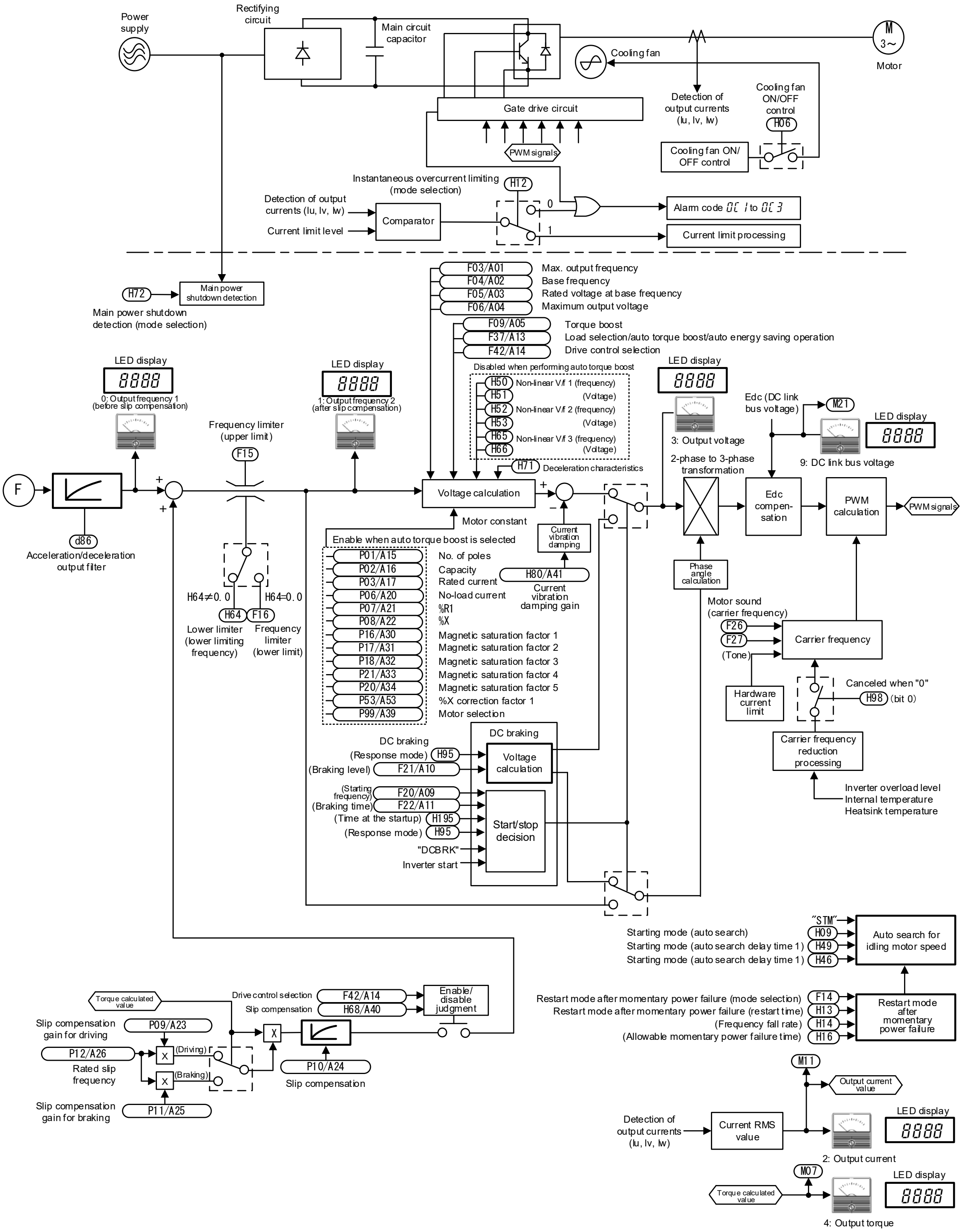


Fig. 8.2-8 V/f control section (without speed feedback) block diagram

[3] V/f control : With speed feedback

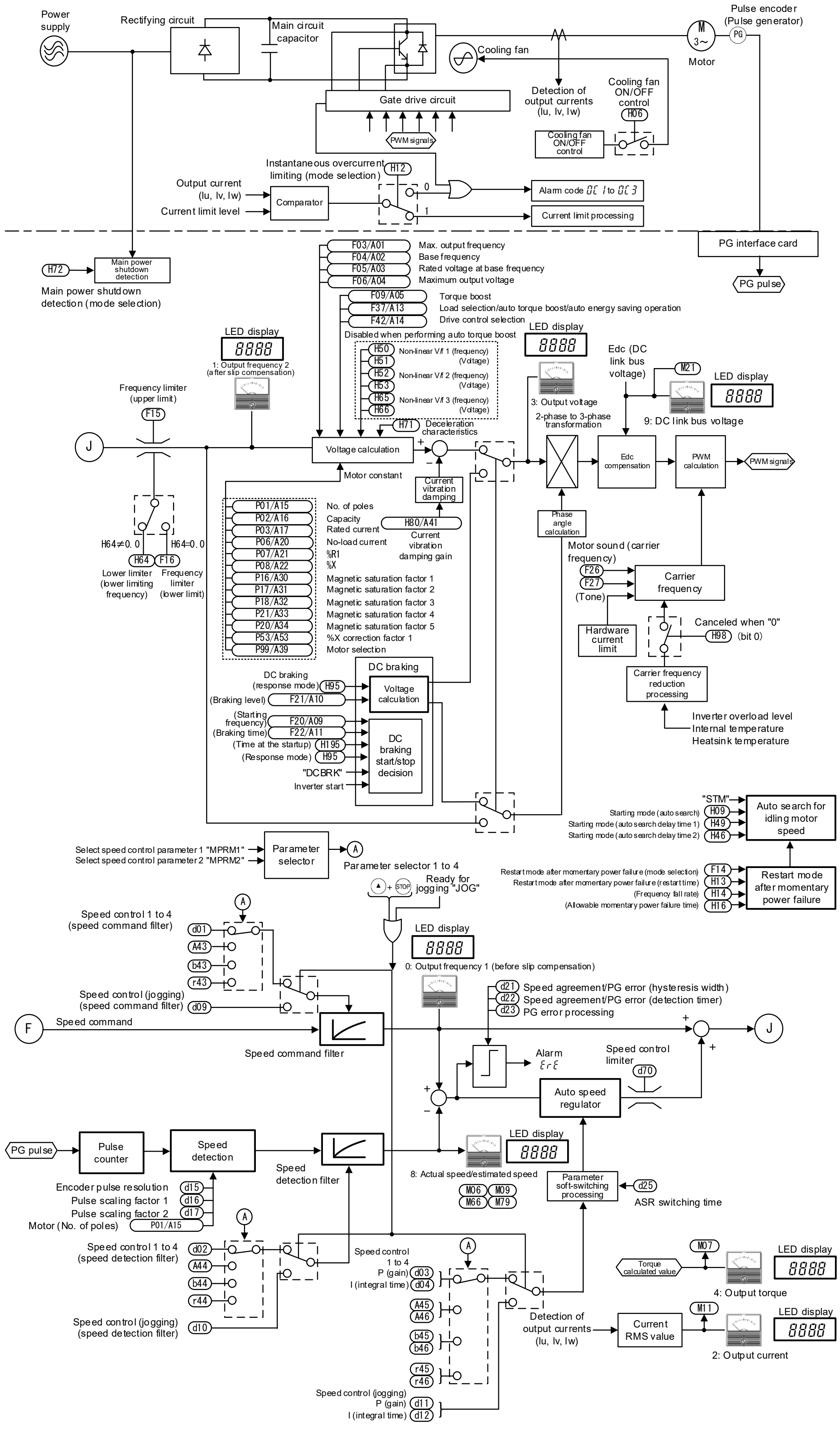


Fig. 8.2-9 V/f control section (with speed feedback) block diagram

8.2.6 Control Section (Vector control)

[1] Vector control : Common

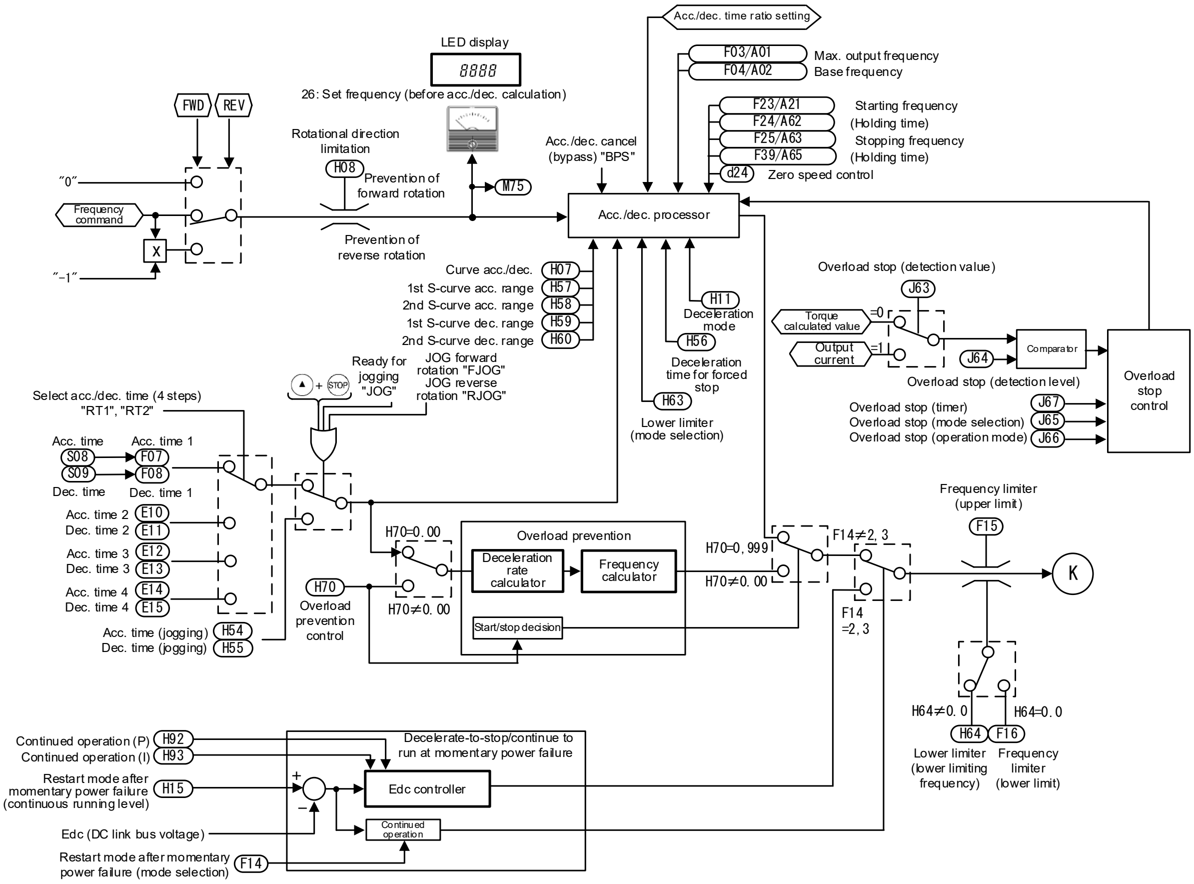
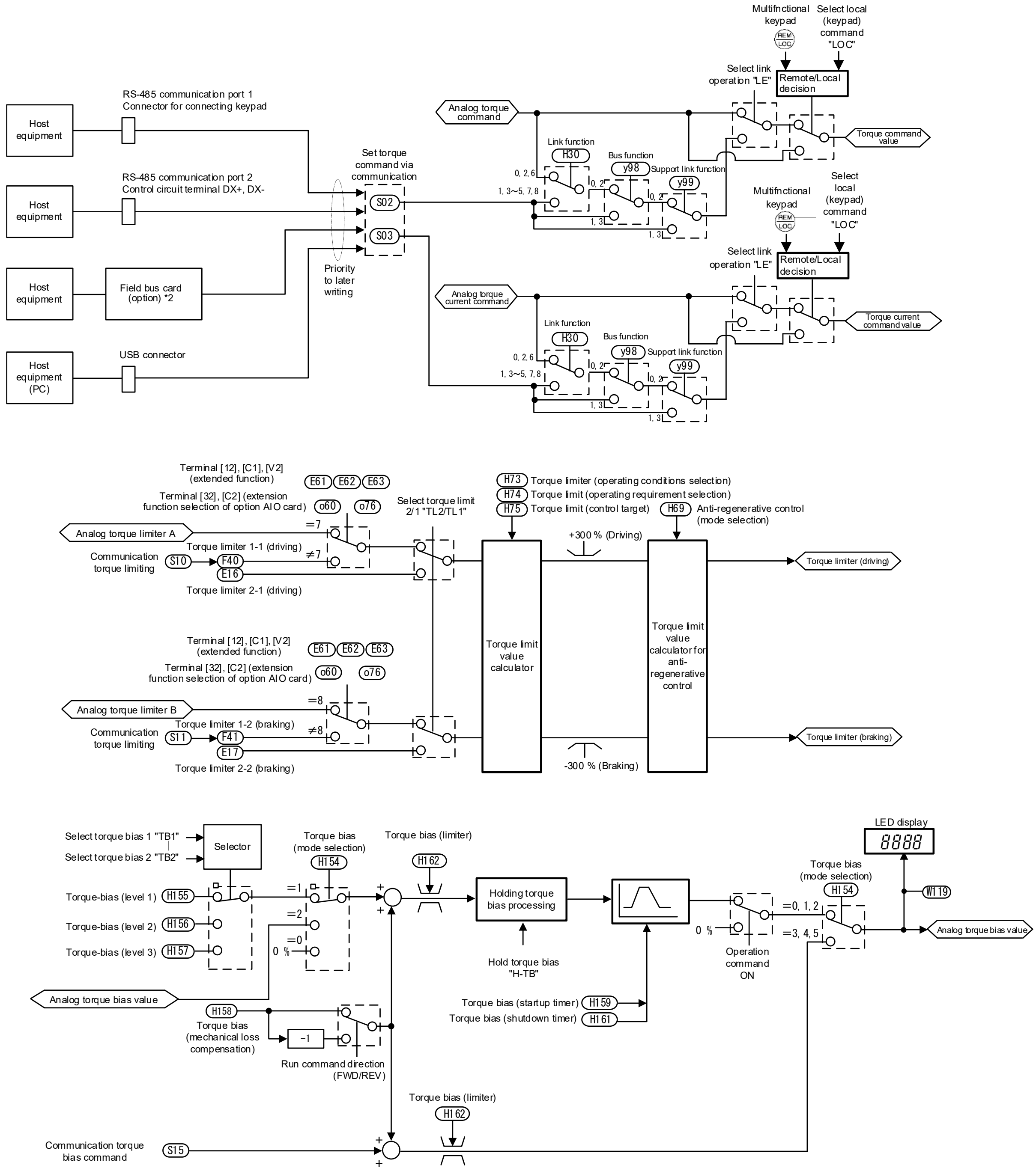


Fig. 8.2-10 Vector control section (common) block diagram

[2] Vector control : Torque command/ torque limit



*2 For details of the options, refer to the instruction manual for each option.

Fig. 8.2-11 Vector control section (torque command / torque limit) block diagram

[3] Vector control : Speed control / torque control

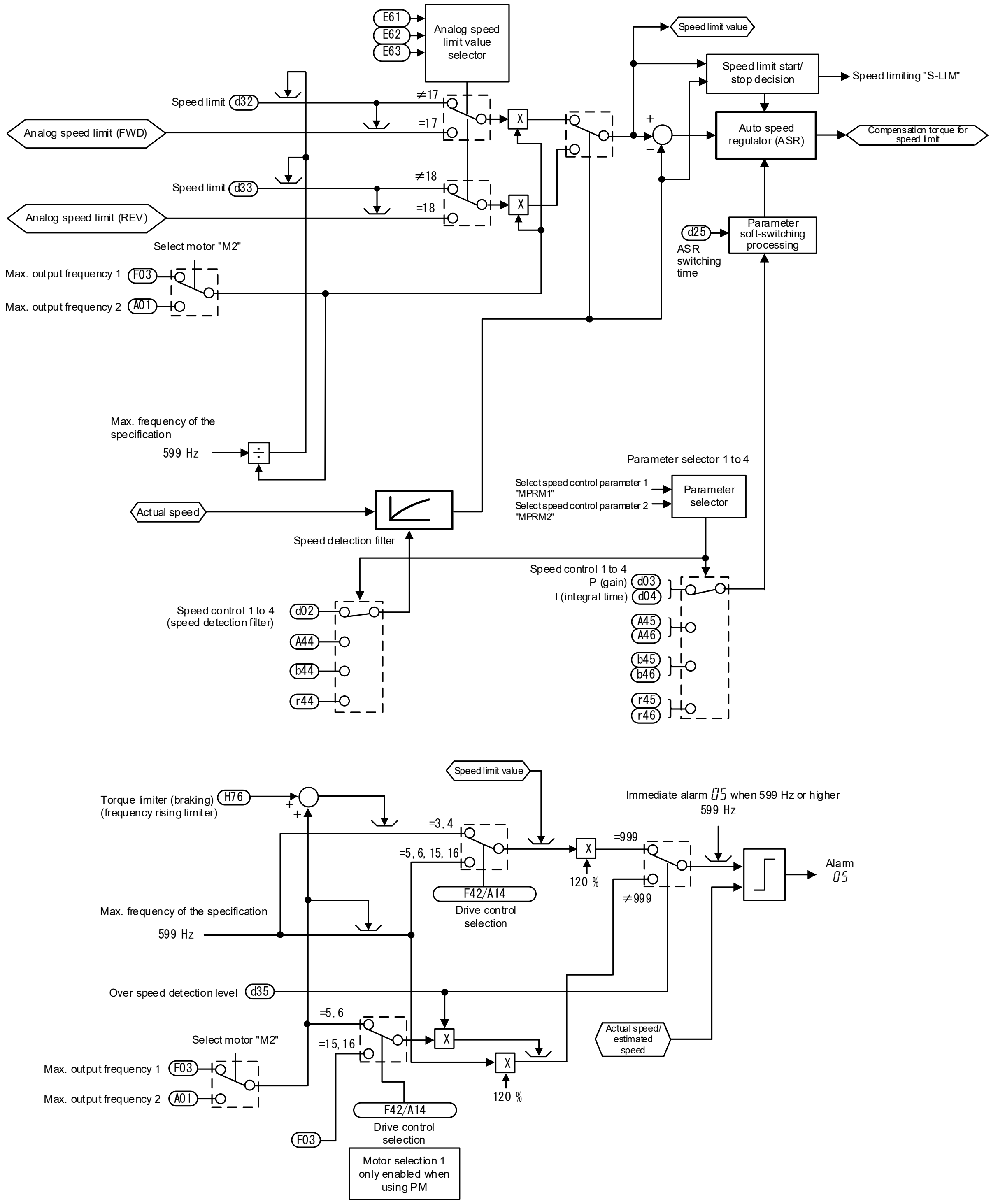


Fig. 8.2-12 Vector control section (speed control / torque control) block diagram

[4] Vector control : Induction motor speed control/torque control

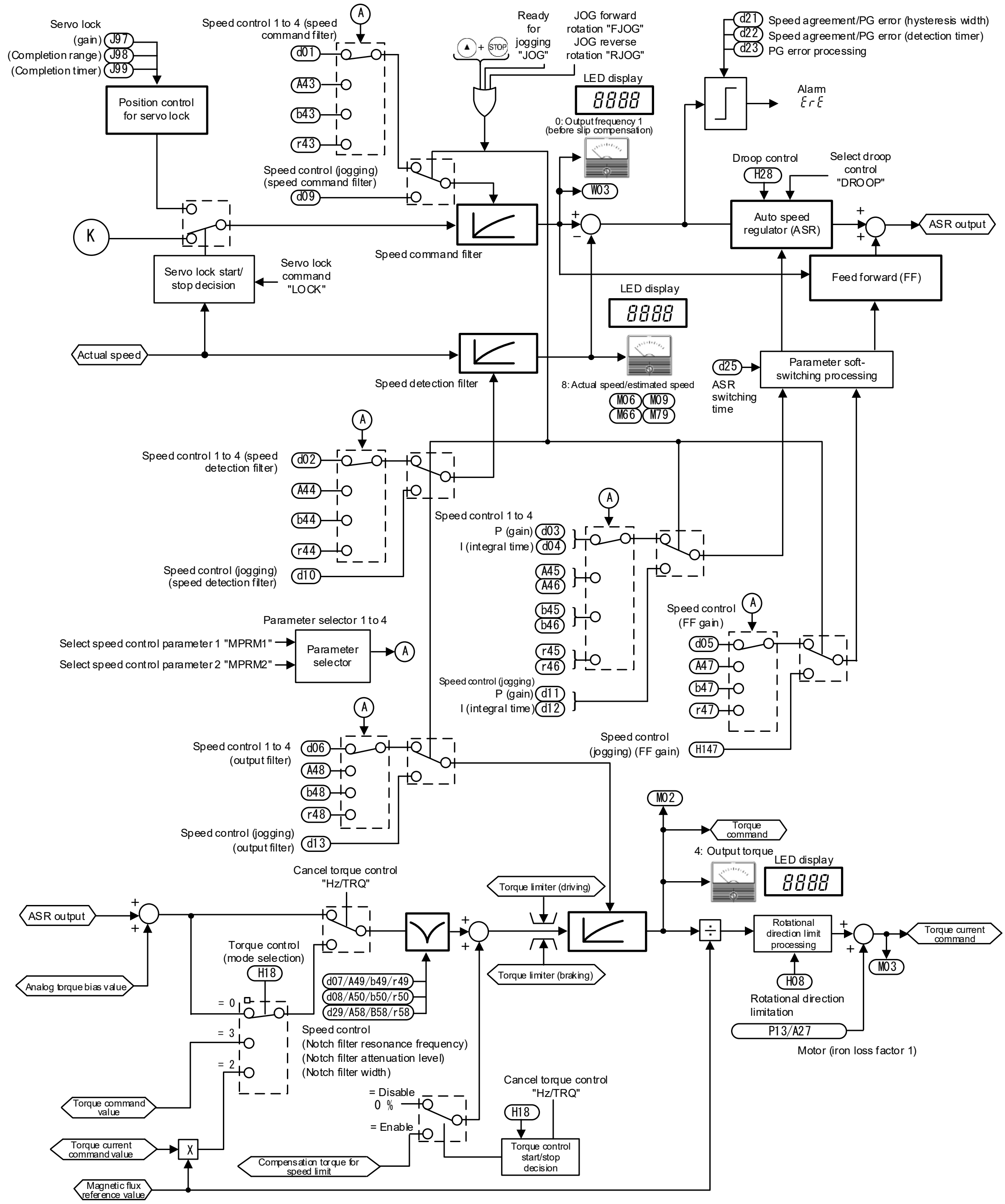


Fig.8.2-13 Vector control (induction motor speed control/torque control) section block diagram

[5] Vector control : Induction motor drive

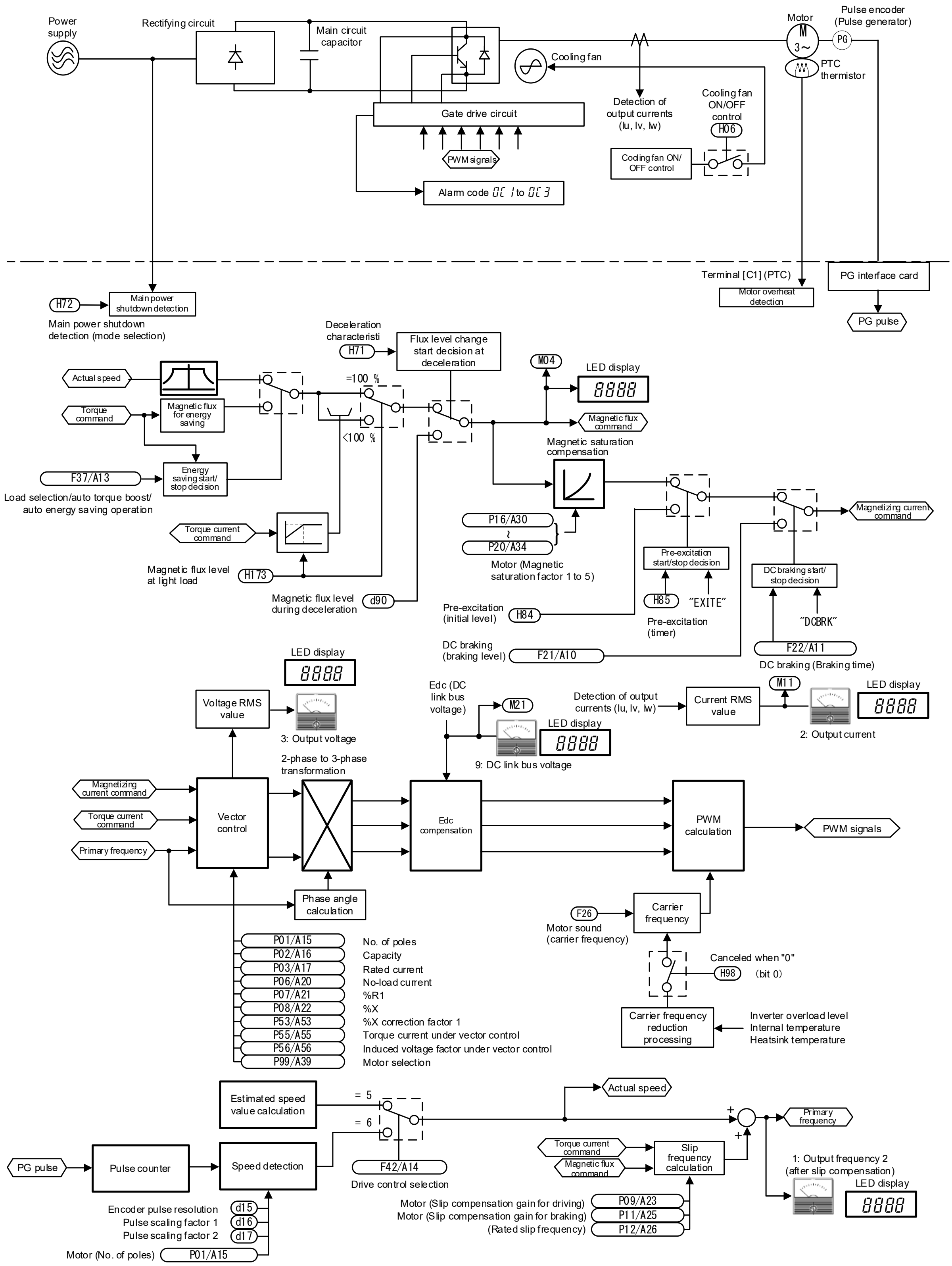


Fig. 8.2-14 Vector control section (Induction motor drive) block diagram

[6] Vector control : Synchronous motor speed control/torque control

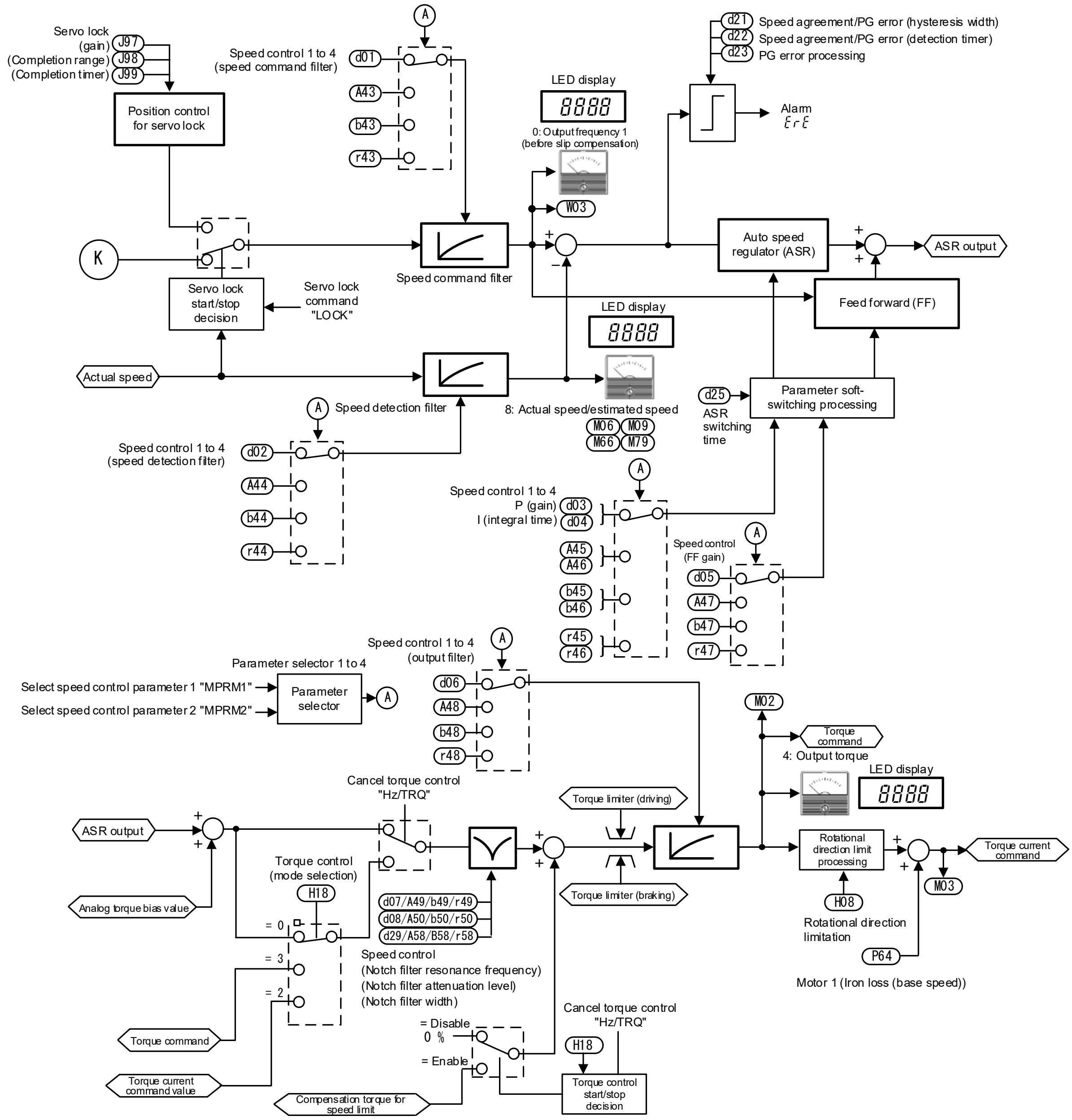


Fig.8.2-15 Vector control (synchronous motor speed control/torque control) section block diagram

[7] Vector control : PMSM drive

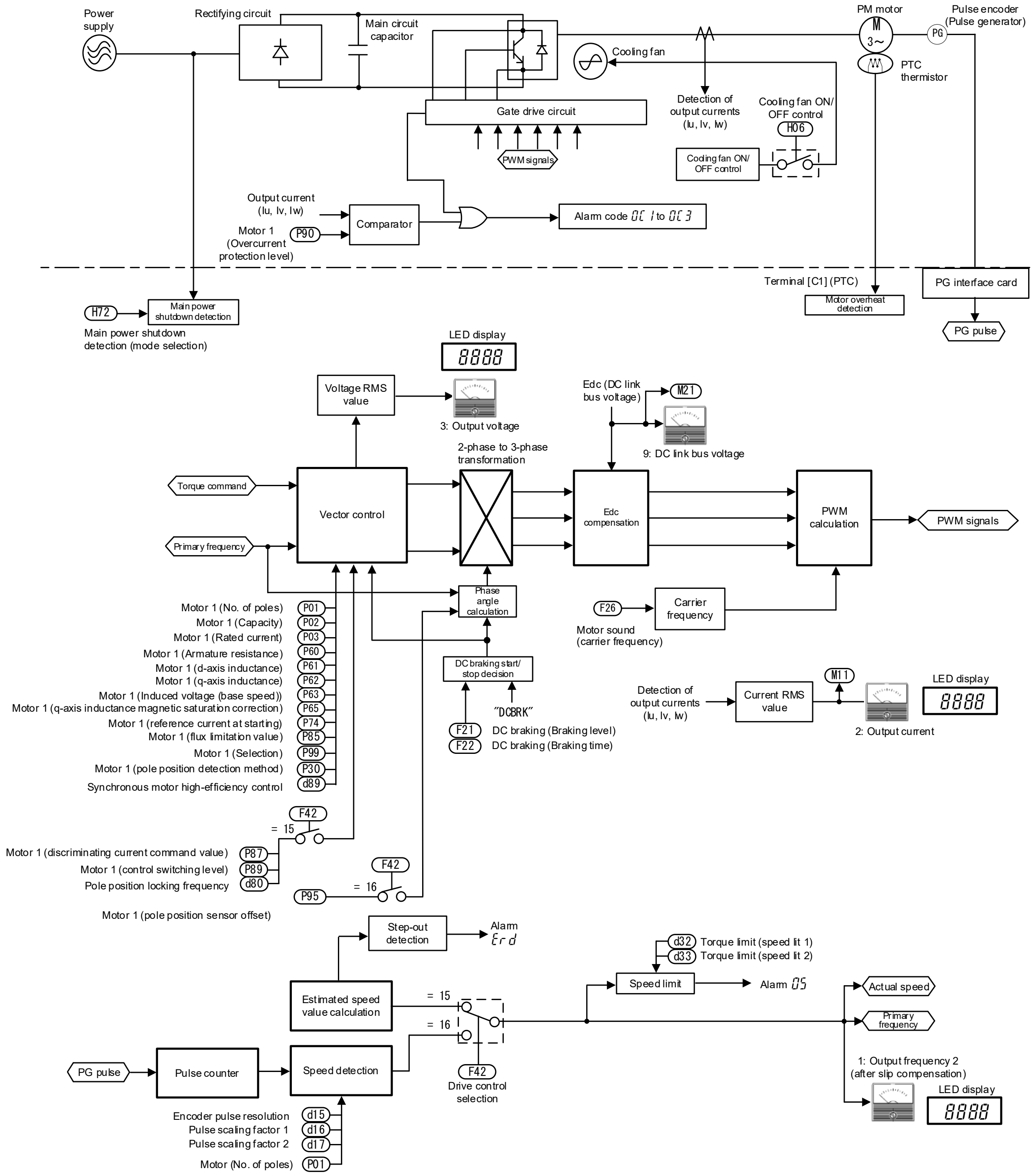


Fig. 8.2-16 Vector control section (PMSM drive) block diagram

8.2.7 FM Output Section

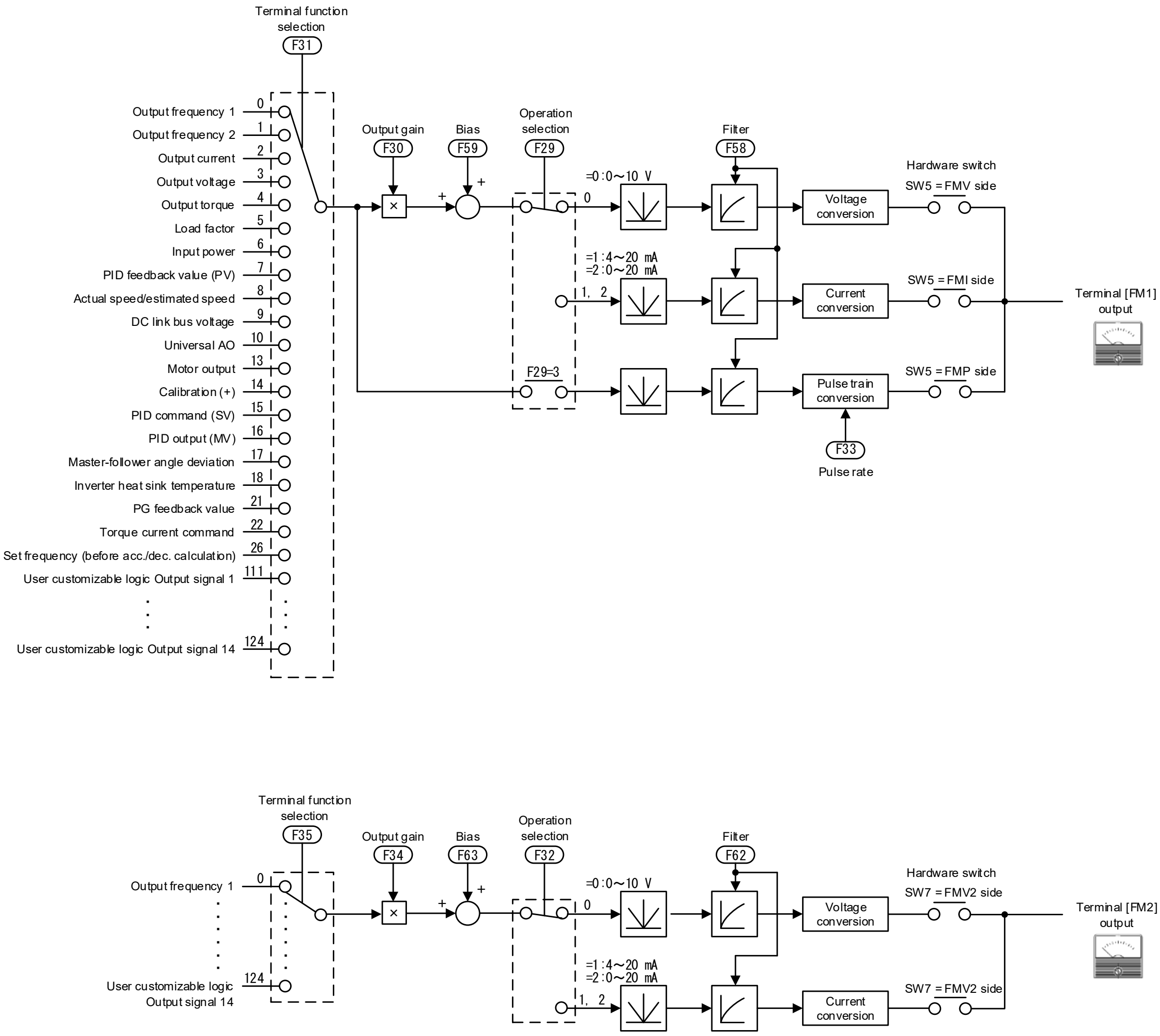


Fig. 8.2-17 FM output section block diagram

8.3 Ethernet built-in type (E3N)

8.3.1 Frequency Setting Section

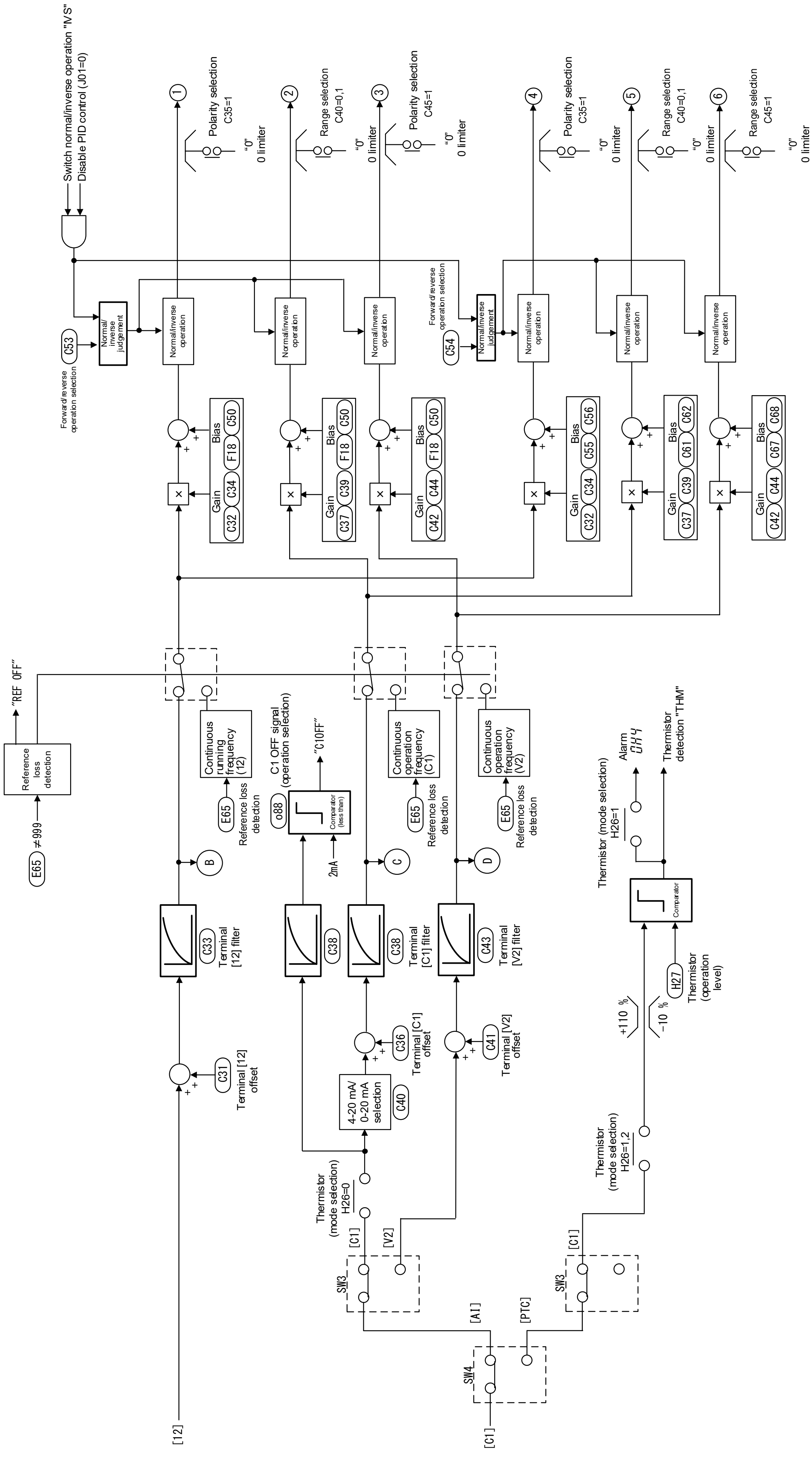


Fig. 8.3-1 Frequency setting section block diagram

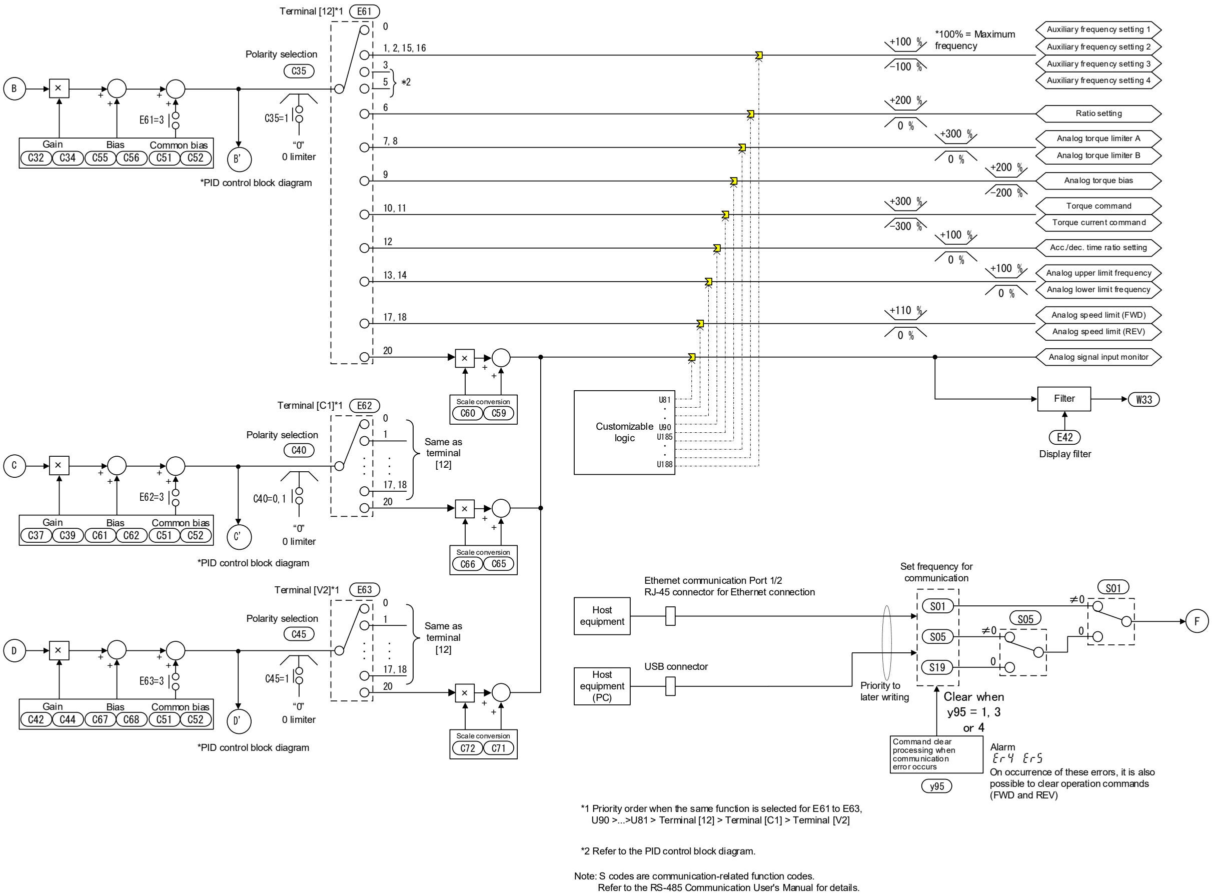


Fig. 8.3-2 Frequency setting section block diagram

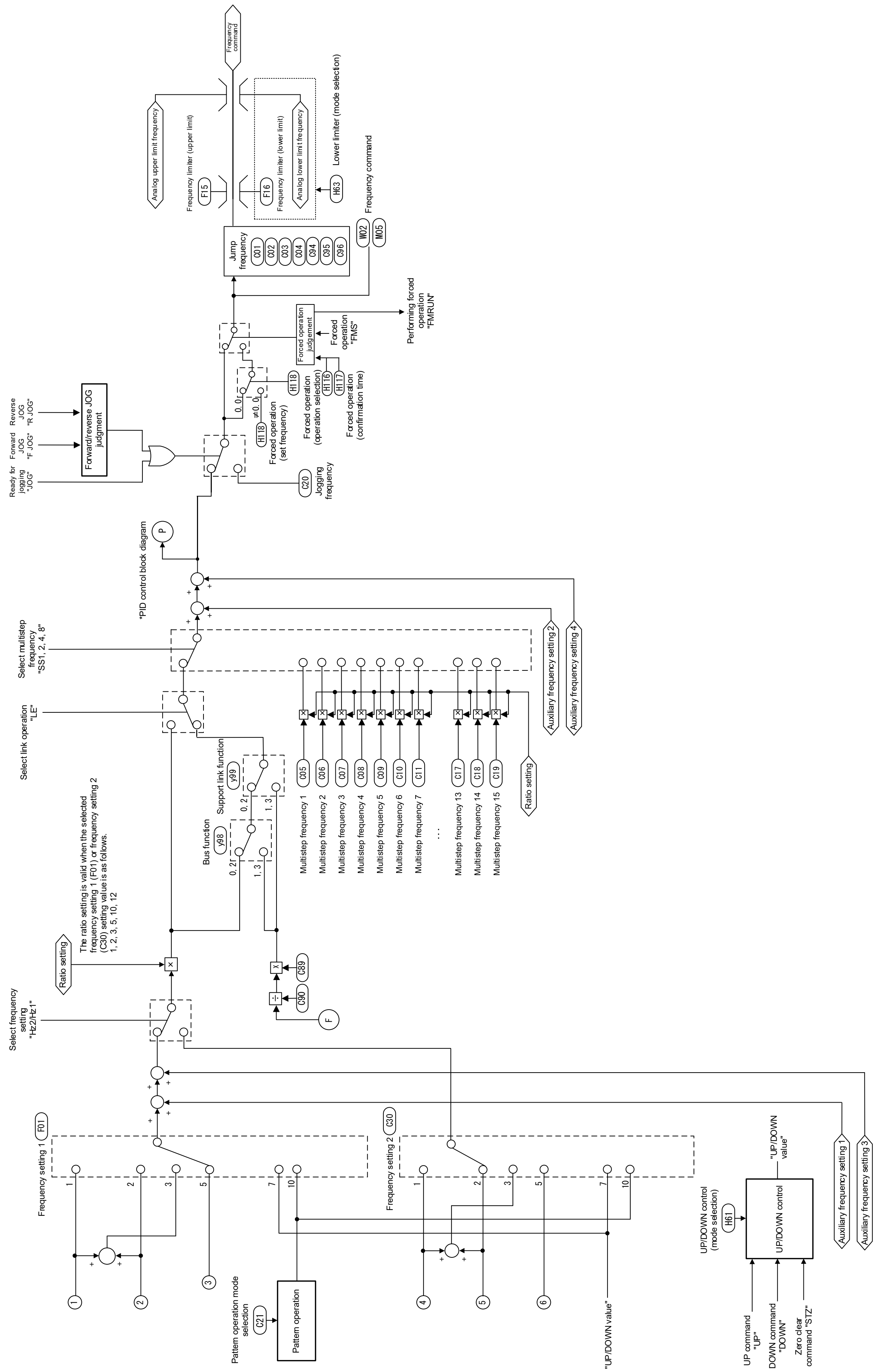


Fig. 8.3-3 Frequency setting section block diagram

Chap 8　BLOCK DIAGRAMS FOR CONTROL LOGIC

8.3.2 Operation Command Section

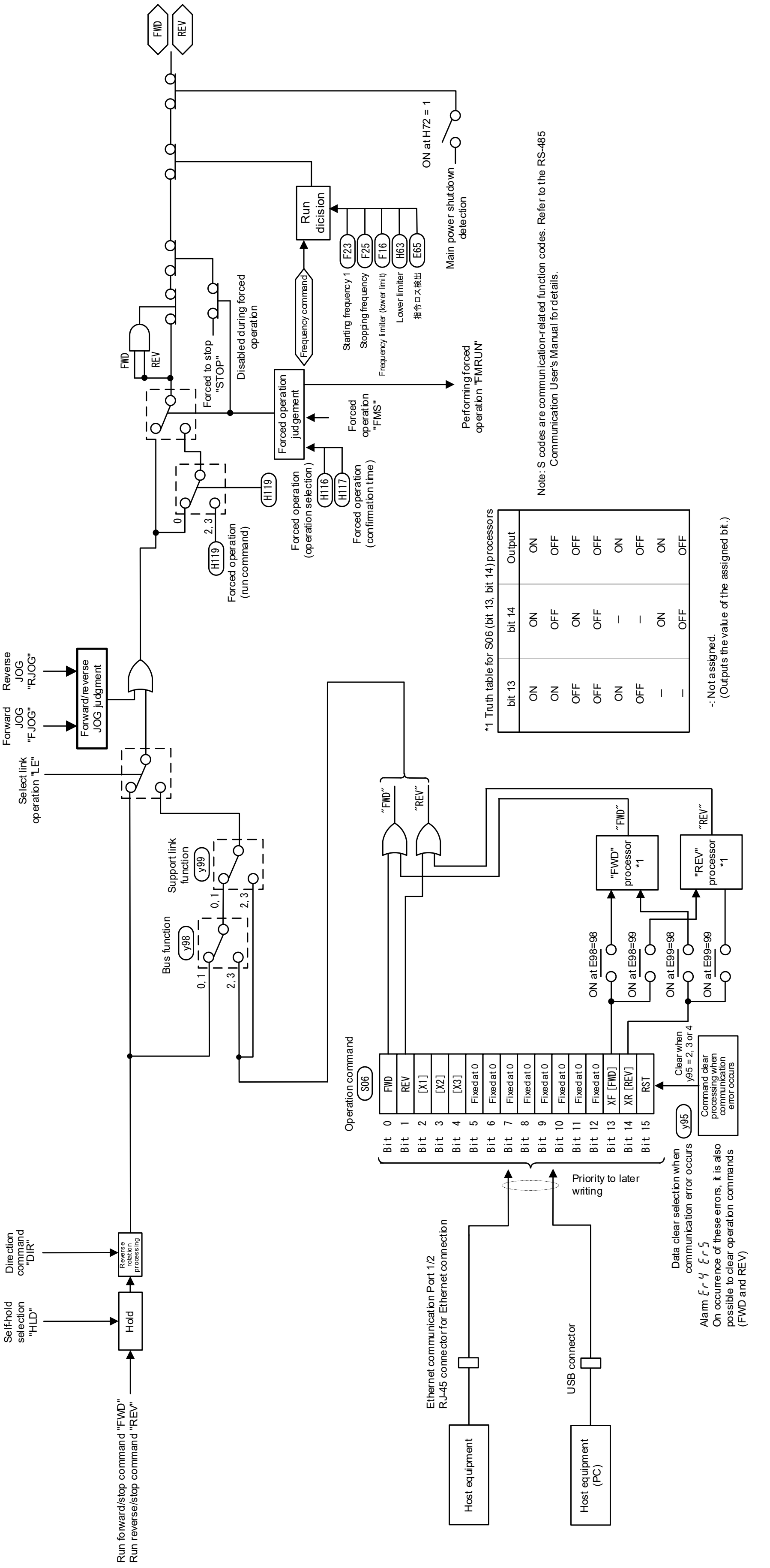


Fig. 8.3-4 Operation command section block diagram

8.3.3 PID Control Section (for Processing)

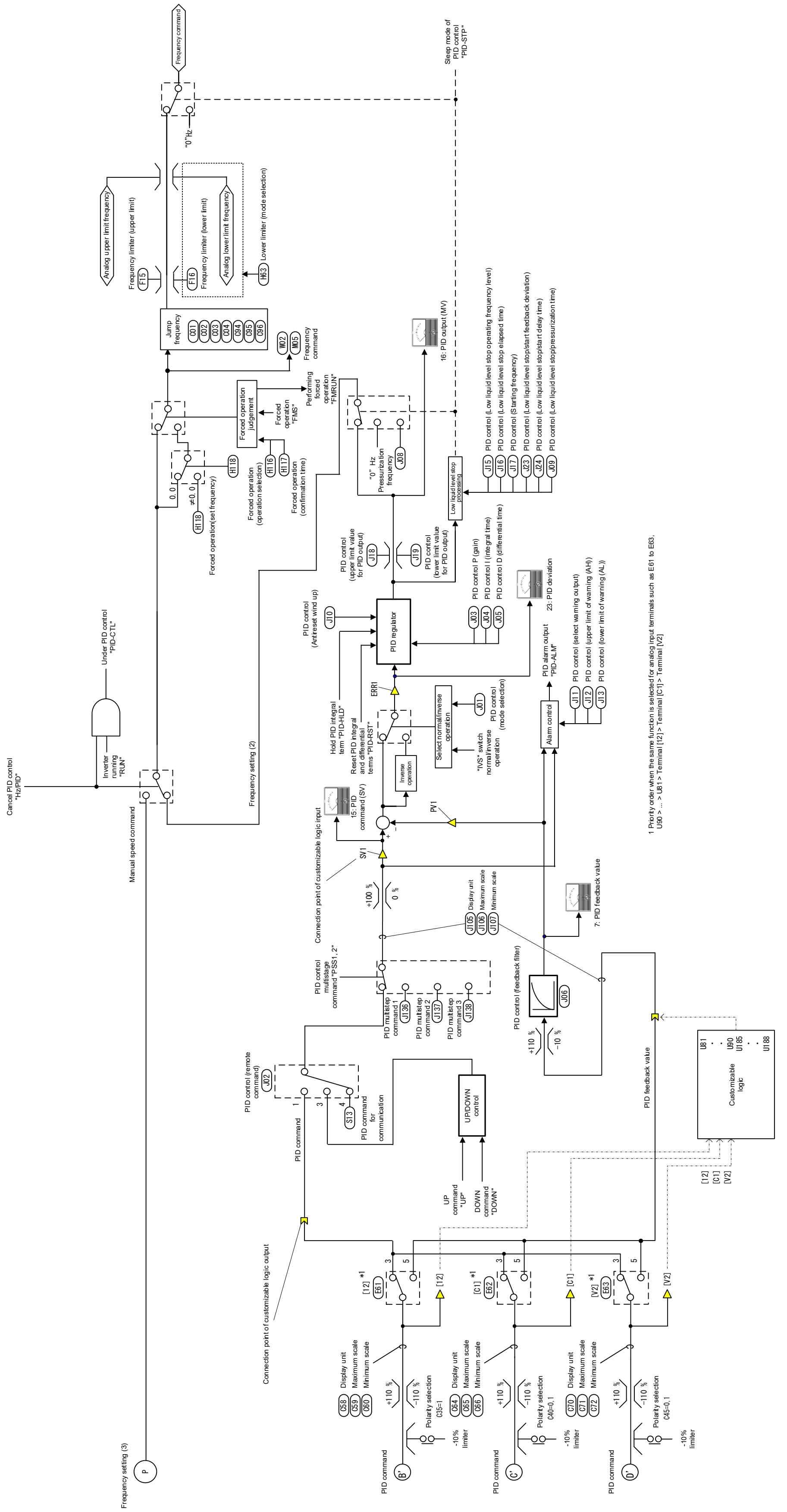


Fig. 8.3-5 PID control section (for processing) block diagram

8.3.4 PID Control Section (for Dancer)

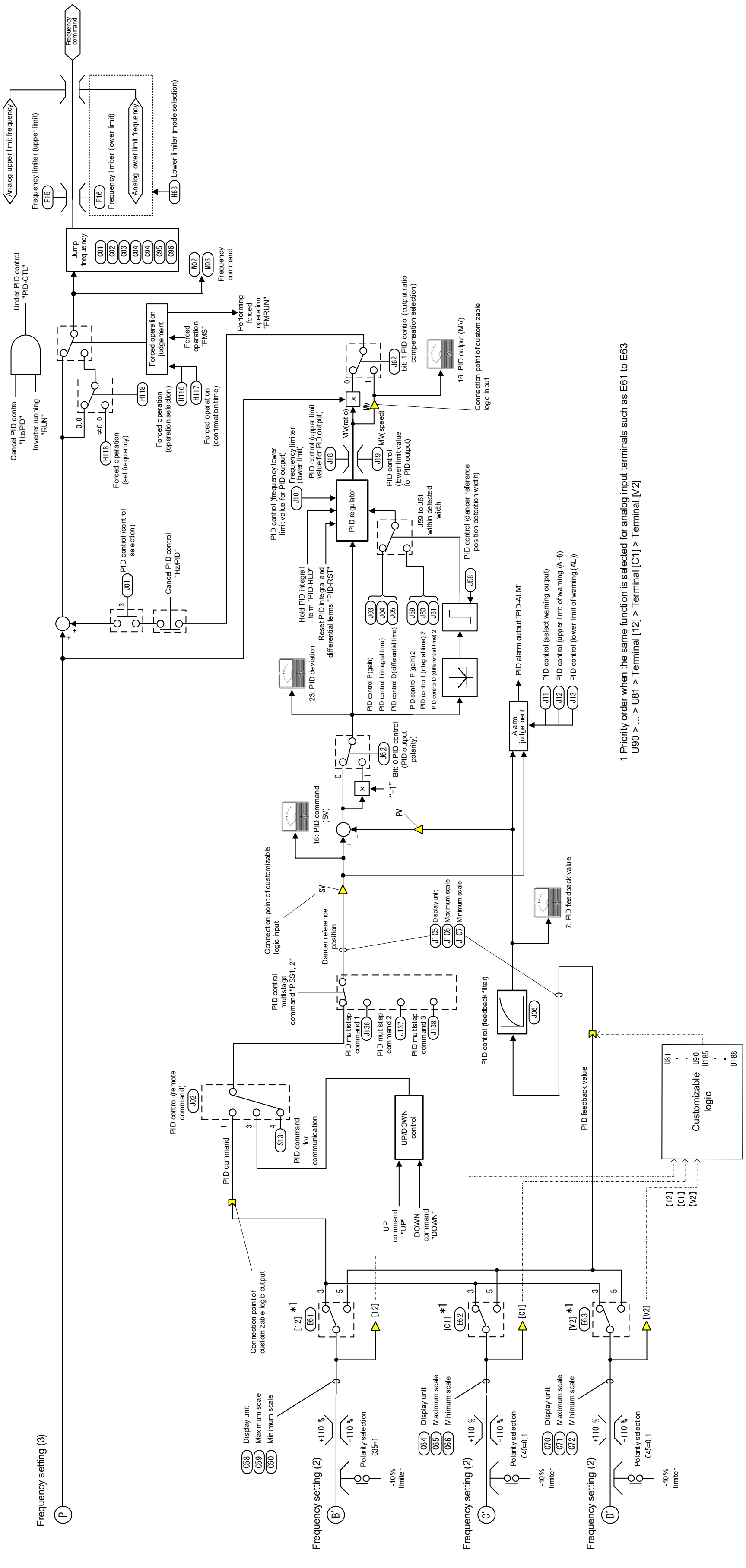


Fig. 8.3-6 PID control section (for dancer) block diagram

8.3.5 V/f Control Section

[1] V/f control : Common

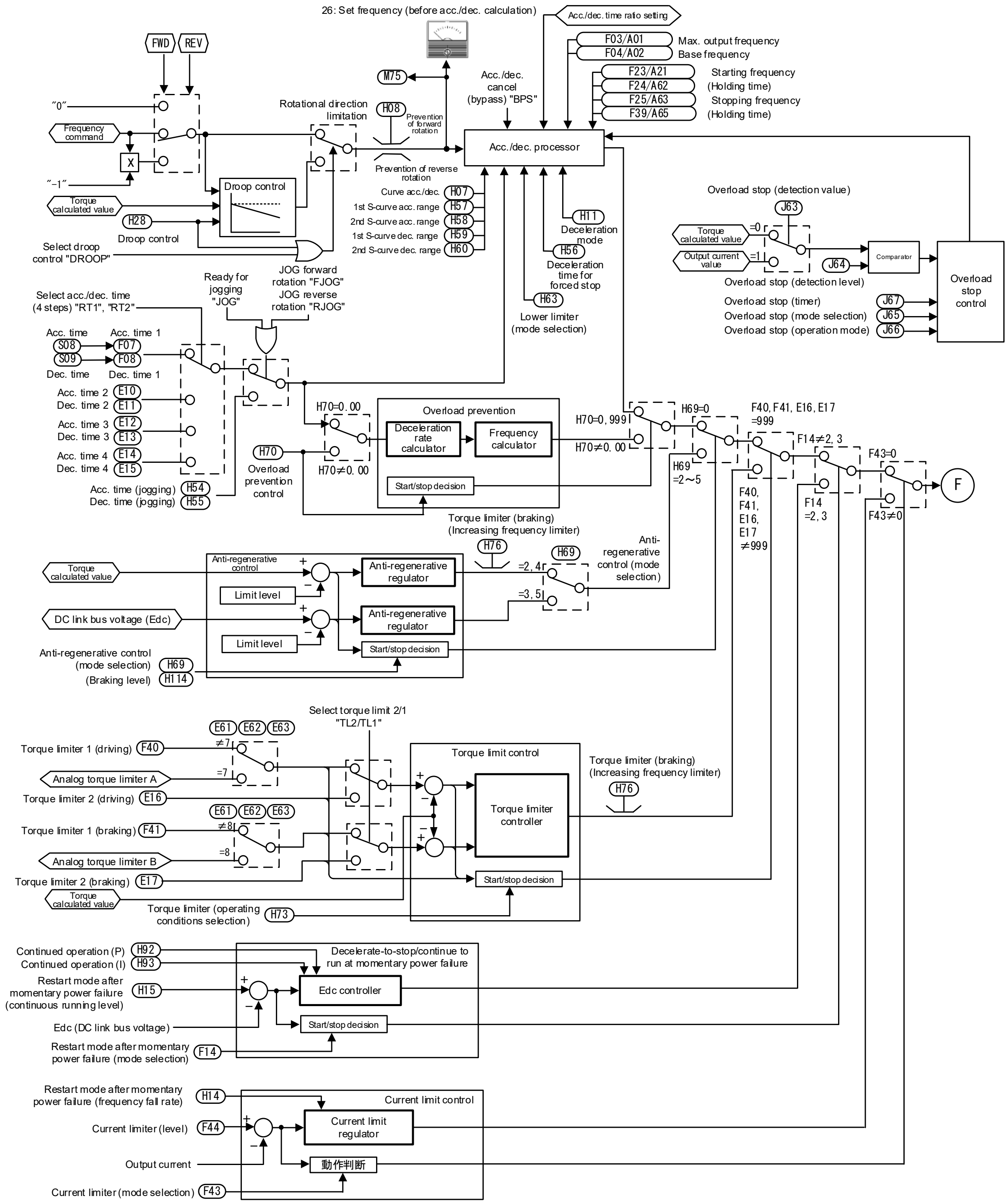


Fig. 8.3-7 V/f control section (common) block diagram

[2] V/f control : Without speed feedback

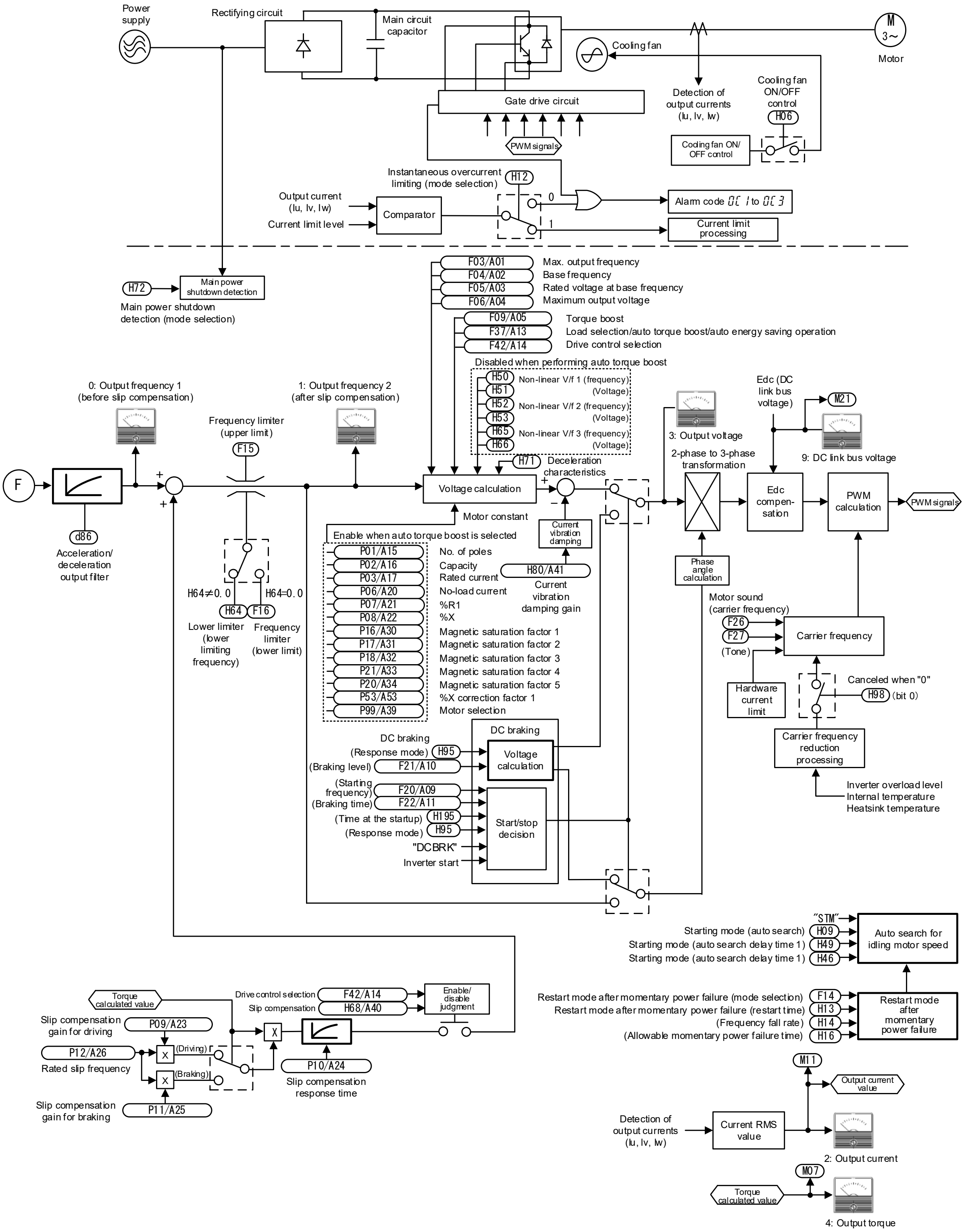


Fig. 8.3-8 V/f control section (without speed feedback) block diagram

8.3.6 Control Section (Vector control)

[1] Vector control : Common

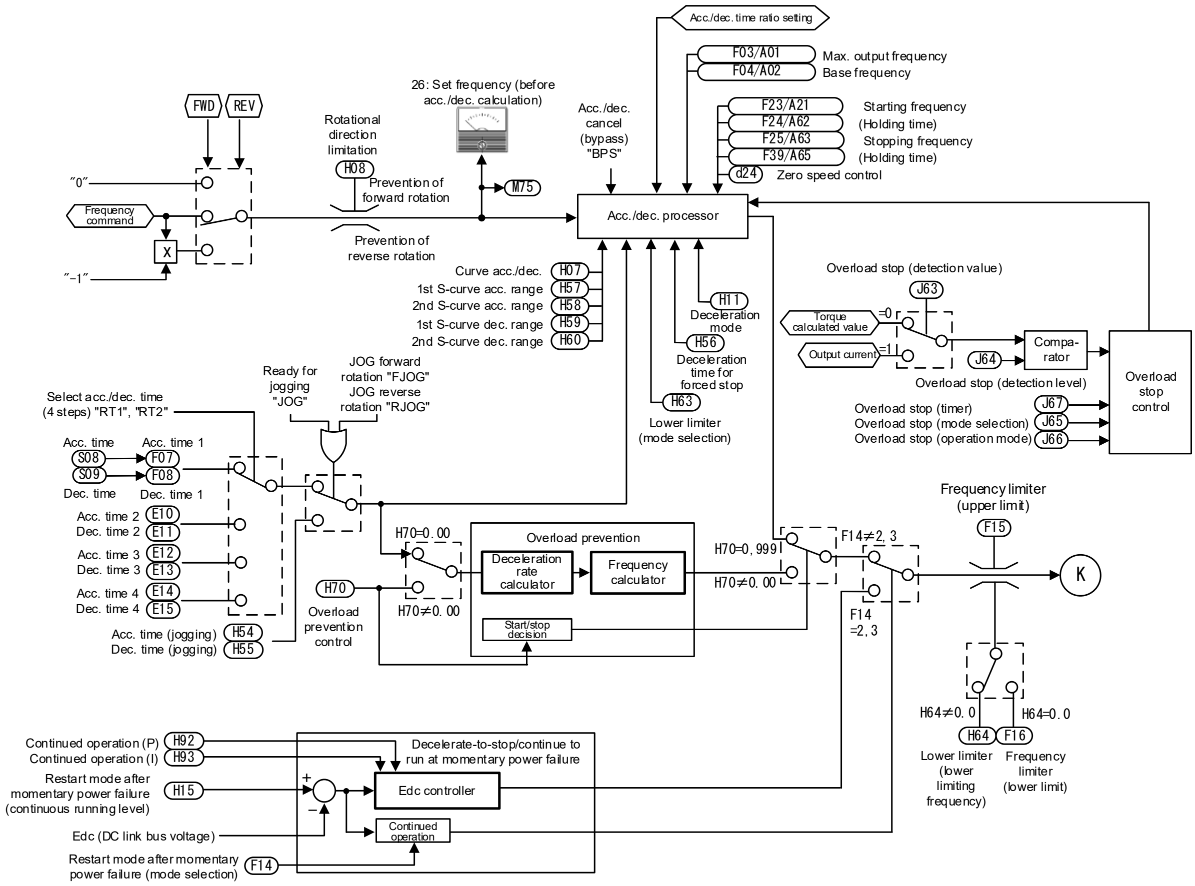


Fig. 8.3-9 Vector control section (common) block diagram

[2] Vector control : Torque command/ torque limit

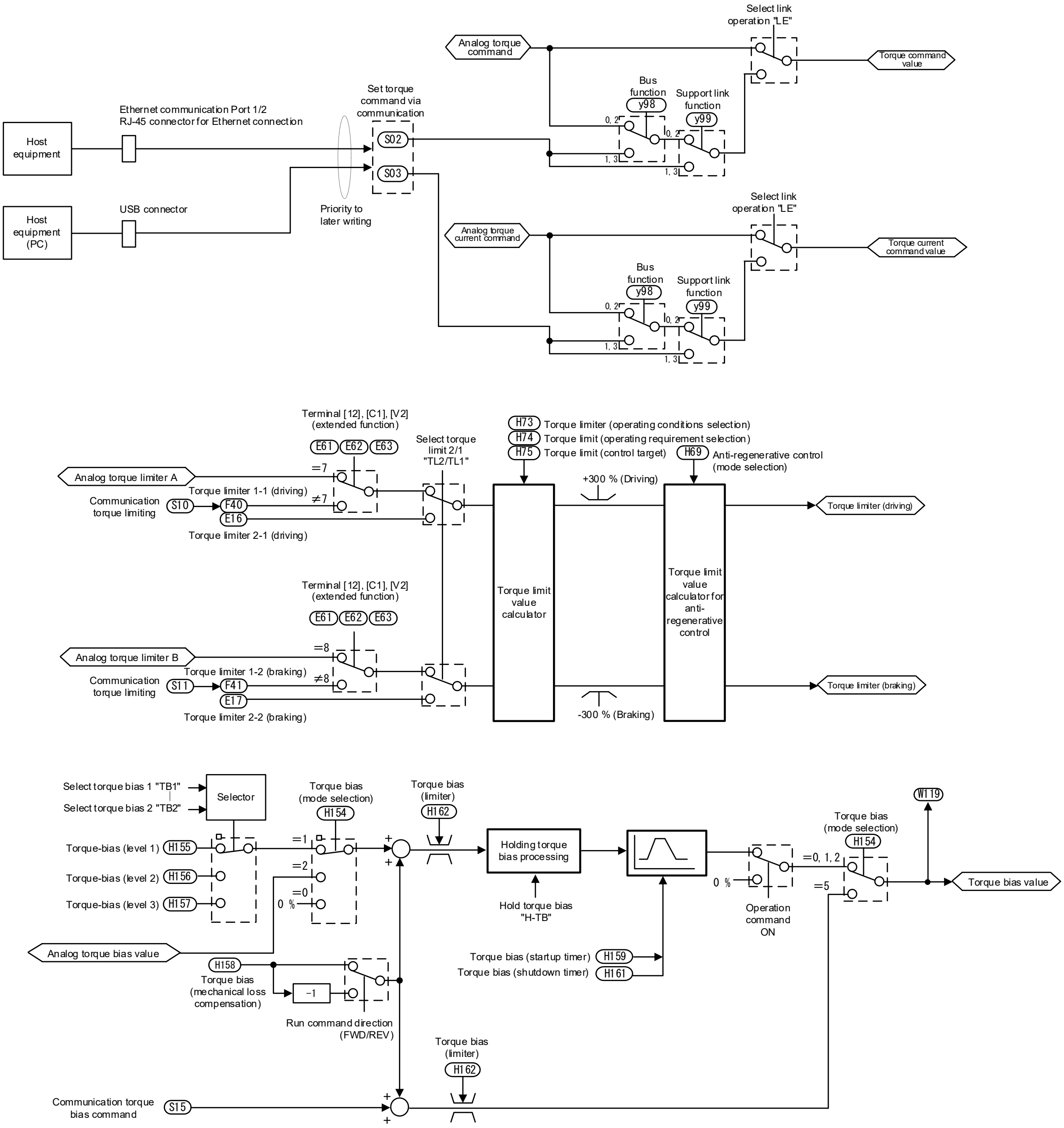


Fig. 8.3-10 Vector control section (torque command / torque limit) block diagram

[3] Vector control : Speed control / torque control

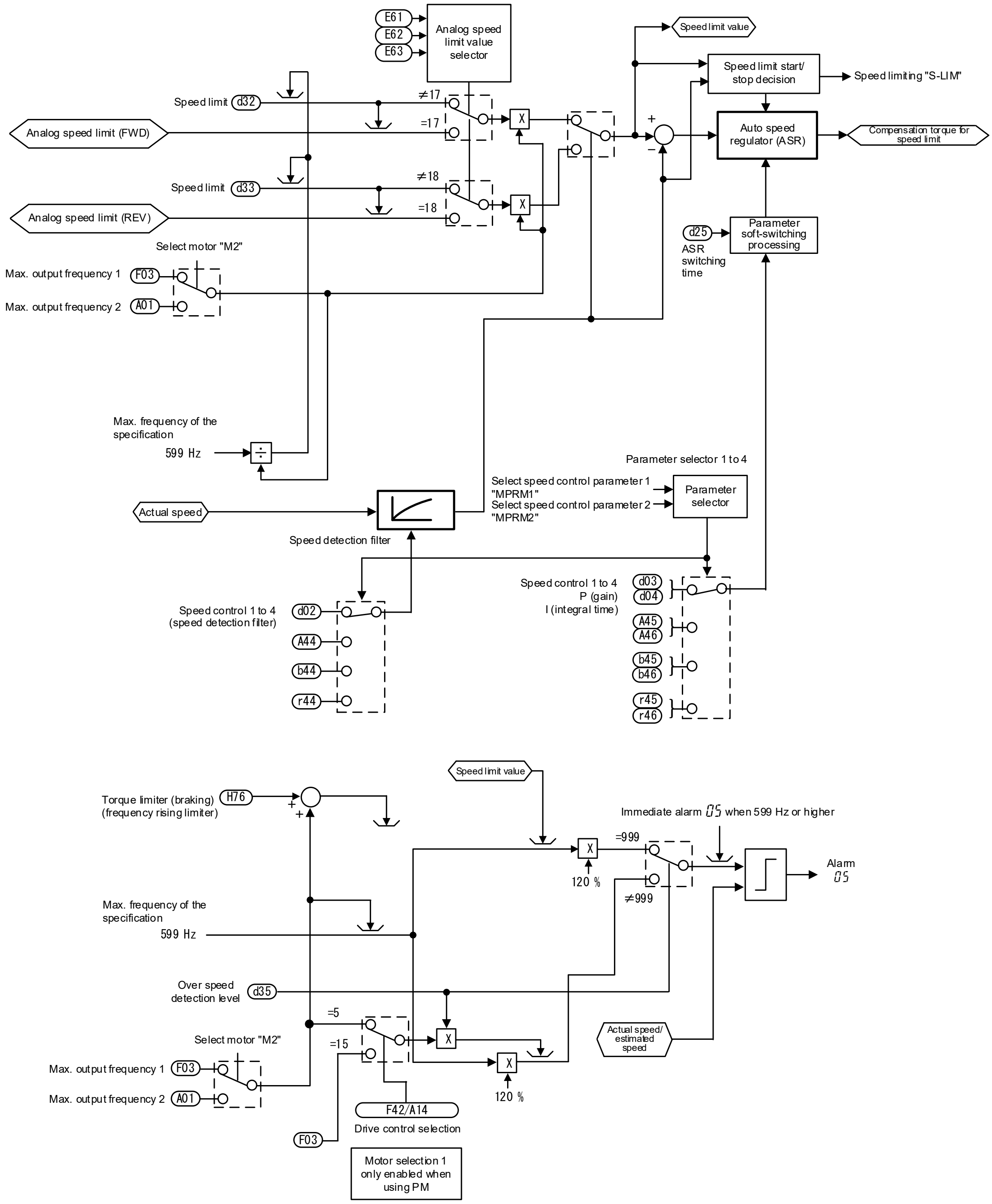


Fig. 8.3-11 Vector control section (speed control / torque control) block diagram

[4] Vector control : Induction motor speed control/torque control

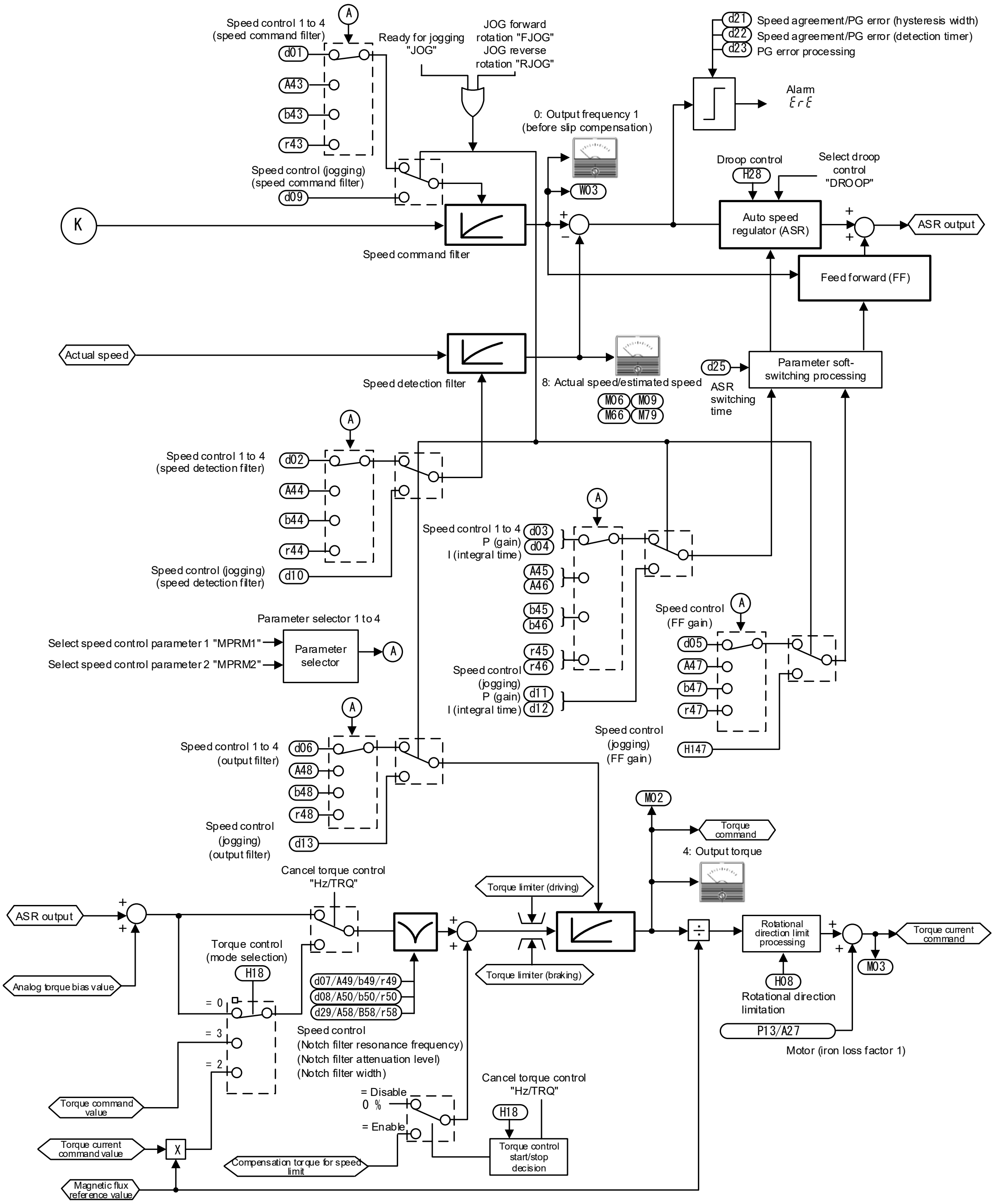


Fig. 8.3-12 Vector control section (induction motor speed control/torque control) block diagram

[5] Vector control : Induction motor drive

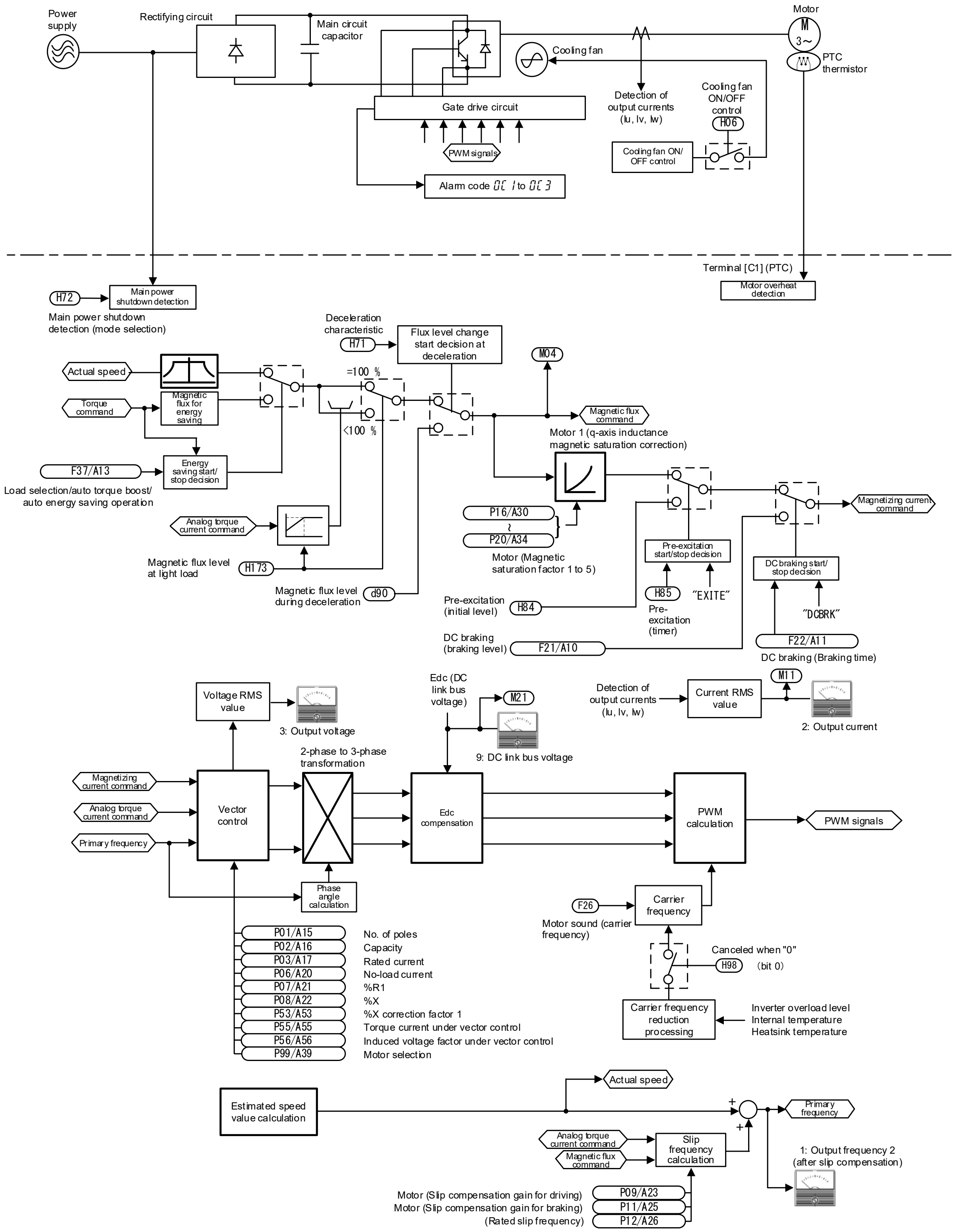


Fig. 8.3-13 Vector control section (Induction motor drive) block diagram

[6]　Vector control : Synchronous motor speed control/torque control

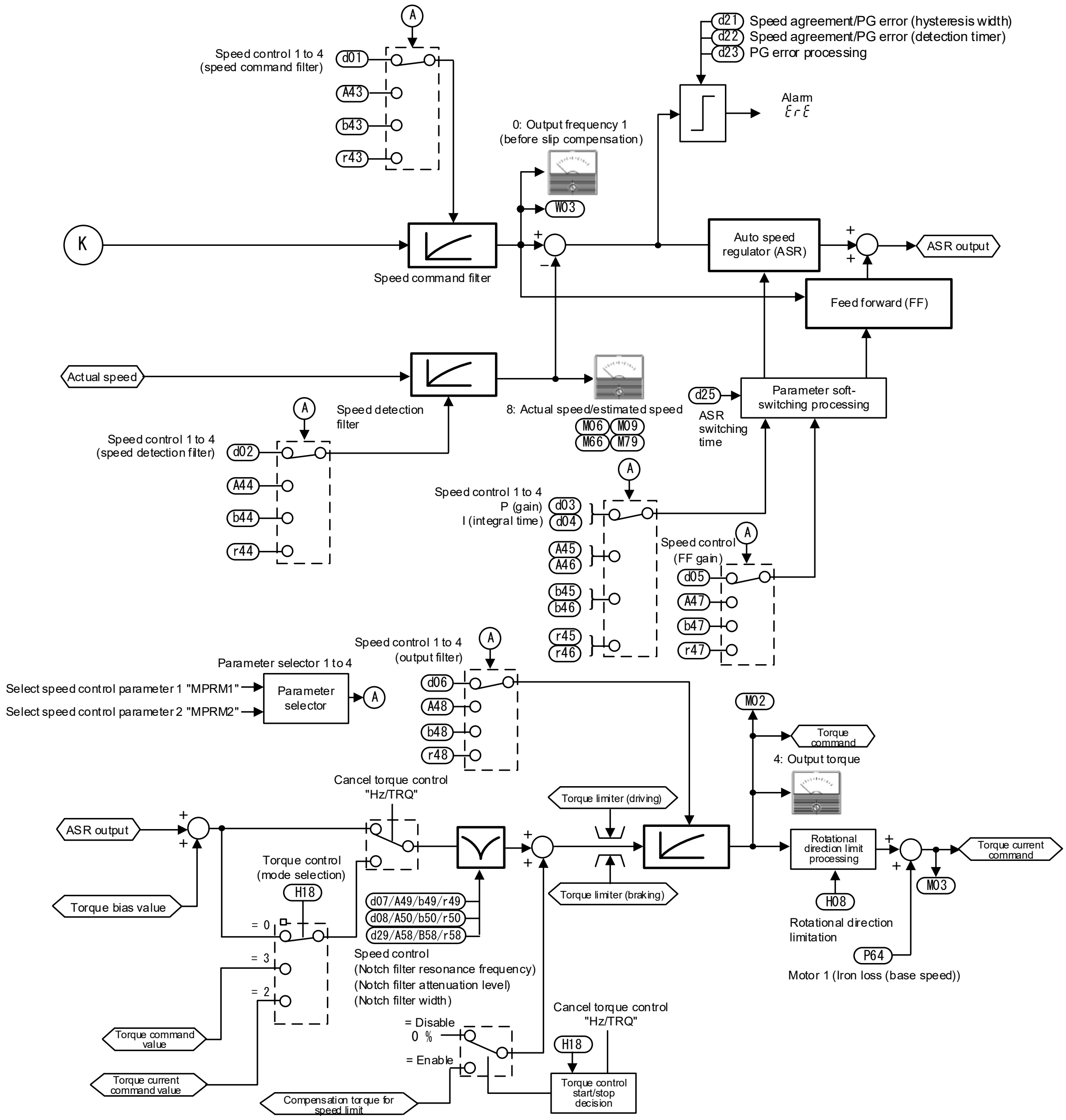


Fig. 8.3-14 Vector control section (synchronous motor speed control/torque control) block diagram

[7] Vector control : PMSM drive

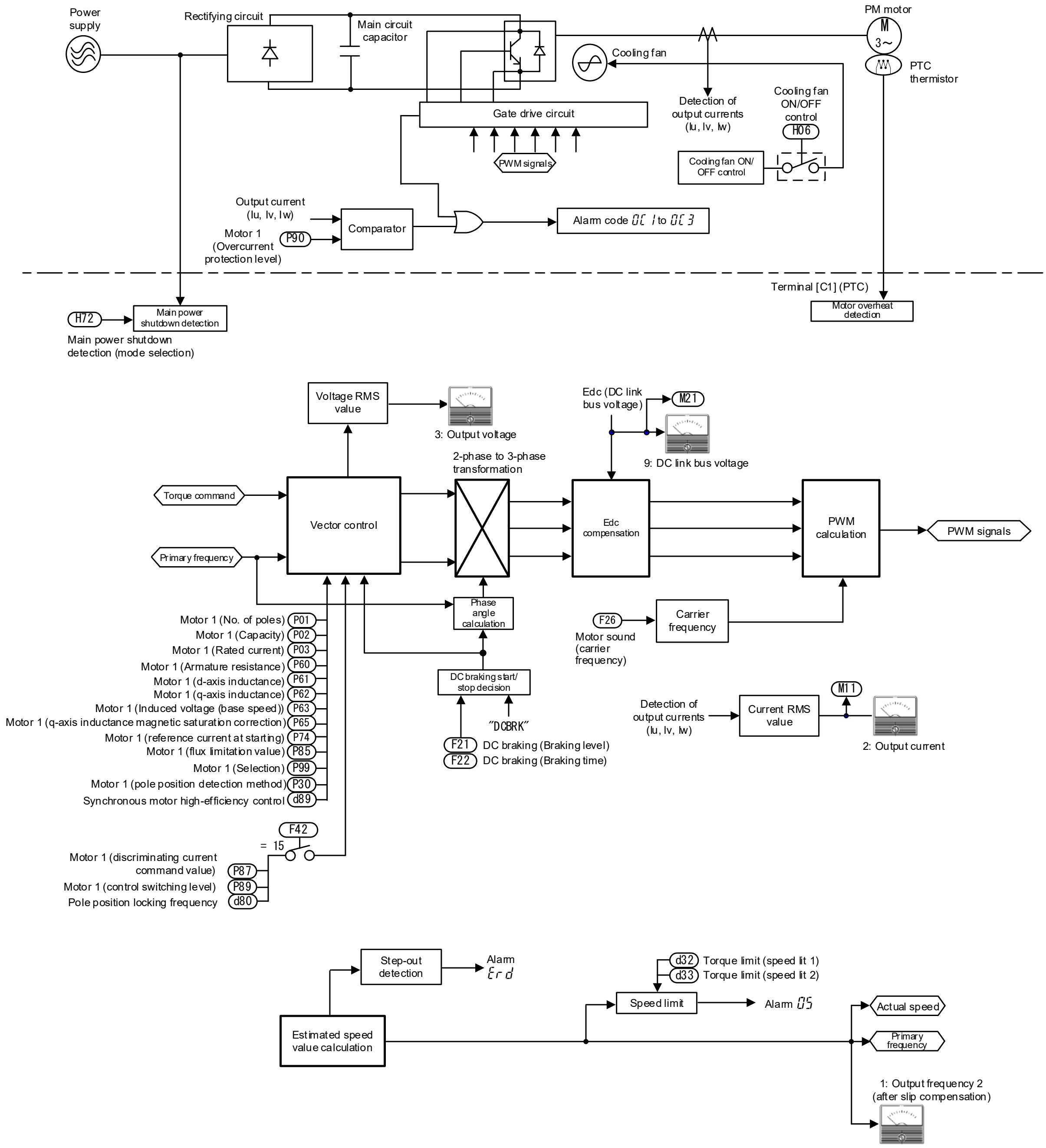


Fig. 8.3-15 Vector control section (PMSM drive) block diagram

8.3.7 FM Output Section

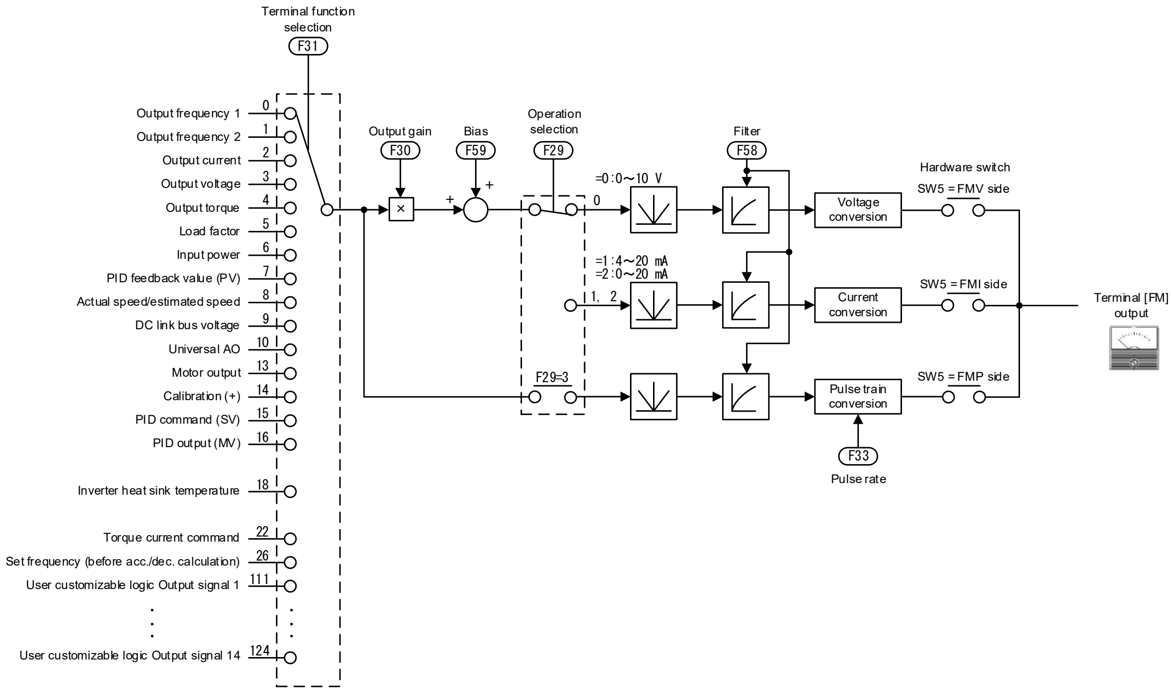


Fig. 8.3-16 FM output section block diagram

Chapter 9
COMMUNICATION FUNCTIONS

This chapter describes an overview of inverter operation through the RS-485 and Ethernet communications.
For details of RS-485 communication, refer to the RS-485 Communication User's Manual.
For details of Ethernet communication, refer to “9.3 Ethernet Communication Overview.”

Contents

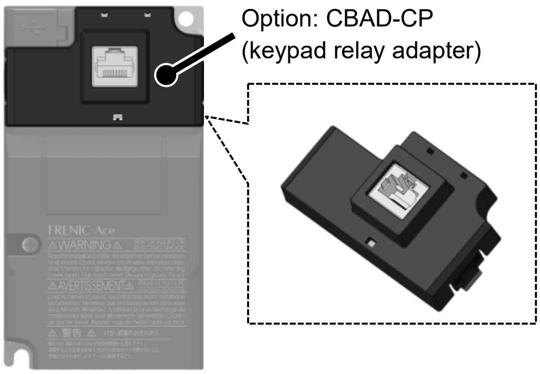
9.1 Overview of RS-485 Communication

The FRENIC-Ace has two RS-485 communication ports at the locations shown below. (RS-485 ports are not installed on the Ethernet built-in type (E3N).)

(i) Communication port 1: RJ-45 connector for the keypad (modular jack)*

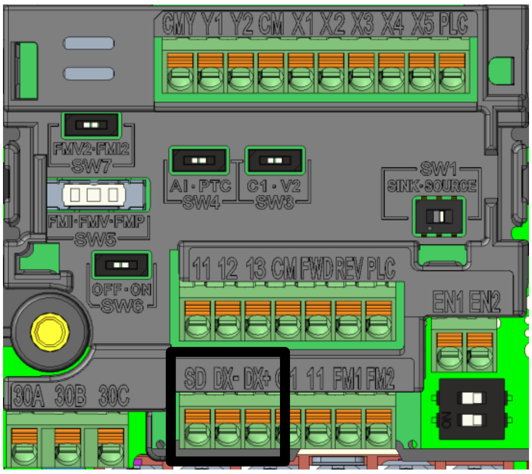
*The optional CBAD-CP is required to use it.

(ii) Communication port 2: RS-485 terminals (control circuit terminals [SD], [DX-], [DX+])



After installing the keypad relay adapter

COM port 1



COM port 1

Using the RS-485 communication ports shown above enables the extended functions listed below.

• Remote operation from a keypad at the remote location (COM port 1)

The standard keypad enables remote operation by mounting the keypad on a remote panel and connecting the keypad to RJ-45 connector with an extension cable. (maximum cable length: 20 m (66 ft))

• Operation by FRENIC Loader (COM ports 1 and 2)

FRENIC Loader (refer to “9.2 FRENIC Loader Overview”) can also be used by connecting RS-485 communication port 1 or 2 to a PC using an RS-485 converter.

• Control via host equipment (COM ports 1 and 2)

Connecting the inverter to the host equipment (upper controller), such as a PC and programmable controller (PLC), enables the user to control the inverter as a subordinate device.

Besides the communication port 1 (RJ-45 connector) shared with the keypad, the FRENIC-Ace has the RS-485 communication port 2 by default.

The protocols for controlling inverters support the Modbus RTU protocol and BACnet MS/TP that is widely used, and Fuji Electric’s general-purpose inverter protocol that is common to Fuji Electric’s inverters including conventional series.

Note

- Connecting the keypad to the COM port 1 automatically switches to the keypad protocol; there is no need to modify the function code setting.
- BACnet MS/TP can only be used on one of the systems.
  For details, refer to Chapter 5 “5.3 Description of Function Codes (5.3.16 y codes (Link functions) Protocol Selection (y10, y20)).”
- If connecting to FRENIC Loader, Modbus RTU protocol is used.
  For details, refer to the FRENIC Loader Instruction Manual.

For details of RS-485 communication, refer to the RS-485 Communication User’s Manual.

COMMUNICATION FUNCTIONS

Chap 9

9.1.1 RS-485 common specifications

Table 9.1-1

Item	Specification		
Protocol	FGI-BUS	Modbus RTU	BACnet MS/TP
Compliance	Fuji general-purpose inverter protocol	Modicon Modbus RTU-compliant (only in RTU mode)	ASHRAE/ANSI/ISO -compliant
Connection quantity	Host device: 1, Inverters: Up to 31		
Electrical mode	EIA RS-485		
Connection to RS-485	RJ-45 connector or terminal block		
Synchronization	Asynchronous		
Communication system	Half-duplex		
Transmission speed (bps)	2400, 4800, 9600, 19200, 38400, 57600, 76800, and 115200		9600, 19200, 38400bps, 76800bps
Max. transmission cable length	500 m (1640 ft)		
Station No.	1 to 31	1 to 247	0 to 127
Message frame format	FGI-BUS	Modbus RTU	MS/TP
Frame synchronization	Header character detection (SOH)	Detection of no-data time (for 3-character period)	Header 2-character (preamble) detection (0x55,0xFF)
Frame length	Normal transmission: 16 bytes (fixed) High-speed transmission: 8 or 12 bytes	Variable length	Variable length
Max. transfer data	Write: 1 word Read: 1 word	Write: 100 words Read: 100 words	Write: 50 words Read: 50 words
Messaging system	Polling/Selecting/Broadcast		
Transmission character format	ASCII	Binary	Binary *String readout data: ASCII
Character length	8 or 7 bits Selectable with the function code	8 bits (fixed)	8 bits (fixed)
Parity	Even, Odd, or None (selectable by the function code)		None
Stop bit length	1 or 2 bits Selectable with the function code	Parity none: 2/1 bit Parity: 1 bit Select by parity setting.	1 bit (fixed)
Error checking	Sum-check	CRC-16	Header CRC Data CRC

9.1.2 Terminal specifications

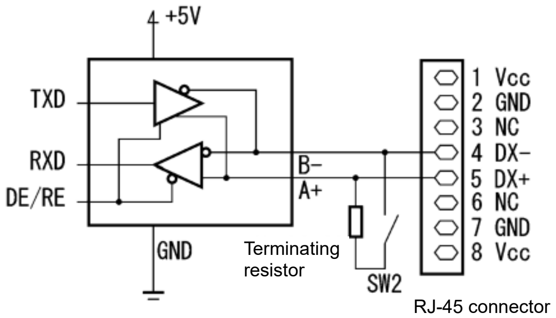
[1] RS-485 communication port 1 (for connecting the keypad)

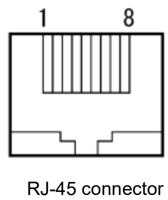
Connect the keypad port using the keypad relay adapter CBAD-CP. The pin assignment for the CBAD-CP's RJ-45 connector is as follows in Table 9.1-2.

Table 9.1-2

Pin	Signal name	Description	Remark
1,8	Vcc	Power source for the keypad	5V
2,7	GND	Ground signal	GND
3,6	NC	Not connected	-
4	DX-	RS-485 signal (-)	The terminating resistor 110 Ω is built in. Open/close with SW2. *
5	DX+	RS-485 signal (+)	

*For details about SW2, refer to Chapter 2, “2.2.7 Switching switches.”





Note: The power supply for the keypad is available in the RJ-45 connector for RS-485 communication (Pins 1, 2, 7, and 8). When connecting other devices to the RJ-45 connector, take care not to use those pins. Use pins **4 and 5 only**.

[2] RS-485 communication port 2

The RS-485 communication port 2 designed for a standard keypad uses an RJ-45 connector having the following pin assignment:

Table 9.1-3

Terminal symbol	Description	Remarks
【SD】	Shield terminal	
【DX-】	RS-485 signal (-)	The terminating resistor 110 Ω is built in. Open/close with SW6. *
【DX+】	RS-485 signal (+)	

*For details about SW6, refer to Chapter 2, “2.2.7 Switching switches.”

9.1.3 Connection method

- Up to 31 inverters can be connected to one host equipment.
- A common protocol is used in the FRENIC series of general-purpose inverters, so programs for similar host equipment can run/stop the inverter.
  (The parameter specifications may differ depending on the equipment.)
- Fixed-length transmission frames facilitate developing programs for hosts.

For details on RS-485 communication, refer to the "RS-485 Communication User's Manual."

Multi-drop connection using the RS-485 COM port 1 (for connecting the keypad)

Remove the keypad, and use the optional keypad relay adapter (CBAD-CP) and a branch adapter for multi-drop (non-Fuji Electric product) as shown in the figure below.

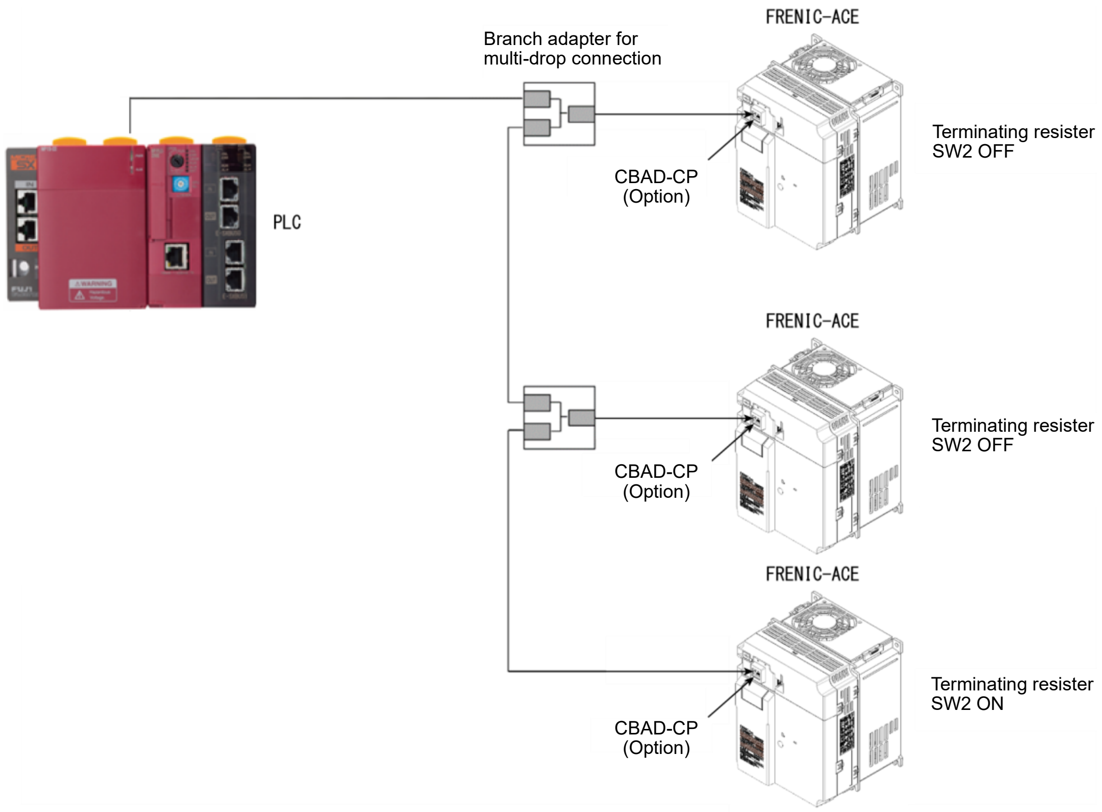


Fig. 9.1-1 Multi-drop connection diagram (RJ-45 connector connection)

Note

- The power supply for the keypad is available in the RJ-45 connector for RS-485 communication (COM port 1) (pins 1, 2, 7 and 8). When connecting other devices to the RJ-45 connector, take care not to use those pins. Use **pins 4 and 5 only**. (For details, refer to "9.1.2 Terminal specifications.")
- When selecting additional devices to prevent damage or malfunction of the control PCB caused by external noise, or to eliminate the influence of common mode noise, be sure to refer to "9.1.4 RS-485 connection devices."
- The maximum wiring length must be 500 m (1640 ft).
- Use the cables and converters which meet the specifications for connecting to the RS-485 COM ports.
  (For details, refer to "[2] Requirements for the cable (COM port 1: for RJ-45 connector)" in "9.1.4 RS-485 connection devices.")

Multi-drop connection using the RS-485 COM port 2 (terminal block)

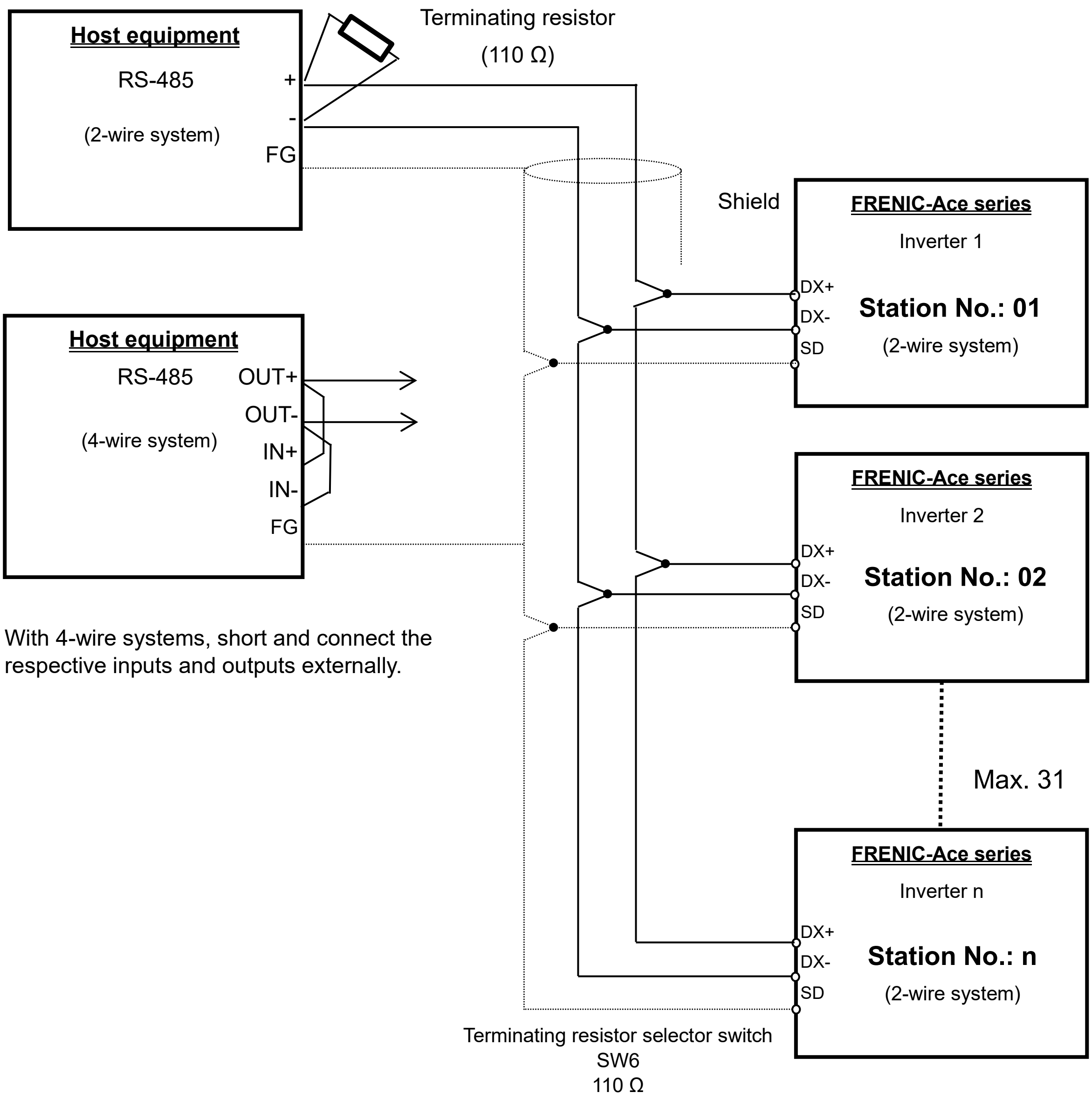


Fig. 9.1-2 Multi-drop connection diagram (terminal block connection)

Note: Use the cables and converters which meet the specifications for connecting to the RS-485 COM ports. (For details, refer to “[3] Requirements for the cable (COM port 2: for RS-485 terminal block connection)” in “9.1.4 RS-485 connection devices.”)

9.1.4 RS-485 connection devices

This section describes the devices required for connecting the inverter to a PC having no RS-485 interface, or for connecting two or more inverters in a multi-drop network.

[1] Converter

PCs are generally not equipped with an RS-485 port. Therefore, an RS-232C - RS-485 converter or USB - RS-485 converter is required. To use the equipment properly, be sure to use a converter which meets the recommended specifications below, as a converter which is not recommended may not work properly.

Specifications for recommended converters

Send/receive switching:	Auto-switching by monitoring the transmission data on the PC (RS-232C)
Electric isolation:	Electrically isolated from the RS-485 port
Fail-safe:	Fail-safe function*
Other requirements:	Superior noise immunity

* The fail-safe function refers to a feature that ensures the RS-485 receiver's output is at "logic high" even if the RS-485 receiver's input is opened or short-circuited or all the RS-485 drivers are inactive.

Recommended converters

System Sacom Sales Corporation (Japan): KS-485PTI (RS-232C - RS-485 converter)
: USB-485I RJ-45-T4P (USB - RS-485 converter)

[2] Requirements for the cable (COM port 1: for RJ-45 connector)

Use a standard LAN cable (straight 10BASE-T/100BASE-TX cable which satisfies US ANSI/TIA/EIA-568A category 5 standard or higher).

Note The power supply for the keypad is available in the RJ-45 connector for RS-485 communication (COM port 1) (pins 1, 2, 7 and 8). When connecting other devices to the RJ-45 connector, take care not to use those pins. Use **pins 4 and 5 only**.

[3] Requirements for the cable (COM port 2: for RS-485 terminal block connection)

Use a twisted-pair cable (AWG16 to 26) for long-distance transmission for the connection cable to ensure a reliable connection.

[4] Branch adapter for multi-drop

The RJ-45 connector is used as the communication connector. To use a standard LAN cable for multi-drop connection, use the branch adapter for the RJ-45 connector.

Recommended branch adapter

SK Koki (Japan): MS8-BA-JJJ

[5] Keypad relay adapter CBAD-CP

It is necessary to install the keypad relay adapter CBAD-CP to use the communication port 1.

Option type: CBAD-CP

9.1.5 RS-485 noise suppression

Depending on the operating environment, a malfunction may occur due to the noise generated by the inverter. Possible measures to prevent such malfunction are: separating the wiring, use of shielded cable, isolating the power supply, and adding an inductance component. The description shown below is an example of adding an inductance.

For details, refer to the RS-485 Communications User's Manual.

Adding inductance components

Keep the impedance of the signal circuit high against the high-frequency noises by inserting an inductance component, such as by inserting a choke coil in series or passing the signal line through a ferrite core.

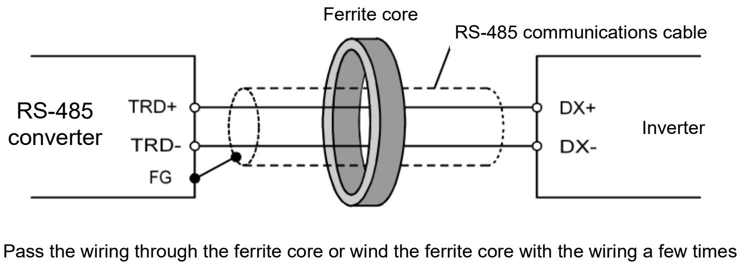


Fig. 9.1-3 Adding an inductance component

9.2 FRENIC Loader Overview

By connecting the inverter with a PC, FRENIC Loader allows users to edit, set, and manage inverter function codes, monitor running data, carry out remote operations such as running and stopping, and monitor data such as the running status and alarm history. FRENIC Loader is also equipped with functions which allow users to create logic circuits for the inverter customizable logic function, and to write data to the inverter.

This software can be downloaded and used free of charge from the Fuji Electric website.

For details, refer to the FRENIC Loader Instruction Manual.
URL: https://felib.fujielectric.co.jp/en

9.2.1 Specifications

Table 9.2-1

Item		Specifications	Remarks
Name		Inverter support loader (FRENIC Loader4)	Compatible with Version 1.3.0.0 or later
Compatible inverters		FRENIC-MEGA/HVAC/AQUA/Ace/eFIT/Multi/Eco/Mini	
Number of connected inverters		USB connection: 1 unit RS-485 connection: Up to 31 units	
Recommended cable		Cable (10BASE-T or higher) compliant with EIA-568A RJ-45 connector	In the case of RS-485 connection
Operating environment	OS	Microsoft Windows 10 (32 bit,64 bit) Microsoft Windows 11	
	Memory	2 GB or more RAM	4 GB or more recommended.
	Hard disk	800 MB or more of available capacity recommended.	
	COM port	RS-232C (conversion to RS-485 communication is required to connect inverters) or USB	
	Monitor	1024 ×768 or higher resolution	FHD (1920×1080) or more monitor is recommended.
Function	Function code setting	• Reading function codes from inverter • Function code editing, data management • Writing function codes to inverter • Auto tuning operation	
	Run monitor	• Inverter I/O signal status check • Maintenance information and alarm information check • Operating status monitor	
	Real-time trace function	• Inverter I/O signals and changes in the operating status on the time axis can be monitored.	Display scale: 20 ms/div to 10 min/div
	Historical trace function	• Inverter I/O signals and changes in the operating status on the time axis can be recorded inside the inverter, allowing the status to be checked with a signal (trigger).	Display scale: 1 ms/div to 60 min/div
	Test run function	• An inverter test run can be carried out from the PC Loader screen.	
	Scheduled operation	• Timer operating condition settings for models with built-in real-time clock	Not applicable to FRENIC-Ace
	Customizable logic	• Logic circuit creation • Writing to inverter • Debug function using on-line monitor	

Item		Specifications	Remarks
	Traceback function	Data specified before or after the occurrence of triggers such as alarms is automatically stored in the inverter or the keypad memory, allowing data to be acquired and waveforms to be displayed on FRENIC Loader. • Data for a single event is stored in the remote keypad TP-E2. • Data for 100 events is stored in the multi-function keypad TP-A2SW (when microSD memory card is installed). • Data for a single event is stored in the inverter when a keypad other than the keypad mentioned above is connected.	The output frequency, output current, intermediate DC voltage, and signals for terminals Y1 to Y5 from 2 seconds before to 0.5 seconds after the last alarm occurred are stored by factory default. The remote keypad (TP-E2) and multi-function keypad (TP-A2SW) are options. The microSD memory card is sold separately.

9.3 Ethernet Communication Overview

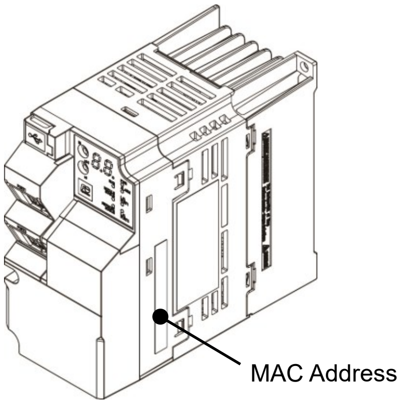
This chapter provides explanations only in relation to the use of the Ethernet built-in type (E3N). For details on Ethernet connection using the Multiprotocol Ethernet® Communication Card (OPC-CP-ETM), refer to the Instruction Manual (INR-SI47-2467-JE) of the Multiprotocol Ethernet® Communication Card.

With the E3N, you can connect the FRENIC-Ace to a master device (PLC, PC for industrial use, etc.) with Ethernet and control the inverter as an “adapter,” a “server (EtherNet/IP)” or a “device (PROFINET)” using run commands, frequency commands, function code access, etc.

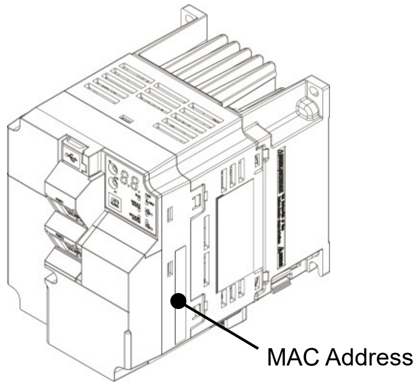
The MAC address of the Ethernet built-in type is indicated on the following label, which is attached to the product.

MAC Address

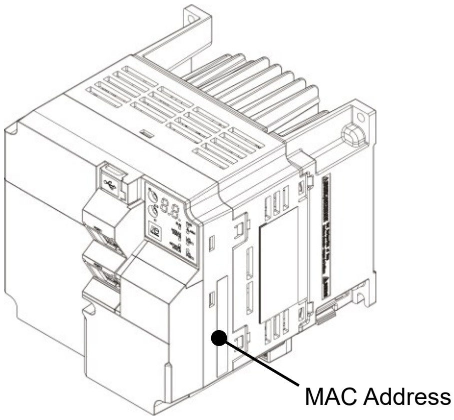
Label position



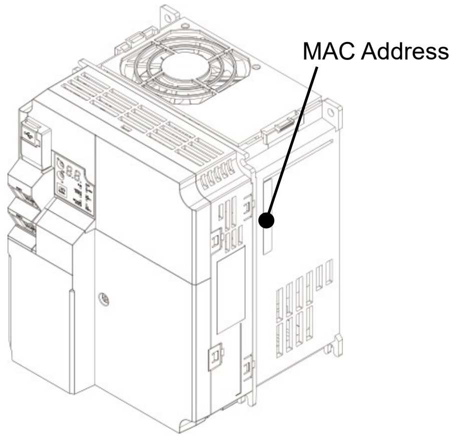
FRN0001E3N-2G, FRN0002E3N-2G
FRN0004E3N-2G, FRN0006E3N-2G
FRN0001E3N-7G, FRN0002E3N-7G
FRN0004E3N-7G, FRN0006E3N-7G



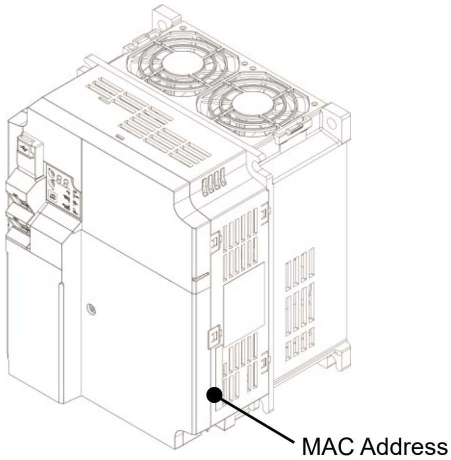
FRN0010E3N-2G, FRN0012E3N-2G
FRN0002E3N-4G, FRN0004E3N-4G
FRN0006E3N-4G, FRN0007E3N-4G
FRN0010E3N-7G

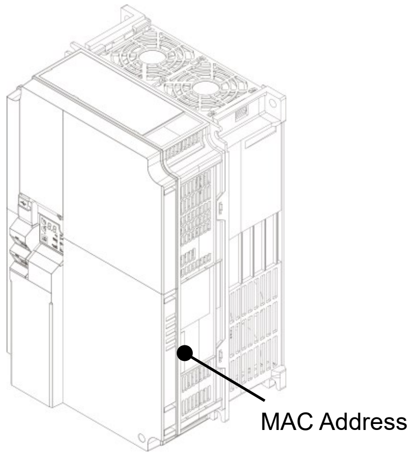


FRN0020E3N-2G, FRN0012E3N-4G
FRN0012E3N-7G



FRN0030E3N-2G, FRN0040E3N-2G
FRN0022E3N-4G, FRN0029E3N-4G





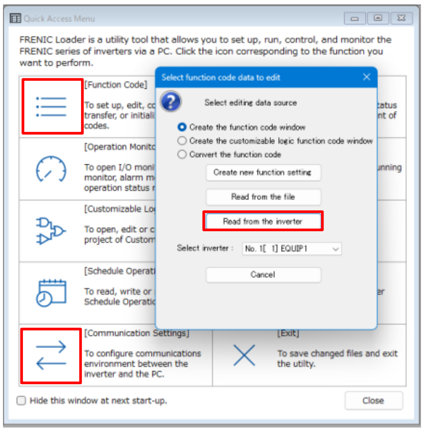
FRN0056E3N-2G, FRN0069E3N-2G
FRN0037E3N-4G, FRN0044E3N-4G

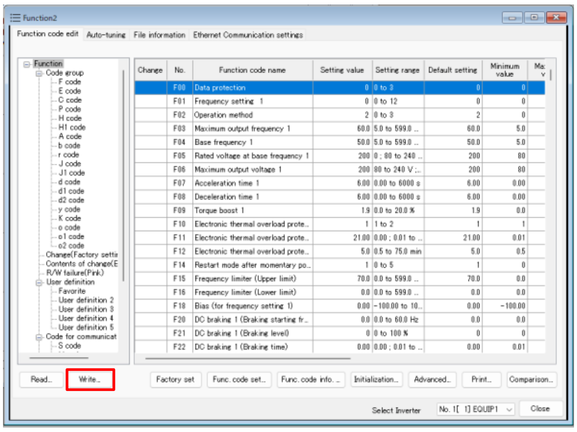
FRN0088E3N-2G, FRN0115E3N-2G
FRN0059E3N-4G, FRN0072E3N-4G

Tip

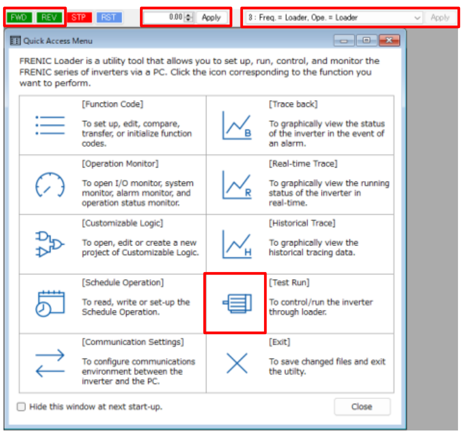
The E3N type is not equipped with a keypad on the main body. To perform initial settings, test runs, etc., connect the inverter to a PC which has FRENIC-Loader installed, and perform through FRENIC-Loader.

(Ex. 1) Function code setting
After completing [Communication settings], perform [Read from inverter] in [Function code settings].
You can view the function code tables, allowing you to transfer changed settings to the inverter by clicking the [Write] button after making the necessary changes. For details on operation, refer to the FRENIC-Loader instruction manual.





(Ex. 2) Test run
After completing [Communication settings], click [Test run] to display the operation menu.
After switching command authority to “Loader,” provide frequency/run commands, and run. For details on operation, refer to the FRENIC-Loader instruction manual.



9.3.1 Setup procedure for Ethernet communication

Section	Step	Description
	Installation	
9.3.2	Cabling this product to the network	Connect between the master and this product with the recommended dedicated cable.
	Configure the master	Use the configuration tool on the master side to define and register the network and connected devices (inverters).
	Configuration of the master	For details, refer to the instruction manuals for each master and configuration tool. (Not described in this manual.)
	Set inverter's function codes (Also refer to "Note" below.)	EDS files and GSDML files can also be used.
	Set the rotary switch	When you want to fix the IP address of this product with the rotary switches, it is recommended to set them before turning the inverter ON.
	Inverter power ON state	
9.3.4	Set Ethernet connection-related settings	Set the IP address, subnet mask, and default gateway.
9.3.4	Select communication protocol	Specify the communication protocol to be used by o214. For details on protocols, refer to 9.3.5.
9.3.4	Set command-related/error operations	• Setting of command privileges and command source (not required for monitoring only) • Operation settings when a fault occurs
	Apply the Ethernet communication settings	Write o299=1 to apply the Ethernet connection settings to the inverter operations. o299 returns automatically to "0." The settings can also be applied by turning the inverter OFF, then ON.
	Check Ethernet communications	
9.3.8	Check the Network Status LED	Check if the network status LED indicates normal status.
	Check Ethernet communications between the master and inverter	Send a command from the master to communicate with the inverter. You can also issue a Ping command from your PC, etc., to the IP address set in the inverter and check whether something is wrong in the settings related to the Ethernet connection, such as the IP address or the cable connection, depending on the response. If a fault occurs, refer to Troubleshooting and remove the cause. For details, refer to Chapter 6 "TROUBLESHOOTING."

ヒント For the E3N type, the factory default settings (function code y97 is set to "1") specify the temporary memory as the save destination for changed function code settings.
When you want to save the changed content to the nonvolatile memory, perform one of the following.

- After changing the function code settings, set y97 to "2."
  The saved content is transferred to the nonvolatile memory. (After transferring, the setting for y97 automatically returns to "1.")
- Set y97 to "0" (save destination: specify nonvolatile memory) before changing the function code settings.(There is a limit to the number of times the nonvolatile memory can be rewritten, so when performing this option, it is recommended to reset y97 to "1" after changing the function code settings.)

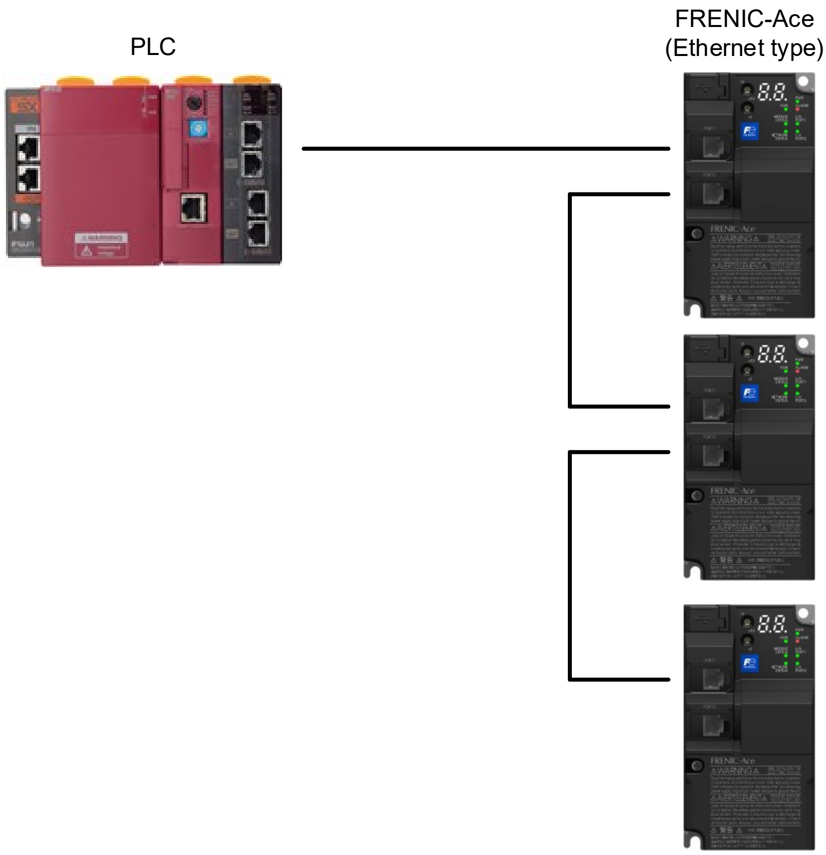
9.3.2 Ethernet cable connection

The supported network topology types vary depending on the protocol, as shown in the table below.
For details, refer to descriptions of each protocol.

Protocol	Ethernet Port		Network Topology		
	Port1	Port2	Star	Bus/Daisy Chain	Ring
EtherNet/IP	**Y**	**Y**	**Y**	**Y**	**N**
PROFINET	**Y**	**N**	**Y**	**N**	**N**
Modbus TCP	**Y**	**Y**	**Y**	**Y**	**N**

Y: Supported N: Not supported

Ethernet connection example (bus/daisy chain connection)



Note
- Use segments of 100 m maximum (328 ft.) for the cable length.
- Use UTP or STP cables of CAT5e or higher.

9.3.3 Recommended communication cables

To connect this product to an Ethernet network, use an Ethernet dedicated cable that complies with the Ethernet/IP or PROFINET specifications in the table below.

Using a cable other than an Ethernet dedicated cable will not guarantee Ethernet/IP or PROFINET performance.

Communication cable specifications

Twisted pair cables (shielded)	Conforms to CAT 5e standards
	OOBT/100BASE-TX compliant
	STP cable (straight/crossable)

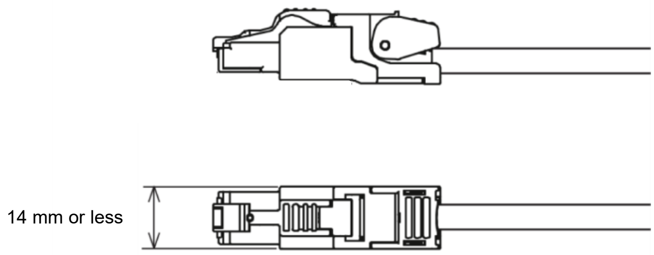
Note For more information on communication cables, refer to the websites below.

- ODVA (Open DeviceNet Vendor Association, Inc.) https://www.odva.org/
- PROFIBUS & PROFINET International (PI) https://www.profibus.com/

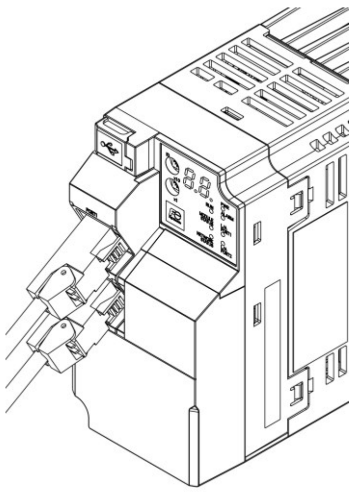
Recommended cables/plugs (As of August 2024)

Cable Assembly	RJ-45 Plug
FNCE-C5EM-T□−□□−□ (Misumi)	J00026A2003 (Japan Telegärtner)
3RHS4-1100-□M (3M Japan)	3R104-1110-□□0 AM (3M Japan)

Recommended plug dimensions



Example cable connection



9.3.4 Function code settings for the inverter

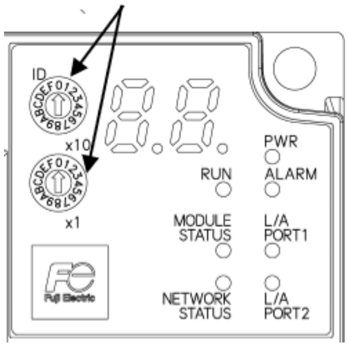
[1] Configuring the IP address

Configure the IP address.

Function Code	Name	Selection	Description
o213	IP address setting mode	0: Fixed	Set with IP address setting 1 to 4 (o201 to o204).
		1: Hard switching	Set with IP address setting 1 to 3 (o201 to o203) + Rotary switch (ID-SW)*1.
		2: DHCP (Other than PROFINET)	Dynamic Host Configuration Protocol (DHCP) is a network management protocol used to dynamically assign an IP address.
		3: DCP (PROFINET)	PROFINET devices are typically assigned device names and IP addresses using Discovery and Configuration Protocol (DCP).

*1 Position (front cover) of rotary switches (ID-SW)

ID-SW (x10, x1)



<u>Function codes for configuring the IP address, subnet mask, and default gateway</u>

If a new configuration is set with these function codes, the inverter must be restarted to apply the new configuration.

Function Code	Name	Description
o201	IP address setting 1	Example: To set to " 192.168.11.1," set as follows. o201 = 192 o202 = 168 o203 = 11 o204 = 1 (when o213 = 1, the setting of the rotary switch (ID-SW) is referenced.)
o202	IP address setting 2	
o203	IP address setting 3	
o204	IP address setting 4	
o205	Subnet mask setting 1	Example: Set as follows if 255.255.255.0 is set. o205 = 255 o206 = 255 o207 = 255 o208 = 0
o206	Subnet mask setting 2	
o207	Subnet mask setting 3	
o208	Subnet mask setting 4	
o209	Default gateway setting 1	Example: Set as follows if 192.168.11.1 is set. o209 = 192 o210 = 168 o211 = 11 o212 = 1
o210	Default gateway setting 2	
o211	Default gateway setting 3	
o212	Default gateway setting 4	

[2] Selecting the communication protocol

Select the communication protocol.

Function Code	Name	Description
o214	Protocol Settings	1：PROFINET-RT 2：EtherNet/IP 3：Modbus TCP

* If a new configuration is set with this function code, restart the inverter or write o229 = 1 to apply the new configuration.

[3] Applying the settings to the network

The network settings are applied to the device operation by setting o299 to “1.”

Tip The network settings can also be applied to the device operation by restarting the inverter.

Function Code	Name	Description
o299	Apply Ethernet settings	0: Initial value 1: The o201 to o284 settings are applied to the network (The value automatically returns to 0.)

[4] Inverter response to network timeout

Inverter function codes o27 and o28 specify the inverter's response when a network timeout occurs.

Inverter response to network timeout (Function codes o27 and o28)

o27	o28	Inverter Response when a Timeout Occurs	Remarks
0, 4 to 9	-	Immediately coast to a stop and Er5 trip	
1	0.0s to 60.0s	After the time specified by o28, coast to a stop and Er5.	
2	0.0s to 60.0s	If the communication link is restored within the time specified by o28, ignore the communication error. After the timeout, coast to a stop and Er5.	
3, 13 to 15	-	Maintains present operation, ignoring the communication error. (No Er5 trip)	
10	-	Immediate forced deceleration. Er5 trip after stopping.	The time for forced deceleration is specified by the inverter function code H56.
11	0.0s to 60.0s	After the time specified by o28, forced deceleration. Er5 trip after stopping.	Same as above
12	0.0s to 60.0s	If the communication link is restored within the time specified by o28, ignore the communication error. After the timeout, forced deceleration and Er5 trip.	Same as above

Related function code

Set whether to clear operation command or setpoint held in the inverter when a communication error occurs.

Function Code	Name	Description
y95	Data clear selection for communication error	0: Data is not cleared when a communication error alarm occurs. 1: When a communication error alarm occurs, the setting data of the function codes S01, S05 and S19 are cleared. 2: When a communication error alarm occurs, the operation command assigned to the bits of function code S06 are cleared. 3: Perform selection 1 and 2. 4: Perform selection 3, and clear the setting data of the function codes S02, S03, S13, S15, S20 and S21. * The target alarms are Er8, ErP, Er4, Er5.

[5] Setting up monitoring and operation via Ethernet communication

The status of the inverter can be monitored via Ethernet communication if you set the master/scanner/client sides according to the procedure for the selected communication protocol.

To monitor and operate via Ethernet communication

Set the following function code.

Function Code	Name	Description		
y98	Bus function (operation selection)	Set value	Frequency/torque command	Run command
		0	Other than Ethernet According to the setting of the inverter	Other than Ethernet According to the setting of the inverter
		1	Via Ethernet	Other than Ethernet According to the setting of the inverter
		2	Other than Ethernet According to the setting of the inverter	Via Ethernet
		3	Via Ethernet	Via Ethernet

To switch between running operation via Ethernet communication and other running operations

Use the following switching function.

Function Code	Name	Description
E01, etc.	Terminal X (Function selection)	24 (1024): Link operation selection (BUS optional) "LE"

• For details, refer to Chapter 5 “FUNCTION CODES.”

Note To interrupt the auto-tuning performed via Ethernet, use the "BX" function assigned to the digital-input terminals ([X1] to [X3], [FWD], [REV]).

[6] Saving function code settings

The setting contents of each function code can be saved to the E3N main body.

For the E3N type, the factory default settings (function code y97 is set to “1”) specify the temporary memory as the save destination for changed function code settings.
When you want to save the changed content to the nonvolatile memory, perform one of the following.

- After changing the function code settings, set y97 to “2.”
  The saved content is transferred to the nonvolatile memory. (After transferring, the setting for y97 automatically returns to “1.”)

- Set y97 to “0” (save destination: specify nonvolatile memory) before changing the function code settings.
  (There is a limit to the number of times the nonvolatile memory can be rewritten, so when performing this option, it is recommended to reset y97 to “1” after changing the function code settings.)

(Reference: Relationship between function code y97 and data save destination)

Function Code	Name	Description
y97	Communication data storage selection	0: Store into nonvolatile memory (Rewritable times are limited) 1: Write into temporary memory (Rewritable times are unlimited) 2: Save all data from temporary memory to nonvolatile memory (After all save, data returns to 1)

[7] Configuring an Ethernet network system

This manual does not describe how to set up the network system.

Set up the network system by referring to the instruction manual of the engineering tool for the network system and related materials.

The EDS file *1 and GSDML file *2 can be installed in the engineering tool of the network system to facilitate communication with the inverter. These files are not included with this product. Obtain these files from our product/technical information site (https://felib.fujielectric.co.jp/en).

*1 EDS file : The EDS file is a file that contains information specific to the Ethernet/IP device.

*2 GSDML file : The GSDML file is an XML format file that contains information specific to the PROFINET IO device.

9.3.5 Protocol specific information

[1] EtherNet/IP

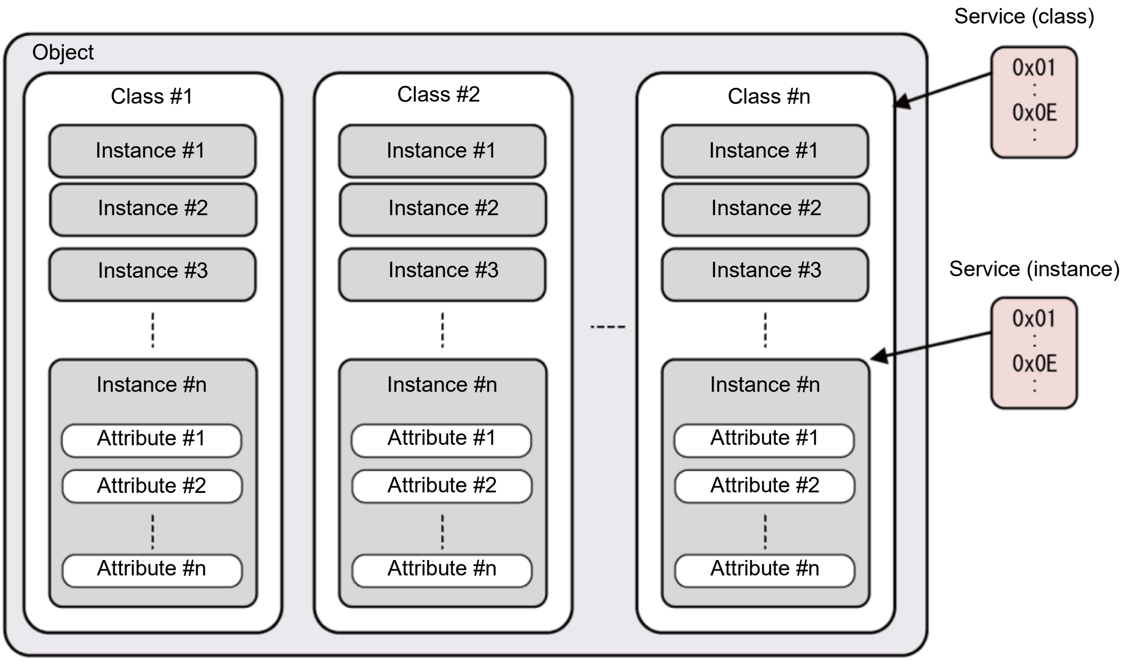
EtherNet/IP is a protocol that applies CIP (Common Industrial Protocol) to standard Ethernet.

Two communication features are provided:
- Implicit message communication, which communicates at a fixed cycle (RPI: Requested Packet Interval)
- Explicit message communication, which sends and receives at arbitrary timing.

Objects defined in CIP have the following elements:

Class	Class is a set of Objects that all represent the same kind of system component.
Instance	Instance is the actual representation of a particular Object within a Class. (Objects may be composed of several things.)
Attribute	Attribute represents detailed information within the instance.
Service	Service represents the means of access provided by the object.

Object Class/Instance/Attribute/Service Relationship



(1) AC Drive profile objects

The AC Drive profile of this product consists of the standard/specific class objects in the table below.
This manual does not describe details about standard class objects.

Refer to the Ethernet/IP specifications published by ODVA.

Note Objects not described in this manual are not supported by this product.

Objects supported by this product

I/O Connection Objects	Class Code	Description
Assembly Objects	0x04	

AC Drive Profile-Specific Objects	Class Code	Description
Motor Data Objects	0x28	These objects interact with the function codes of the inverter.
Control Supervisor Objects	0x29	
AC/DC Drive Objects	0x2A	

Vendor-Specific Objects	Class Code	Description
Fuji Electric Specific Objects	0x64	Provides direct access to the inverter function codes.
	0xA2	

Other CIP (EtherNet/IP) Common Objects	Class Code	Description
Identity Objects	0x01	Provides general identification information.
Connection Manager Objects	0x06	
TCP/IP Interface Objects	0xF5	
Ethernet Link Objects	0xF6	
QoS Objects	0x48	

Data types used in objects

Data type	Description	Range	
		Minimum	Maximum
BOOL	Boolean	0 (False)	1 (True)
SINT	Signed 8-bit integer value	-128	127
INT	Signed 16-bit integer value	-32768	32767
DINT	Signed 32-bit integer value	-2^{31}	$2^{31}-1$
USINT	Unsigned 8-bit integer value	0	255
UINT	Unsigned 16-bit integer value	0	65535
UDINT	Unsigned 32-bit integer value	0	$2^{32}-1$
STRING	Text (1 byte/character)		
SHORT_STRING	Character string (1 byte/character.1 byte length information)		
BYTE	Bit-value (8-bit)		
WORD	Bit-value (16-bit)		
DWORD	Bit-value (32-bit)		
EPATH	CIP bus segment		

1) Identity objects (Class code 0x01)

Identity objects provide identification and general information about the device.

Class attribute (Instance ID: 0x00)

Attribute ID	Access Rules	Name	Data Type	Description	Value
1	Get	Revision	UINT	Revision information for this object	1
2	Get	Max Instance	UINT	Maximum number of instances of the object currently being created	1
3	Get	Number of Instance	UINT	Number of object instances that are currently being created	1

Class service

Service Code	Name	Description
0x01	Get_Attribute_All	Reads the content of all attributes.
0x0E	Get_Attribute_Single	Reads the content of the specified attribute.

Instance attribute (Instance ID: 0x01)

Attribute ID	Access Rules	Name	Data Type	Description	Value
1	Get	Vender ID	UINT	Identification number of each vendor	319 (Fuji Electric)
2	Get	Device Type	UINT	General type of product	2 (AC drive)
3	Get	Product Code	UINT	Identification of each vendor's individual product	0x2430
4	Get	Revision	STRUCT of	Revision of the field represented by identity	Includes the following
		Major Revision	USINT	Major revision	1 to 255
		Minor Revision	USINT	Minor Revision	1 to 255
5	Get	Status	WORD	Device Overview Status	According to CIP specifications.
6	Get	Serial Number	UDINT	Serial number of the device	Same as MAC address
7	Get	Product Name	SHORT_STRING	Distinguished name that the user can recognize	“FRENIC-Ace(E3N)”

Instance services

Service Code	Name	Description
0x01	Get_Attribute_All	Reads the content of all attributes.
0x05	Reset	Starts RESET service.
0x0E	Get_Attribute_Single	Reads the content of the specified attribute.

2) Message router objects (Class Code 0x02)

This product does not support access to class and instance attributes for these objects. It is only used to route Explicit messaging to other objects.

3) Assembly objects (Class code 0x04)

These objects provide the setting and monitoring of parameters related to the control of the motor.
This product supports only Data attribute (Attribute ID 3) of I/O Assembly instances in Assembly objects.

Class attribute (Instance ID: 0x00)

Attribute ID	Access Rules	Name	Data Type	Description	Value
1	Get	Revision	UINT	Revision information for this object	2
2	Get	Max Instance	UINT	Maximum number of instances of the object currently being created	199
3	Get	Number of Instance	UINT	Number of object instances that are currently being created	8

Class service

Service Code	Name	Description
0x0E	Get_Attribute_Single	Reads the content of the specified attribute.

Instance attribute (Instance ID: Selected I/O Assembly instance)

Attribute ID	Access Rules	Name	Data Type	Description	Value
3	Get/Set	Data	ARRAY of BYTE	I/O Assembly object data	According to the selection of I/O Assembly instances.

Instance services

Service Code	Name	Description
0x0E	Get_Attribute_Single	Reads the content of the specified attribute.
0x10	Set_Attribute_Single	Writes the content of the specified attribute.

Supported instance

<table>
<tr><th>Instance ID</th><th>Attribute ID</th><th>Access Rules</th><th>Name</th><th>Size Byte</th><th>Remarks</th></tr>
<tr><td>20</td><td rowspan="6">3</td><td rowspan="3">Get/Set</td><td>Basic Speed Control Output</td><td>4</td><td rowspan="3">Output
(Set and command from master to inverter)</td></tr>
<tr><td>21</td><td>Extended Speed Control Output</td><td>4</td></tr>
<tr><td>100</td><td>Fuji Drive Assembly Output *1</td><td>0 to 64 variable</td></tr>
<tr><td>70</td><td rowspan="3">Get</td><td>Basic Speed Control Input</td><td>4</td><td rowspan="3">Input
(Monitor status from inverter to master)</td></tr>
<tr><td>71</td><td>Extended Speed Control Input</td><td>4</td></tr>
<tr><td>150</td><td>Fuji Drive Assembly Input *1</td><td>2 to 64 variable</td></tr>
</table>

*1: These Instances are Fuji Electric-specific instances.

Instance ID = 20, 21 or 100: Can be configured from 0 to 32 WORD (0 Byte to 64 Byte) in WORD size,
Instance ID = 70, 71, 150: Can be configured from 1 to 32 WORD (2 Byte to 64 Byte) in WORD size.

An I/O Assembly instance is an assembly of data components scattered around each object that are related to motor control. Each of these data can also be accessed from the original object using an Explicit message.

4) Connection Manager objects (Class code 0x06)

Use these objects for connection and connectionless communications, including establishing connections across multiple subnets.

Class attribute (Instance ID: 0x00)

Attribute ID	Access Rules	Name	Data Type	Description	Value
1	Get	Revision	UINT	Revision information for this object	1
2	Get	Max Instance	UINT	Maximum number of instances of the object currently being created	1
3	Get	Number of Instance	UINT	Number of object instances that are currently being created	1

Class service

Service Code	Name	Description
0x01	Get_Attribute_All	Reads the content of all attributes.
0x0E	Get_Attribute_Single	Reads the content of the specified attribute.

Instance attribute (Instance ID: 0x01)

Attribute ID	Access Rules	Name	Data Type	Description	Value
1	Get	Open Request	UINT		0
2	Get	Open Format Rejects	UINT		0
3	Get	Open Resource Rejects	UINT		0
4	Get	Open Other Rejects	UINT		0
5	Get	Close Request	UINT		0
6	Get	Close Format Requests	UINT		0
7	Get	Close Other Requests	UINT		0
8	Get	Connection Timeouts	UINT		0

Instance services

Service Code	Name	Description
0x01	Get_Attribute_All	Reads the content of all attributes.
0x0E	Get_Attribute_Single	Reads the content of the specified attribute.
0x4E	Forward_Close	
0x52	Unconnected_Send	
0x54	Forward_Open	
0x5B	Large_Forward_Open	

5) Motor data objects (Class code 0x28)

These objects serve as a database of motor parameters.
The settings of these objects interact with the parameters of the inverter.

Class attribute (Instance ID: 0x00)

Attribute ID	Access Rules	Name	Data Type	Description	Value
1	Get	Revision	UINT	Revision information for this object	1
2	Get	Max Instance	UINT	Maximum number of instances of the object currently being created	1
3	Get	Number of Instance	UINT	Number of object instances that are currently being created	1

Class service

Service Code	Name	Description
0x01	Get_Attribute_All	Reads the content of all attributes.
0x0E	Get_Attribute_Single	Reads the content of the specified attribute.

Instance attribute (Instance ID: 0x01)

Attribute ID	Access Rules	Name	Data Type	Description	Value
1	Get	NumAttr	USINT	Number of Attributes	4
3	Get	MotorType	USINT	Specify motor type	3 = PMSM 7 = Squirrel-cage induction motor
6	Get/Set	RatedCurrent	UINT	Motor rated current (Unit: 100 mA)	According to the setting of the inverter Example) 6 = 0.6 A
7	Get/Set	RatedVoltage	UINT	Motor rated voltage (Unit: 1 V)	According to the setting of the inverter. Example) 200 = 200 V
12	Get/Set	PoleCount	UINT	Number of motor poles	According to the setting of the inverter

Instance services

Service Code	Name	Description
0x0E	Get_Attribute_Single	Reads the content of the specified attribute.
0x10	Set_Attribute_Single	Writes the content of the specified attribute.

6) Control Supervisor objects (Class code 0x29)

These objects model all the management features of the motor control device.
The settings of these objects interact with the parameters of the inverter.

Class attribute (Instance ID: 0x00)

Attribute ID	Access Rules	Name	Data Type	Description	Value
1	Get	Revision	UINT	Revision information for this object	1
2	Get	Max Instance	UINT	Maximum number of instances of the object currently being created	1
3	Get	Number of Instance	UINT	Number of object instances that are currently being created	1

Class service

Service Code	Name	Description
0x01	Get_Attribute_All	Reads the content of all attributes.
0x0E	Get_Attribute_Single	Reads the content of the specified attribute.

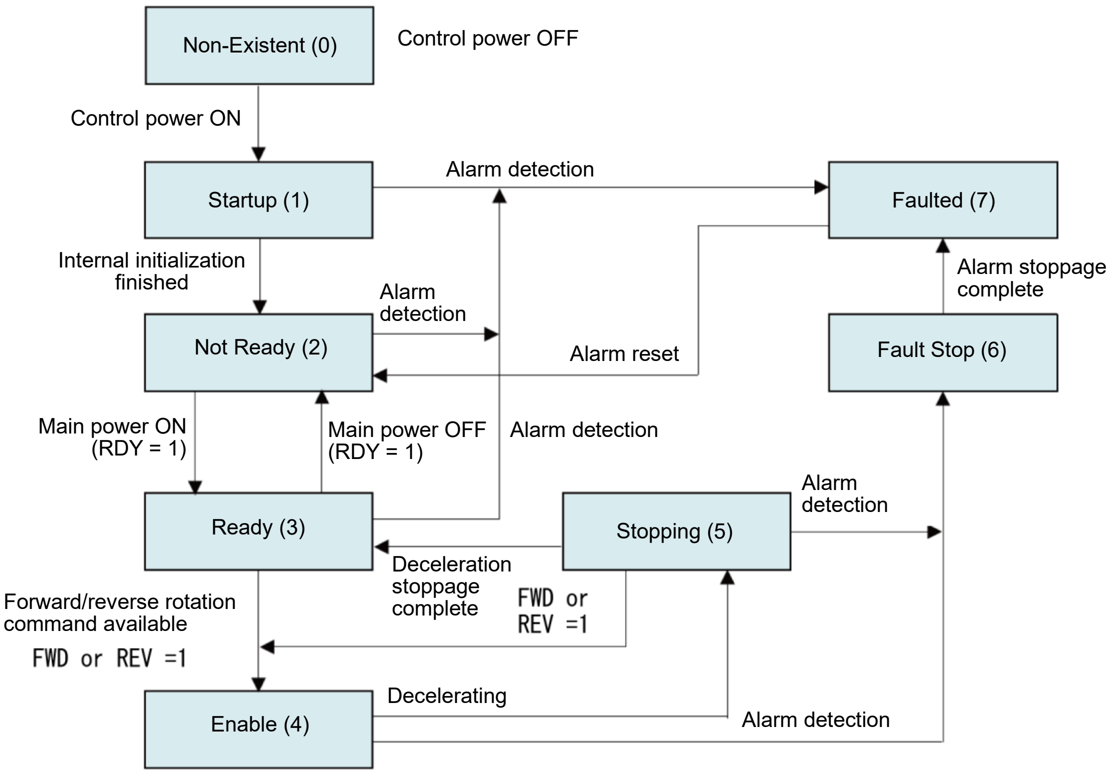
Instance attribute (Instance ID: 0x01)

Attribute ID	Access Rules	Name	Data Type	Description	Value
3	Get/Set	Run1	BOOL	Forward operation command	0: Stop command (initial value) 1: Operation command
4	Get/Set	Run2	BOOL	Reverse operation command	0: Stop command (initial value) 1: Operation command
5	Get/Set	NetCtrl	BOOL	Operation command privileges The actual status can be monitored by attribute 15 (CtlFromNet).	0: Other than network (default) 1: Network control
6	Get/Set	State	UINT	Inverter status 📖 For details, refer to "[State transition]."	1 = Startup 2 = Not_ready 3 = Ready 4 = Enabled 5 = Stopping 6 = Fault_Stop 7 = Faulted
7	Get	Running1	BOOL	Operation status (forward)	0: Stop or reverse operation 1: During forward operation (FWD)
8	Get	Running2	BOOL	Operation status (reverse)	0: Stop or forward operation 1: During reverse operation (REV)
9	Get	Ready	BOOL	Status of inverter operation preparation	1: Operation ready (RDY) 0: Otherwise
10	Get	Faulted	BOOL	Alarm occurrence status	1: Alarm occurring 0: Normal
11	Get	Warning	BOOL	Warning occurrence status	Fixed at 0
12	Get/Set	FaultRst	BOOL	Request to cancel the alarm status	0→1: Alarm release request
15	Get	CtlFromNet	BOOL	Status of the run operation command control side	0: Controlled outside the network 1: Control from the network

Instance services

Service Code	Name	Description
0x05	Reset	Switches to Startup state. (Sets the speed command to 0 and the instance attribute to the default value.)
0x0E	Get_Attribute_Single	Reads the content of the specified attribute.
0x10	Set_Attribute_Single	Writes the content of the specified attribute.

[State transition]



7) AC/DC Drive objects (Class code 0x2A)

These objects model functions specific to AC drives such as speed setting and acceleration/deceleration time. The settings of these objects affect the parameters of the inverter.

Class attribute (Instance ID: 0x00)

Attribute ID	Access Rules	Name	Data Type	Description	Value
1	Get	Revision	UINT	Revision information for this object	1
2	Get	Max Instance	UINT	Maximum number of instances of the object currently being created	1
3	Get	Number of Instance	UINT	Number of object instances that are currently being created	1

Class service

Service Code	Name	Description
0x01	Get_Attribute_All	Reads the content of all attributes.
0x0E	Get_Attribute_Single	Reads the content of the specified attribute.

Instance attribute (Instance ID: 0x01)

Attribute ID	Access Rules	Name	Data Type	Description	Value
3	Get	AtReference	BOOL	Frequency attainment [FAR]	1: Frequency being reached
4	Get/Set	NetRef	BOOL	Operation privileges of the frequency command * The actual status can be monitored by attribute 29 (RefFromNet).	0: Other than network (default) 1: Network control
6	Get	DriveMode	USINT	Operation mode	0: Vendor-specific mode (Fixed at 0)
7	Get	SpeedActual	INT	Speed detection value (unit: $\frac{r/min}{2^{SpeedScale}}$) * *SpeedScale* is set with attribute 22.	Range: -32768 to 32767 *According to the value detected by the inverter.
8	Get/Set	SpeedRef	INT	Speed setting value (unit: $\frac{r/min}{2^{SpeedScale}}$)	Range: -32768 to 32767 (Initial value: 0)
9	Get	CurrentActual	INT	Output current (unit: $\frac{100mA}{2^{CurrentScale}}$) * *CurrentScale* is set with attribute 23.	Range: -32768 to 32767 *According to the value detected by the inverter.

Attribute ID	Access Rules	Name	Data Type	Description	Value
17	Get	OutputVoltage	INT	Output voltage (unit: $\frac{V}{2^{VoltageScale}}$) * *VoltageScale* is set with attribute 27.	Range: -32768 to 32767 *According to the value detected by the inverter.
18	Get/Set	AccelTime	UINT	Acceleration time (unit: $\frac{ms}{2^{TimeScale}}$) * *TimeScale* is set with attribute 28.	Range: 0 to 65535 (Initial value: 6000/20000)
19	Get/Set	DecelTime	UINT	Deceleration time (unit: $\frac{ms}{2^{TimeScale}}$) * *TimeScale* is set with attribute 28.	Range: 0 to 65535 (Initial value: 6000/20000)
20	Get/Set	LowSpeedLimit	UINT	Lower limit frequency (unit: $\frac{r/min}{2^{SpeedScale}}$)	Range: 0 to 65535 (Initial value: 0)
21	Get/Set	HighSpeedLimit	UINT	Maximum Frequency (unit: $\frac{r/min}{2^{SpeedScale}}$)	Range: 0 to 65535 (Initial value: 1800)
22	Get/Set	SpeedScale	SINT	Speed scaling factor * Adjusts the setting range.	Range: -128 to 127 (Initial value: 0)
23	Get/Set	CurrentScale	SINT	Current scaling factor * Adjusts the setting range.	Range: -128 to 127 (Initial value: 0)
27	Get/Set	VolatageScale	SINT	Voltage scaling factor * Adjusts the setting range.	Range: -128 to 127 (Initial value: 0)
28	Get/Set	TimeScale	SINT	Time scaling factor * Adjusts the setting range.	Range: -128 to 127 (Initial value: 0)
29	Get	RefFromNet	BOOL	Status of the frequency setting command control side	0: Controlled outside the network 1: Control from the network

<u>Instance services</u>

Service Code	Name	Description
0x0E	Get_Attribute_Single	Reads the content of the specified attribute.
0x10	Set_Attribute_Single	Writes the content of the specified attribute.

8) QoS objects (Class code 0x48)

Class attribute (Instance ID: 0x00)

Attribute ID	Access Rules	Name	Data Type	Description	Value
1	Get	Revision	UINT	Revision information for this object	1
2	Get	Max Instance	UINT	Maximum number of instances of the object currently being created	1
3	Get	Number of Instance	UINT	Number of object instances that are currently being created	1

Class service

Service Code	Name	Description
0x0E	Get_Attribute_Single	Reads the content of the specified attribute.

Instance attribute (Instance ID: 0x01)

Attribute ID	Access Rules	Name	Data Type	Description	Value
4	Get/Set	DSCP Urgent	USINT	CIP transmission Class 1 with Urgent Priority Message	55
5	Get/Set	DSCP Scheduled	USINT	CIP Transmission Class 1 with Scheduled Priority Message	47
6	Get/Set	DSCP High	USINT	CIP transmission Class 1 with High Priority Message	43
7	Get/Set	DSCP Low	USINT	CIP transmission Class 1 with Low Priority Message	31
8	Get/Set	DSCP Explicit	USINT	CIP UCMM and CIP Class 3	27

Instance services

Service Code	Name	Description
0x0E	Get_Attribute_Single	Reads the content of the specified attribute.
0x10	Set_Attribute_Single	Writes the content of the specified attribute.

9) Fuji vendor-specific objects (Class code 0x64)

These objects are addressed to identify the Fuji Electric inverter-specific function code on the profile.
Any function code can be written/read directly.
Function codes are assigned to one instance for each type (F code, E code, etc.). The function code number is assigned to the attribute ID. Therefore, one function code can be specified by specifying an instance and an attribute.
Each function code data is expressed as 2-byte data. The format of this data is defined for each function code.

For details, refer to the RS-485 Communication User's Manual.

Class attribute (Instance ID: 0x00)

Attribute ID	Access Rules	Name	Data Type	Description	Value
1	Get	Revision	UINT	Revision information for this object	1
2	Get	Max Instance	UINT	Maximum number of instances of the object currently being created	255
3	Get	Number of Instance	UINT	Number of object instances that are currently being created	255

Class service

Service Code	Name	Description
0x01	Get_Attribute_All	Reads the content of all attributes.
0x0E	Get_Attribute_Single	Reads the content of the specified attribute.

The instance ID specifies the type number of the function code.

For details, refer to “9.3.7 Setting inverter function codes.”

Attribute ID specifies the address number of the function code.
If a function code that does not exist is specified, an “Attribute not supported Error” occurs.
Examples 1 to 4 show typical function code groups.

Example 1) Function code group S instance attribute (Instance ID: 0x02)

Attribute ID	Access Rules	Name	Data Type	Description
1	Get/Set	Fuji inverter function code S01	UINT	S01 data
: :	: :	: :	: :	: :
99	Get/Set	Fuji inverter function code S99	UINT	S99 data

Example 2) Function code group M instance attribute (Instance ID: 0x03)

Attribute ID	Access Rules	Name	Data Type	Description
1	Get/Set	Fuji inverter function code M01	UINT	M01 data
: :	: :	: :	: :	: :
99	Get/Set	Fuji inverter function code M99	UINT	M99 data

Example 3) Function code group F instance attribute (Instance ID: 0x04)

Attribute ID	Access Rules	Name	Data Type	Description
1	Get/Set	Fuji inverter function code F01	UINT	F01 data
: :	: :	: :	: :	: :
99	Get/Set	Fuji inverter function code F99	UINT	F99 data

Example 4) Function code group E instance attribute (Instance ID: 0x05)

Attribute ID	Access Rules	Name	Data Type	Description
1	Get/Set	Fuji inverter function code E01	UINT	E01 data
: :	: :	: :	: :	: :
99	Get/Set	Fuji inverter function code E99	UINT	E99 data

Instance services

Service Code	Name	Description
0x0E	Get_Attribute_Single	Reads the content of the specified attribute.
0x10	Set_Attribute_Single	Writes the content of the specified attribute.

Note The monitor function codes such as M group are valid only for "Get." If "Set" is performed, an error code will be returned.
An error code is also returned when "Set" is performed during operation for function codes such as F01, F02, etc. whose attribute cannot be changed during operation.

10) Fuji vendor-specific objects (Class code 0xA2)

These objects are addressed to identify the Fuji Electric inverter-specific function code on the profile.
Any function code can be written/read directly.
Attribute ID is fixed at 1.
One function code can be specified by specifying an instance using the following formula.

"Instance ID=" (Group number x 256) + Function code number + 1

Each function code data is expressed as 2-byte data. The format of this data is defined for each function code.

For details on data format for each function code, refer to the RS485 Communications User's Manual.

Class attribute (Instance ID: 0x00)

Attribute ID	Access Rules	Name	Data Type	Description	Value
1	Get	Revision	UINT	Revision information for this object	1
2	Get	Max Instance	UINT	Maximum number of instances of the object currently being created	65535
3	Get	Number of Instance	UINT	Number of object instances that are currently being created	65535

Class service

Service Code	Name	Description
0x01	Get_Attribute_All	Reads the content of all attributes.
0x0E	Get_Attribute_Single	Reads the content of the specified attribute.

Instance services

Service Code	Name	Description
0x0E	Get_Attribute_Single	Reads the content of the specified attribute.
0x10	Set_Attribute_Single	Writes the content of the specified attribute.

Function Code Type		Group No.	Register Usage Example
Motor to Drive	Name		
F	Basic function	0	F00: (0 × 256) + 0 + 1 = 1 ⋮ F07(Acceleration time 1) : (0 × 256) + 7 + 1 = 8 ⋮ F99: (0 × 256) + 99 + 1 = 100
E	Terminal functions	1	E00: (1 × 256) + 0 + 1 = 257 ⋮ E98 Terminal [FWD] (Function selection): (1 × 256) + 98 + 1 = 355 ⋮ E99: (1 × 256) + 99 + 1 = 356
C	Control Functions	2	C00: (2 × 256) + 0 + 1 = 513 ⋮ C99: (2 × 256) + 99 + 1 = 612
P	Motor 1 parameters	3	P00: (3 × 256) + 0 + 1 = 769 ⋮ P99: (3 × 256) + 99 + 1 = 868
H	High Performance function	4	H00: (4 × 256) + 0 + 1 = 1025 ⋮ H99: (4 × 256) + 99 + 1 = 1124
A	Motor 2 parameters	5	A00: (5 × 256) + 0 + 1 = 1281 ⋮ A99: (5 × 256) + 99 + 1 = 1380
o	Optional Functions	6	o00: (6 × 256) + 0 + 1 = 1537 ⋮ o99: (6 × 256) + 99 + 1 = 1636
S	Command data	7	S00: (7 × 256) + 0 + 1 = 1793 ⋮ S05(Reference frequency) : (7 × 256) + 5 + 1 = 1798 ⋮ S99: (7 × 256) + 99 + 1 = 1892
M	Monitor data 1	8	M00: (8 × 256) + 0 + 1 = 2049 ⋮ M99: (8 × 256) + 99 + 1 = 2148
r	Speed Control 4 Parameters	10	r00: (10 × 256) + 0 + 1 = 2561 ⋮ r99: (10 × 256) + 99 + 1 = 2660
U	Customizable logic	11	U00: (11 × 256) + 0 + 1 = 2817 ⋮ U99: (11 × 256) + 99 + 1 = 2916
J	Application Functions	13	J00: (13 × 256) + 0 + 1 = 3329 ⋮ J99: (13 × 256) + 99 + 1 = 3428
y	Link Functions	14	y00: (14 × 256) + 0 + 1 = 3585 ⋮ y99: (14 × 256) + 99 + 1 = 3684
W	Monitor data 2	15	W00: (15 × 256) + 0 + 1 = 3841 ⋮ W99: (15 × 256) + 99 + 1 = 3940

Function Code Type		Group No.	Register Usage Example
Motor to Drive	Name		
X	Alarm Data	16	X00: (16 × 256) + 0 + 1 = 4097 ⋮ X99: (16 × 256) + 99 + 1 = 4196
Z	Alarm Data 2	17	Z00: (17 × 256) + 0 + 1 = 4353 ⋮ Z99: (17 × 256) + 99 + 1 = 4452
b	Speed Control 3 Parameters	18	b00: (18 × 256) + 0 + 1 = 4609 ⋮ b99: (18 × 256) + 99 + 1 = 4708
d	Application Functions 2	19	d00: (19 × 256) + 0 + 1 = 4865 ⋮ d99: (19 × 256) + 99 + 1 = 4964
W1	Monitor data 2	22	W100: (22 × 256) + 0 + 1 = 5633 ⋮ W199: (22 × 256) + 99 + 1 = 5732
X1	Alarm Data	25	X100: (25 × 256) + 0 + 1 = 6401 ⋮ X199: (25 × 256) + 99 + 1 = 6500
K	Keypad Functions	28	K00: (28 × 256) + 0 + 1 = 7169 ⋮ K99: (28 × 256) + 99 + 1 = 7268
H1	High Performance function	31	H100: (31 × 256) + 0 + 1 = 7937 ⋮ H199: (31 × 256) + 99 + 1 = 8036
o1	Optional Functions	37	o100: (37 × 256) + 0 + 1 = 9473 ⋮ o199: (37 × 256) + 99 + 1 = 9572
o2	Optional Functions	38	o200: (38 × 256) + 0 + 1 = 9729 ⋮ o299: (38 × 256) + 99 + 1 = 9828
U1	Customizable logic functions	39	U100: (39 × 256) + 0 + 1 = 9885 ⋮ U199: (39 × 256) + 99 + 1 = 10084
M1	Monitor Data	41	M100: (41 × 256) + 0 + 1 = 10497 ⋮ M199: (41 × 256) + 99 + 1 = 10596
J1	Application Functions	48	J100: (48 × 256) + 0 + 1 = 12289 ⋮ J199: (48 × 256) + 99 + 1 = 12388
d1	Application Functions 2	54	d100: (54 × 256) + 0 + 1 = 13825 ⋮ d199: (54 × 256) + 99 + 1 = 13924
d2	Application Functions 2	55	d200: (55 × 256) + 0 + 1 = 14081 ⋮ d299: (55 × 256) + 99 + 1 = 14180

11) TCP/IP Interface objects (Class code 0xF5)

Class attribute (Instance ID: 0x00)

Attribute ID	Access Rules	Name	Data Type	Description	Value
1	Get	Revision	UINT	Revision information for this object	4
2	Get	Max Instance	UINT	Maximum number of instances of the object currently being created	1
3	Get	Number of Instance	UINT	Number of object instances that are currently being created	1

Class service

Service Code	Name	Description
0x01	Get_Attribute_All	Reads the content of all attributes.
0x0E	Get_Attribute_Single	Reads the content of the specified attribute.

Instance attribute (Instance ID: 0x01)

Attribute ID	Access Rules	Name	Data Type	Description	Value*
1	Get	Status	DWORD	Interface status	2
2	Get	Configuration Capability	DWORD	Interface capability flags	32
3	Get	Configuration Control	DWORD	Interface control flags	0
4	Get	Physical Link	STRUNCT of	Path to physical link object	
		Path size	UINT	Size of Path	2
		Path	Padded EPATH	Logical segments identifying the physical link object	20 F6 24 01
5	Get	Interface Configuration	STRUCT of		
		IP Address	UDINT	The device's IP address	0A 00 A8 C0 (192.168.0.10)
		Network Mask	UDINT	The device's network mask	00 FF FF FF (255.255.255.0)
		Gateway Address	UDINT	Default gateway address	00 00 00 00 (0.0.0.0)
		Name Server	UDINT	Primary name server	00 00 00 00 (0.0.0.0)
		Name Server 2	UDINT	Secondary name server	00 00 00 00 (0.0.0.0)
		Domain Name	STRING	Default domain name	00 00
6	Get	Host Name	STRING	The Host Name attribute contains the device's host name	00 00
8	Get	TTL Value	USINT	TTL value for EtherNet/IP multicast packets	1

Attribute ID	Access Rules	Name	Data Type	Description	Value*
9	Get	Mcast Config	STRUNT of IP	IP multicast address configuration	
		Alloc Control	USINT	Multicast address allocation control word. Determines how addresses are allocated.	0
		Reserved	USINT		0
		Num Mcast	UINT	Number of IP Multicast addresses to allocate for EtherNet/IP	32
		Mcast Start Addr	UDINT	Starting multicast address from which to begin allocation.	20 02 C0 EF (239.192.2.32)
10	Get/Set	SelectACD	BOOL	Activates the use of ACD 0: ACD disabled 1: ACD enabled	1
11	Get/Set	LastConflict Detected	STRUNT of:		
		AcdActivity	USINT	State of ACD activity when last conflict detected	0
		RemoteMAC	Array of 6 USINT	Remote MAC	
		ArpPdu	Array of 28 USINT	ARP PDU	
13	Get/Set	Encapsulation Inactivity Timeout	USINT	Number of seconds of inactivity before TCP connection is closed	120

* Values shown in this column are initial values or fixed values. They change during operation.

<u>Instance services</u>

Service Code	Name	Description
0x01	Get_Attribute_All	Reads the content of all attributes.
0x0E	Get_Attribute_Single	Reads the content of the specified attribute.
0x10	Set_Attribute_Single	Writes the content of the specified attribute.

12) Ethernet Link objects (Class code 0xF6)

Class attribute (Instance ID: 0x00)

Attribute ID	Access Rules	Name	Data Type	Description	Value
1	Get	Revision	UINT	Revision information for this object	4
2	Get	Max Instance	UINT	Maximum number of instances of the object currently being created	3
3	Get	Number of Instance	UINT	Number of object instances that are currently being created	3

Class service

Service Code	Name	Description
0x01	Get_Attribute_All	Reads the content of all attributes.
0x0E	Get_Attribute_Single	Reads the content of the specified attribute.

Instance attributes (Instance ID: 0x01: Port 1, 0x02 :Port 2, 0x03: Internal)

Attribute ID	Access Rules	Name	Data Type	Description	Value*
1	Get	Interface Speed	UDINT	Interface speed currently in use	100: “100Mbps” 0: “0 Mbps”
2	Get	Interface Flags	DWORD	Interface status flags	15: “Successfully negotiated speed and duplex” 16: “Auto-negotiation not attempted”
3	Get	Physical Address	ARRAY of 6 USINTs	MAC layer address	MAC address
4	Get	Interface Counters	STRUCT of		
		In Octets	UDINT	Octets received on the interface	0
		In Ucast Packets	UDINT	Unicast packets received on the interface	0
		In NUcast Packets	UDINT	Non-unicast packets received on the interface	0
		In Discards	UDINT	Inbound packets received on the interface but discarded	0
		In Errors	UDINT	Inbound packets that contain errors (does not include In Discards)	0
		In Unknown Protos	UDINT	Inbound packets with unknown protoco	0
		Out Octets	UDINT	Octets sent on the interface	0
		Out Ucast Packets	UDINT	Unicast packets sent on the interface	0
		Out NUcast Packets	UDINT	Non-unicast packets sent on the interface	0
		Out Discards	UDINT	Outbound packets discarded	0
		Out Errors	UDINT	Outbound packets that contain errors	0

* Values shown in this column are initial values or fixed values. They change during operation.

Attribute ID	Access Rules	Name	Data Type	Description	Value*
5	Get	Media Counters	STRUCT of	Media-specific counter	0
		Alignment Errors	UDINT	Frames received that are not an integral number of octets in length	0
		FCS Errors	UDINT	Frames received that do not pass the FCS check	0
		Single Collisions	UDINT	Successfully transmitted frames which experienced exactly one collision	0
		Multiple Collisions	UDINT	Successfully transmitted frames which experienced more than one collision	0
		SQE Test Errors	UDINT	Number of times SQE test error message is generated	0
		Deferred Transmissions	UDINT	Frames for which first transmission attempt is delayed because the medium is busy	0
		Late Collisions	UDINT	Number of times a collision is detected later than 512 bit-times into the transmission of a packet	0
		Excessive Collisions	UDINT	Frames for which transmission fails due to excessive collisions	0
		MAC Transmit Errors	UDINT	Frames for which transmission fails due to an internal MAC sub layer transmit error	0
		Carrier Sense Errors	UDINT	Times that the carrier sense condition was lost or never asserted when attempting to transmit a frame	0
		Frame Too Long	UDINT	Frames received that exceed the maximum permitted frame size	0
		MAC Receive Errors	UDINT	Frames for which reception on an interface fails due to an internal MAC sub layer receive error	0
6	Get/Set	Interface Control	STRUCT of	Configuration for physical interface	0
		Control Bit	WORD	Interface Control Bits	0
		Forced Interface Seed	UINT	Speed at which the interface shall be forced to operate	0
7	Get	Interface Type	USINT	Type of interface: twisted pair, fiber, internal, etc.	2: “Twisted-pair” 1: “The interface is internal to the device”

* Values shown in this column are initial values or fixed values. They change during operation.

Attribute ID	Access Rules	Name	Data Type	Description	Value*
8	Get	Interface State	USINT	Current state of the interface: operational, disabled, etc.	1 “The interface is enabled”
9	Get/Set	Admin State	USINT	Administrative state: enable, disable	1 “Enable the interface”
10	Get	Interface Label	SHORT_ STRING	Human readable identification	06 50 6f 72 74 20 31 “Port 1” 06 50 6f 72 74 20 32 “Port 2” Size: 6Byte 08 69 6e 74 65 72 6e 61 6c “internal” Size: 8Byte
11	Get	Interface Capability	STRUCT of	Indication of capabilities of the interface	
		Capability Bits	DWORD	Interface capabilities, other than speed/duplex	6 “Auto-negotiate, Auto-MDIX”
		Speed/ Duplex Options	STRUCT of	Indicates speed/duplex pairs supported in the interface Control Attribute	
		Speed/ Duplex Array Count	USINT		4
		Speed/Duplex Array	ARRAY of		
		Speed/Duplex Pair	STRUCT of		
		Interface Speed	UINT		10
		Interface Duplex Mode	USINT		0
		Interface Speed	UINT		10
		Interface Duplex Mode	USINT		1
		Interface Speed	UINT		100
		Interface Duplex Mode	USINT		0
		Interface Speed	UINT		100
		Interface Duplex Mode	USINT		1

* Values shown in this column are initial values or fixed values. They change during operation.

Instance services

Service Code	Name	Description
0x01	Get_Attribute_All	Reads the content of all attributes.
0x0E	Get_Attribute_Single	Reads the content of the specified attribute.
0x10	Set_Attribute_Single	Writes the content of the specified attribute.

(2) Description of each I/O instance

Note When using more than one of instance IDs 20, 21, and 150 for IO communication, do not set the same value for the Requested Packet Interval (RPI) of IDs 20 and 150, or IDs 21 and 150.
Also, do not set ID 20 and ID 21 at the same time.

1) Basic I/O instance

Output (master → inverter): Basic speed control output

Instance	Byte	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
20 (0x14)	0	-	-	-	-	-	Fault Reset	-	Run Fwd
	1	(Fixed at 0)							
	2	Speed Reference (lower Byte) (r/min)							
	3	Speed Reference (upper Byte) (r/min)							

Run Fwd (Forward rotation command): 0 = Stop 1 = Forward rotation command ON

Fault Reset (Alarm cancel): 0 = Normal 1 = Cancel alarm status

Speed Reference (Speed setting): Speed command (in r/min)

Input (inverter → master): Basic speed control input

Instance	Byte	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
70 (0x46)	0	-	-	-	-	-	Running1	-	Faulted
	1	(Fixed at 0)							
	2	Speed Actual (lower Byte) (r/min)							
	3	Speed Actual (upper Byte) (r/min)							

Faulted (Alarm status):1 = Inverter alarm status

Running1 (During forward rotation):1 = Running forward rotation status

Speed Actual (Output rate): Actual rotational speed (in r/min)

2) Extension I/O instance

Output (master → inverter): Extended speed control output

Instance	Byte	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
21 (0x15)	0	-	NetRef	NetCtrl	-	-	Fault Reset	Run Rev	Run Fwd
	1	(Fixed at 0)							
	2	Speed Reference (lower Byte) (r/min)							
	3	Speed Reference (upper Byte) (r/min)							

Run Fwd (Forward rotation command): 0 = Stop, 1 = Forward rotation command ON

Run Rev (Reverse rotation command): 0 = Stop, 1 = Reverse rotation command ON

Fault Reset (Alarm cancel): 0 = Normal, 1 = Cancel alarm status

NetCtrl: 1 = Operation command privilege enable request from Ethernet/IP,
0 = Operation command privilege disable request from other than Ethernet/IP

NetRef: 1 = Speed command privilege enable request from Ethernet/IP,
0 = Speed command privilege disable request from other than Ethernet/IP

Speed Reference (Speed setting): Speed command (in r/min)

The actual inverter speed command (r/min) is as follows for the value of Speed Reference.

SpeedScale is a resolution adjustment value set in the attributes of AC/DC Drive objects, and also affects SpeedActual.

$$\text{Inverter speed command (r/min)} = \frac{\mathit{Speed\ Reference}\ \ (\mathrm{r/min})}{2^{\mathit{Speedscale}}}$$

Input (inverter → master): Extended speed control input

Instance	Byte	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
71 (0x47)	0	At Reference	Ref FromNet	Ctrl FromNet	Ready	Running2	Running1	-	Faulted
	1	Drive State							
	2	Speed Actual (lower Byte) (r/min)							
	3	Speed Actual (upper Byte) (r/min)							

Faulted (Alarm status):1 = Inverter alarm status

Running1 (During forward rotation): 1 = Running forward rotation status

Running2 (During reverse rotation): 1 = Running reverse rotation status

Ready: 1 = Inverter ready

At Reference (Reference speed reached): 1 = Running at reference speed

Drive State (Inverter status): Memory check in progress at power-on = 1, Not Ready (Operation not ready) = 2, Ready = 3, Acceleration/constant speed medium = 4, deceleration in progress = 5, forced deceleration in progress at error = 6, alarm status = 7

Speed Actual (Output rate): Actual rotational speed (in r/min)

3) Fuji drive assembly output

This format is specific to Fuji Electric. Up to 32 function codes of the inverter can be specified and written from the master to inverter. The write function codes can be specified by setting those to the function codes o221 to o252 of the inverter.

Note After setting o221 to o252, restart the inverter, write o299 = 1, or perform RESET service to apply the settings to the inverter.

For details, refer to the master or configurator manual.

Output (master → inverters): Fuji drive assembly output

<table>
<tr><th>Instance</th><th>Byte</th><th>Bit7</th><th>Bit6</th><th>Bit5</th><th>Bit4</th><th>Bit3</th><th>Bit2</th><th>Bit1</th><th>Bit0</th></tr>
<tr><td rowspan="17">100 (0x64)</td><td>0</td><td colspan="8">Write to the function code specified by function code o221 (Lower Byte)</td></tr>
<tr><td>1</td><td colspan="8">Write to the function code specified by function code o221 (Upper Byte)</td></tr>
<tr><td>2</td><td colspan="8">Write to the function code specified by function code o222 (Lower Byte)</td></tr>
<tr><td>3</td><td colspan="8">Write to the function code specified by function code o222 (Upper Byte)</td></tr>
<tr><td>4</td><td colspan="8">Write to the function code specified by function code o223 (Lower Byte)</td></tr>
<tr><td>5</td><td colspan="8">Write to the function code specified by function code o223 (Upper Byte)</td></tr>
<tr><td>6</td><td colspan="8">Write to the function code specified by function code o224 (Lower Byte)</td></tr>
<tr><td>7</td><td colspan="8">Write to the function code specified by function code o224 (Upper Byte)</td></tr>
<tr><td>:
:</td><td colspan="8">:
:</td></tr>
<tr><td>58</td><td colspan="8">Write to the function code specified by function code o250 (Lower Byte)</td></tr>
<tr><td>59</td><td colspan="8">Write to the function code specified by function code o250 (Upper Byte)</td></tr>
<tr><td>60</td><td colspan="8">Write to the function code specified by function code o251 (Lower Byte)</td></tr>
<tr><td>61</td><td colspan="8">Write to the function code specified by function code o251 (Upper Byte)</td></tr>
<tr><td>62</td><td colspan="8">Write to the function code specified by function code o252 (Lower Byte)</td></tr>
<tr><td>63</td><td colspan="8">Write to the function code specified by function code o252 (Upper Byte)</td></tr>
</table>

* Can be configured from 0 to 32 WORD (0 to 64 Byte) in WORD size.

4) Fuji drive assembly input

This format is specific to Fuji Electric. Up to 32 function codes of the inverter can be specified and read from the inverter to master.
The readout function codes can be specified by setting those to the function codes o253 to o284 of the inverter.

Note After setting o253 to o284, restart the inverter, write o299 = 1, or perform RESET service to apply the settings to the inverter.

For details, refer to the master or configurator manual.

Input (inverter → master): Fuji drive assembly input

Instance	Byte	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
150 (0x96)	0	Read from the function code specified by function code o253 (Lower Byte)							
	1	Read from the function code specified by function code o253 (Upper Byte)							
	2	Read from the function code specified by function code o254 (Lower Byte)							
	3	Read from the function code specified by function code o254 (Upper Byte)							
	4	Read from the function code specified by function code o255 (Lower Byte)							
	5	Read from the function code specified by function code o255 (Upper Byte)							
	6	Read from the function code specified by function code o256 (Lower Byte)							
	7	Read from the function code specified by function code o256 (Upper Byte)							
	:	:							
	:	:							
	58	Read from the function code specified by function code o282 (Lower Byte)							
	59	Read from the function code specified by function code o282 (Upper Byte)							
	60	Read from the function code specified by function code o283 (Lower Byte)							
	61	Read from the function code specified by function code o283 (Upper Byte)							
	62	Read from the function code specified by function code o284 (Lower Byte)							
	63	Read from the function code specified by function code o284 (Upper Byte)							

* Can be configured from 1 to 32 WORD (2 to 64 Byte) in WORD size.

(3) Alarm

If the inverter detects an alarm, it can be checked as follows.

In addition, while an alarm is occurring, Minor Recoverable (Bit8) is reflected in “Status” of [1) Identity objects (Class code 0x01)].

- “Faulted” of input instances (70,71)
- ALM (Bit11) of the operation status monitor (M14)

For details on alarms, the function codes M16 to M19 can be read and checked by using [9) Fuji vendor-specific objects (Class code 0x64)] etc.

(4) Error code list for explicit message errors

If an explicit message sent from the master contains any error, the communication card responds to the master with the error codes in the table below.

The error codes consist of two bytes: the General code and the Additional code.

Errors without Additional codes are indicated by “0xFF.”

General code = “0x1F: Vendor specific error” indicates an error when accessing the inverter function code with the class code 0x64: Fuji vendor-specific Object.

Error code list for explicit message errors

Error Code		Error Name	Description	Measure
General Code	Additional Code			
0x08	0xFF	Service not supported	Invalid service code	Correct service code.
0x09	0xFF	Invalid attribute value	Invalid attribute.	Correct attribute.
0x0E	0xFF	Attribute not settable	Attempted to change an attribute which is a nonwritable attribute.	Check and correct attribute again.
0x13	0xFF	Not enough data	The written data is not sufficient.	Correct data.
0x14	0xFF	Attribute not supported	Access to a nonexistent attribute.	Check the specified attributes again.
0x15	0xFF	Too much data	The written data is too much.	Correct data.
0x16	0xFF	Object does not exist	Access to a nonexistent object.	Corrects the content of the Class and instance.
0x1F	Vender-Specific Error			
	0x01	Link priority error	Command data/operation command data was written with y98 = 0 or LE = OFF.	Set y98 to other than 0, or set LE = ON.
	0x02	No function code (in writing)	Attempted to write to a nonexistent function code.	Correct the function code number specified.
	0x03	Function code cannot be changed	Attempted to write to a read-only function code.	Correct the function code number specified.
	0x06	Cannot be changed during running	Attempted to write to a function code that cannot be changed when the inverter is running.	Write after the inverter is stopped.
	0x07	Cannot be changed with X terminal ON	Attempted to write to a function code that cannot be changed when X terminal is ON.	Write after the X terminal is turned OFF.
	0x08	Data entry range error	Attempted to write data out of the range of a function code.	Write data within the range.
	0x09	Unselectable during data protecting error	Attempted to write data under password protection.	Enter the password to unlock or invalidate the password.
	0x0F	Function code data being written	Requested to write to a function code being written.	Request to write after completion of the current writing operation.
	0x21	No function code (in reading)	Attempted to read from a nonexistent function code.	Correct the function code number specified.
0x20	0xFF	Invalid parameter	Attempted to write a value out of the range.	Correct the value within the range.

(5) Class3 explicit message (Tag name)

Class 3 explicit messages can read/write the function code of the inverter (CIP Data Table Read/CIP Data Table Write) using the tag name.

For the tag name, specify the inverter function code as an ASCII character string.

The function code group is expressed by one or two characters, and the function code number is expressed by two characters from 00 to 99.

Example) "M14": The function code group is M and the number is 14,
"W168": The function code group is W1 and the number is 68.

* The function code group is basically specified in uppercase letters (Example: W), but it can also be specified in lowercase letters (Example: o1).

Example of using Rockwell Automation's Studio 5000™

[Read From inverter to master (CIP Data Table Read)]

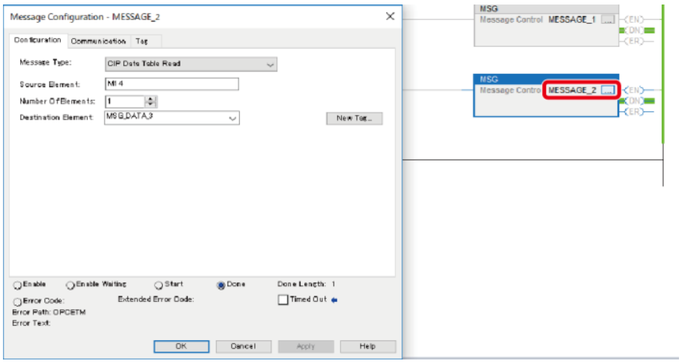
1) Message Type : CIP Data Table Read

2) Source Element (tag name of reading source): Inverter function code tag name (Example: M14)

3) Number of Elements: Fixed at 1

4) Destination Element (storage destination of read data): Specify the data on the PLC side (data type : UINT)

Example) Read the function code M14



[Write to inverter from master (CIP Data Table Write)]

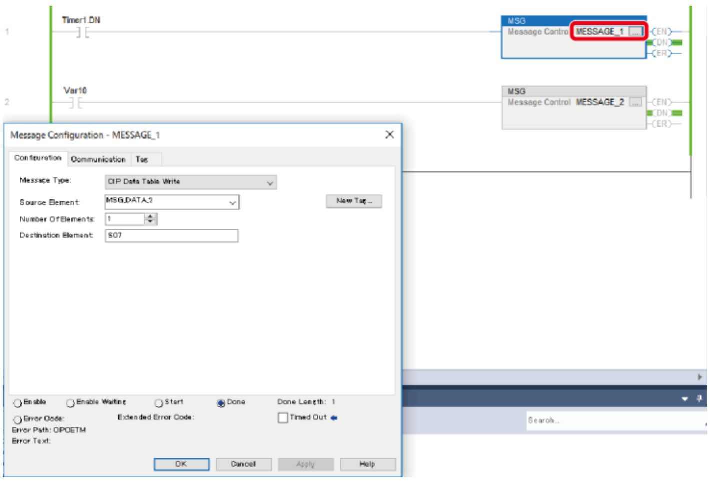
1) Message Type : CIP Data Table Write

2) Source Element (storage source of write data): Specify the data on the PLC side (data type: UINT)

3) Number of Elements: Fixed at 1

4) Destination Element (tag name of the write destination): Tag name of the inverter function code (Example: S07)

Example) Write the function code S07



[2] PROFINET IO

PROFINET is a communication standard for automation created by PROFIBUS & PROFINET International (PI).

By installing this product, inverters can be used as a PROFINET IO Device

By using PROFINET, it is possible to save wiring, construct networks in various topologies, perform real-time communication, and coexist with IT and control communication.

(1) PROFIDrive communication profile

In addition to Control Word/Status Word according to PROFIDrive profiles, it can also be operated using Fuji Electric-specific operation commands, frequency commands, and the operation status monitor.

1) Standard Telegram 1

Drive profile Telegram1 input/output list

I/O Word Offset	Output Data (Master → Inverter)	Input Data (Inverter → Master)
1	Control word (STW1)	Status word (ZSW1)
2	Speed command (NSOLL_A)	Speed actual (NIST_A)

2) Telegram 100

Standard Telegram 1 and COMM3 user assignment data 1 to 4 (4PZD) are combined.

Drive profile Telegram100 input/output list

I/O Word Offset	Output Data (Master → Inverter)	Input Data (Inverter → Master)
1	Control word (STW1)	Status word (ZSW1)
2	Speed command (NSOLL_A)	Speed actual (NIST_A)
3	Write to the function code specified by function code o221	Read from the function code specified by function code o253
4	Write to the function code specified by function code o222	Read from the function code specified by function code o254
5	Write to the function code specified by function code o223	Read from the function code specified by function code o255
6	Write to the function code specified by function code o224	Read from the function code specified by function code o256

3) Telegram 101

Telegram101 can specify up to 32 user-configurable I/O datafiles.

To specify I/O data, set the desired function code group and number to the function codes o221 to o252 (write) and o253 to o284 (read).

Drive profile Telegram101 input/output list

I/O Word Offset	Output Data (Master → Inverter)	Input Data (Inverter → Master)
1	Write to the function code specified by function code o221	Read from the function code specified by function code o253
2	Write to the function code specified by function code o222	Read from the function code specified by function code o254
3	Write to the function code specified by function code o223	Read from the function code specified by function code o255
4	Write to the function code specified by function code o224	Read from the function code specified by function code o256
: :	: :	: :
31	Write to the function code specified by function code o251	Read from the function code specified by function code o283
32	Write to the function code specified by function code o252	Read from the function code specified by function code o284

(2) Control Word (STW1)

Telegram1 and Telegram100 send commands from the control word and status notifications to the status word according to PROFIDrive specifications. The configuration of the control word STW1 and the meaning of each bit is shown in the table below.

Configuration of control word (STW1)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Reset	Enable Setpoint	Freeze Ramp	Enable Ramp	Enable Operation	ON3/OFF3	ON2/OFF2	ON/OFF1
Bit15	**Bit14**	**Bit13**	**Bit12**	**Bit11**	**Bit10**	**Bit9**	**Bit8**
—	X3	X2	X1	Direction	Control By PLC	—	—

Bit definition in control word (STW1)

Bit	Name	Value	Description
0	ON	1	Run command ON
	OFF1	0	Run command OFF
1	ON2	1	No coast to a stop
	OFF2	0	Coast to a Stop
2	ON3	1	No quick stop
	OFF3	0	Quick Stop
3	Enable Operation	1	Enable inverter operation
		0	Disable inverter operation
4	Enable Ramp	1	Enable Ramp Generator (Accelerator/Decelerator)
		0	Hold the output frequency to 0Hz.
5	Freeze Ramp	1	Release from the freeze status of Ramp Generator (Accelerator/Decelerator)
		0	Freeze Ramp Generator (Accelerator/Decelerator) with the current output frequency.
6	Enable Setpoint	1	Enable command
		0	Disable command
7	Reset	1	Reset the alarm on a positive edge (0 → 1)
		0	Do not reset the alarm
8 9	—	0	Not used (fixed at 0)
10	Control By PLC	1	Enable remote control. The IO process data (STW1,NSOLL_A) is valid.
		0	Disable remote control. The IO process data (STW1,NSOLL_A) is not valid.
11	Direction	1	Run in the reverse direction
		0	Run in the forward direction
12	X1	1	Inverter digital input terminal X1=ON
		0	Inverter digital input terminal X1=OFF
13	X2	1	Inverter digital input terminal X2=ON
		0	Inverter digital input terminal X2=OFF
14	X3	1	Inverter digital input terminal X3=ON
		0	Inverter digital input terminal X3=OFF
15	—	0	Not used (fixed at 0)

(3) Status Word (ZSW1)

The configuration of the status word (ZSW1) that notifies the status of the inverter and the meaning of each bit is shown in the table below.

Configuration of status word (ZSW1)

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Warning	Switch On	Quick Stop	Coast Stop	Fault	Operation Enabled	Ready to Operation	Ready to Switch On
Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8
Direction	—	—	—	—	Speed Reached or Exceeded	Remote	Speed Error at Setpoint

Bit definition in status word (ZSW1)

Bit	Name	Value	Description
0	Ready to Switch On	1	Ready to run command
		0	Not ready to run command
1	Ready to Operation	1	Ready to run
		0	Not ready to run
2	Operation Enabled	1	Running
		0	Running disabled
3	Fault	1	Inverter tripped as indicated by ALM.
		0	No trip present as indicated by ALM.
4	Coast Stop	1	ON2 active
		0	OFF2 active (Coast Stop)
5	Quick Stop	1	ON3 active
		0	OFF3 active (Quick Stop)
6	Switch On	1	Not ready to run command ON
		0	Ready to run command ON
7	Warning	0	Not used (fixed at 0)
8	Speed Error at Setpoint	1	The actual speed NIST_A has reached the reference speed within a tolerance range specified by the inverter's function code E30. This corresponds to the frequency arrival signal "FAR" = ON of the inverter.
		0	The actual speed NIST_A has not reached the reference speed. This corresponds to the frequency arrival signal "FAR" = ON of the inverter.
9	Remote	1	Indicates that either the operation command or speed setpoint is provided from the PROFINET master.
		0	Indicates that both the operation command and speed setpoint are provided from other than the PROFINET master.
10	Speed Reached or Exceeded	1	The speed actual NIST_A is reached or exceeded the speed specified by the inverter's function code E31. This corresponds to the frequency detection signal "FDT" = ON of the inverter.
		0	The speed actual NIST_A is not reached the speed specified by the inverter's function code E31 subtracted the hysteresis width E32. This corresponds to the frequency detection signal "FDT" = OFF of the inverter.
11 to 14	—	1	Not used (fixed at 0)
		0	Run in the reverse direction
15	Direction	1	Run in the reverse direction
		0	Run in the forward direction

(4) Speed command (NSOLL_A) and speed Monitor (NIST_A)

NSOLL_A is a Speed setpoint A, and shows the output-frequency setting data. This is used to set the normal operation frequency.

Note NSOLL_A does not operate when high priority frequency setting such as multi-stage frequency operation or JOG operation is selected.

NIST_A is a Speed actual value, and shows the monitor data of the output frequency/detection frequency.

The current output frequency (before slip compensation) can be monitored when a control method that does not use the speed sensor is selected, and the detection speed can be monitored when a control method that uses the speed sensor is selected.

These data are 16-bit signed data (int16) and the sign represents the rotational orientation. Normal rotation is positive and reverse rotation is negative. However, the actual rotation orientation is related to the sign and STW1 Bit11 of NSOLL_A.

The reference frequency for these data is the frequency set to F03.

(Example) When F03 = 60.0 [Hz] and NSOLL_A = 8192 (0x2000 : 50%), the inverter output frequency operates at 30.0 [Hz].

If NSOLL_A is set to an absolute value greater than 100%, it runs at 100%.

Frequency command NSOLL_A Normalized Setpoint	int16	Given as a percentage of the maximum rotation speed. 0x4000 is equivalent to 100% (maximum rotation speed). NSOLL_A = Frequency reference of inverter (Hz) / Maximum frequency F03 (Hz) ×16384
Output frequency NIST_A Actual speed value	int16	Given as a percentage of the maximum rotation speed. NSOLL_A = Frequency reference of inverter (Hz) / Maximum frequency F03 (Hz) ×16384 0x4000 is equivalent to 100% (maximum rotation speed).

1) Operation by frequency command [Hz]

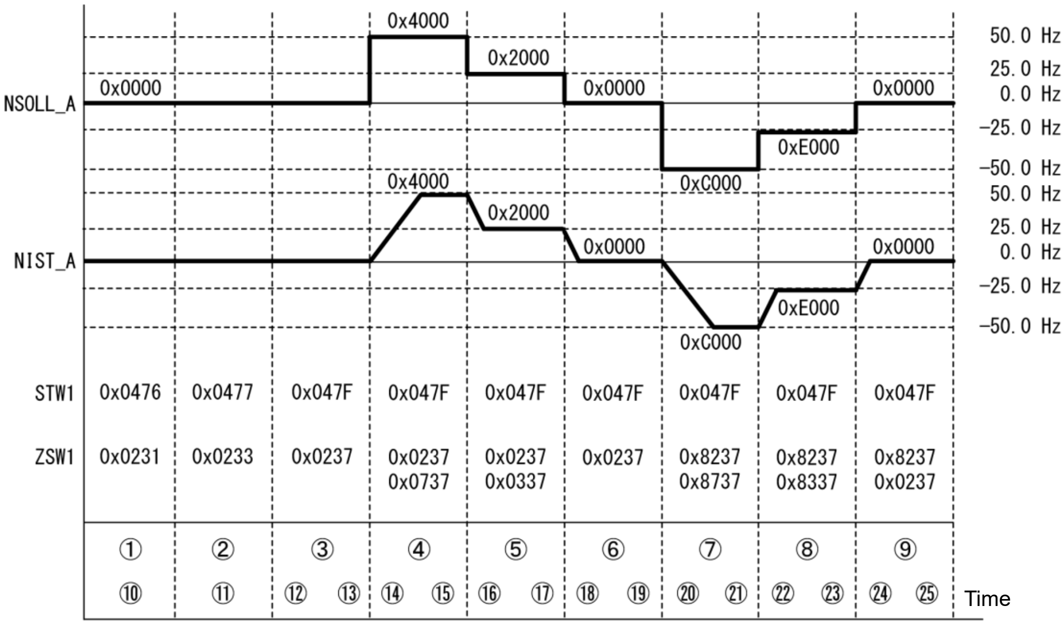
For details on how to operate the PROFINET IO controller, refer to the instruction manual for your PROFINET IO controller.

For details, refer to the PROFINET IO Controller Instruction Manual.

An operation example is shown below.

2) Operation with Standard Telegram 1 or Telegram 100

An operation example with Standard Telegram 1 or Telegram 100 and F03 = 50.0 [Hz] is shown below.



Here,

STW1: Control word, ZSW1: Status word, NSOLL_A: Output frequency setting, NIST_A: Output frequency monitor

[Setpoint (PROFINET IO Controllers-> PROFINET IO Devices)]

① **Set 0x476 to STW1.**
② **Set 0x477 to STW1. (Operation command = ON)**
③ **Set 0x047F to STW1. (Inverter operation possible)**
④ **Set 0x4000 (100%) to NSOLL_A.**
⑤ **Set 0x2000 (50%) to NSOLL_A.**
⑥ **Set 0x0000 (0%) to NSOLL_A.**
⑦ **Set 0xE000 (-50%) to NSOLL_A.**
⑧ **Set 0xC000 (-100%) to NSOLL_A.**
⑨ **Set 0x0 (0%) to NSOLL_A.**

[Actual value (PROFINET IO Devices-> PROFINET IO Controllers)]

⑩ **Switches to PROFIDrive status Ready For switching On.**
Stop status.
⑪ **Switches to PROFIDrive status Switched On.**
Stop status.
⑫ **Switches to PROFIDrive status Operation.**
⑬ **0x0 (0%: Frequency 0 [Hz]) in operation.**
⑭ **During forward acceleration.**
⑮ **Constant speed status.**
0x4000 (100%: Frequency 50.0 [Hz]) reached.
⑯ **Decelerating.**
⑰ **Constant speed status.**
0x1000 (50%: frequency 25.0 [Hz]) reached.
⑱ **Decelerating.**
⑲ **0x0 (0%: Frequency 0 [Hz]) in operation.**
⑳ **Reverse acceleration in progress.**
㉑ **Constant speed status.**
0xC000 (-100%: frequency-50 [Hz]) reached.
㉒ **Decelerating.**
㉓ **Constant speed status.**
0xE000 (-50%: Frequency-25 [Hz]) reached.
㉔ **Decelerating.**
㉕ **0x0000 (0%: Frequency 0 [Hz]) in operation.**

3) Operation using Telegram 101

The following shows an operation example with Telegram 101.

Telegram 101 makes it possible to control the inverter using Fuji Electric inverter-specific function codes without using STW1 and NSOLL_A.

- Set F03 = 50.0Hz
- Assign o221 = 0201_H (frequency command S01[*1]).

*1: S01: ±20000/±maximum output frequency (Rotating speed) data

Specify the maximum output frequency with F03, etc. The maximum output frequency changes due to the motor switching.

Example: Write the following data when you want to provide 15 Hz of the frequency setting with the maximum output frequency of 60 Hz.

15 [Hz] × 20000 / 60 [Hz] = 5000 = 0x1388

- Assign o222 = 0206_H (operation command S06).

[Operation command (S06) assignment]

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
—	—	—	X3	X2	X1	REV	FWD
—			Multi-Function Input			Reverse Operation Command	Forward Operation Command
Bit15	**Bit14**	**Bit13**	**Bit12**	**Bit11**	**Bit10**	**Bit9**	**Bit8**
RST	XR 〔REV〕	XF 〔FWD〕	0	0	—	—	—
Alarm Reset	Multi-Function Input		—				

- Assign o253 = 0306_H (Output frequency 1 M06).

* M06: ±20000/±maximum output frequency (Rotating speed) data

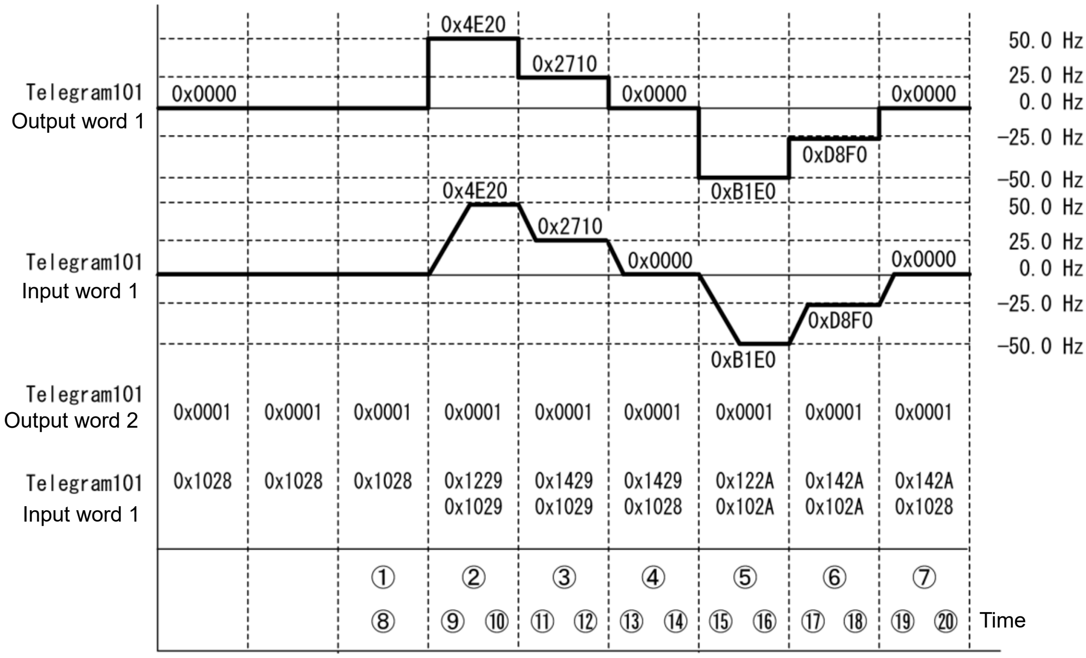
Specify the maximum output frequency with F03, etc. The maximum output frequency changes due to the motor switching.

- Assign o254 = $030E_H$ (operation status M14).

[Operation status (M14) assignment]

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
VL	TL	NUV	BRK	INT	EXT	REV	FWD
Voltage Limiting	Torque Limiting	The DC Bus Voltage is Established	Braking	Inverter Output Shut-down	DC Injection Braking	Reverse Rotating	Forward Rotating
Bit15	**Bit14**	**Bit13**	**Bit12**	**Bit11**	**Bit10**	**Bit9**	**Bit8**
BUSY	0	0	RL	ALM	DEC	ACC	IL
Function Code Writing	-	-	Communication Enabled	Package Alarm	Decelerating	Accelerating	Current Limiting

Operation using Telegram 101



① Write 0x001 (forward rotation command FWD = ON) to Output Word 2 of Telegram101.
② Write 20000 (50.00 Hz) to Output Word 1 of Telegram101.
③ Write 10000 (25.00 Hz) to Output Word 1 of Telegram101.
④ Write 0 (0.00 Hz) to Output Word 1 of Telegram101.
⑤ Write-20000 (-50.00 Hz) to Output Word 1 of Telegram101.
⑥ Write-10000 (-25.00 Hz) to Output Word of Telegram101.
⑦ Write 0 (0.00 Hz) to Output Word 1 of Telegram101.
⑧ Read Input Word 1 of Telegram101. 0x1028 (0x0000 (0%: Frequency 0 [Hz]) in operation.
⑨ Read Input Word 1 of Telegram101. 0x1229 (During Forward Acceleration)
⑩ Read Input Word 1 of Telegram101. 0x1029 (Forward Constant Speed Status). 0x4E20 (100%: frequency 50.0 [Hz]) reached.
⑪ Read Input Word 1 of Telegram101. 0x1429 (During Forward Deceleration)
⑫ Read Input Word 1 of Telegram101. 0x1029 (Forward Constant Speed Status). 0x2710 (100%: Frequency 25.0 [Hz]) reached.
⑬ Read Input Word 1 of Telegram101. 0x1429 (During Forward Deceleration)
⑭ Read Input Word 1 of Telegram101. 0x1028 (0x0000 (0%: Frequency 0 [Hz]) in operation.
⑮ Read Input Word 1 of Telegram101. 0x122A (During Reverse Acceleration)
⑯ Read Input Word 1 of Telegram101. 0x102A (Reverse Constant Speed Status) 0xB1E0 (100%: frequency 50.0 [Hz]) reached.
⑰ Read Input Word 1 of Telegram101. 0x142A (During Reverse Deceleration)
⑱ Read Input Word 1 of Telegram101. 0x102A (Reverse Constant Speed Status) 0xDBF0 (100%: frequency 50.0 [Hz]) reached.
⑲ Read Input Word 1 of Telegram101. 0x142A (During Reverse Deceleration)
⑳ Read Input Word 1 of Telegram101. 0x1028 (0x0000 (0%: Frequency 0 [Hz]) in operation.

(5) PROFIDrive state transition

The figure below shows a state transition diagram of the PROFIDrive.

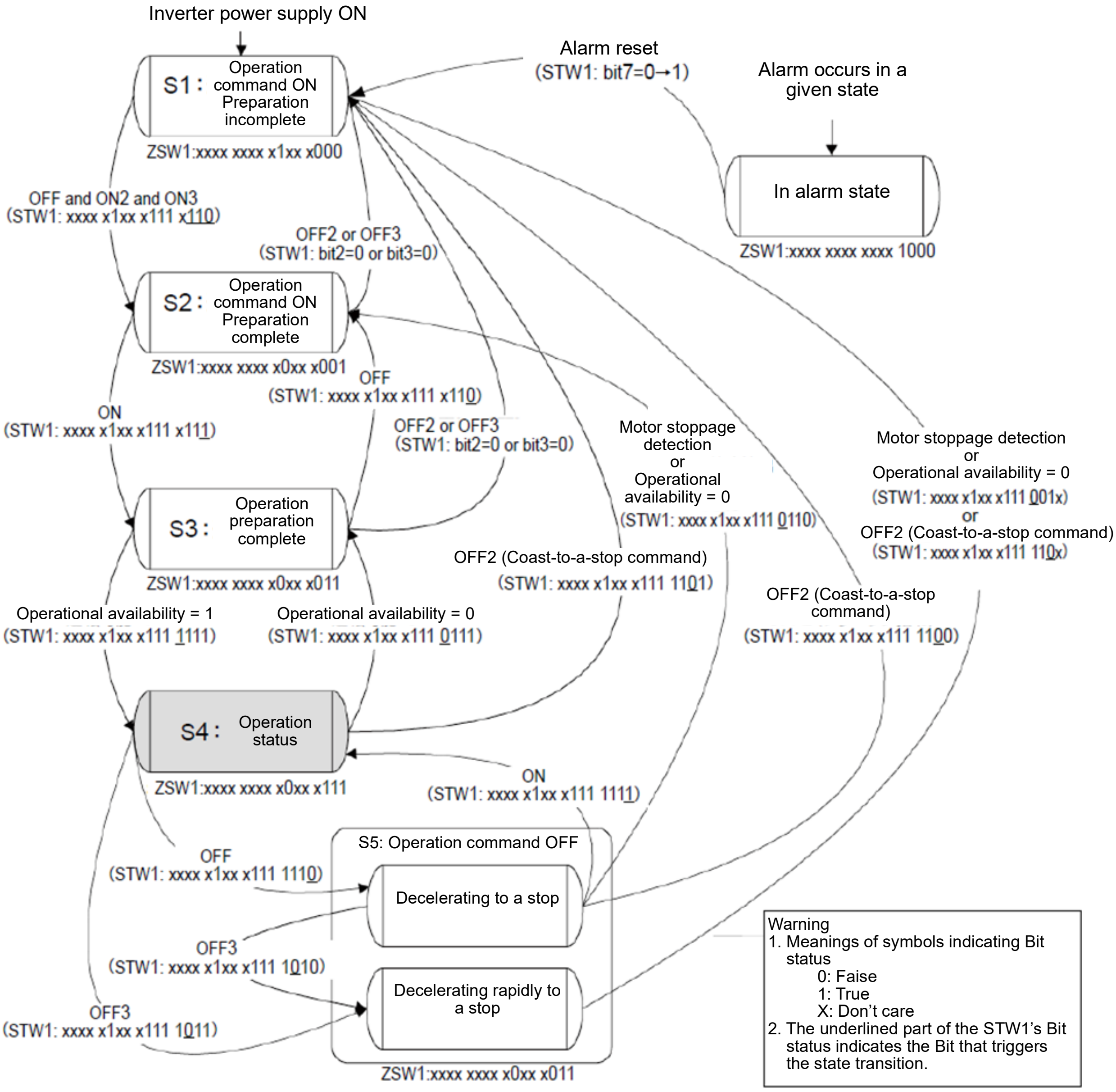
Immediately after the inverter is turned ON, the status first moves to S1 "Not ready to turn a run command ON." Bit manipulation in STW1 transitions to the S2 status "Ready to turn a run command ON," S3 "Ready to run" and finally S4 "Running" in sequence. In S4 status, the inverter enters the running status.

Turning a run command OFF in the S4 state transitions to the S5 status "Turn a run command OFF."

After the motor stops, it transitions to the S2 or S1 status.

Note In the figure below, to simplify the description, values of Bit 4 to Bit 6 and Bit 10 in STW1 are always "1." If any one of these bit values is not "1," the inverter will not enter the running status even if the state transition is correct.

PROFIDrive state transition



(6) Acyclic communication data access

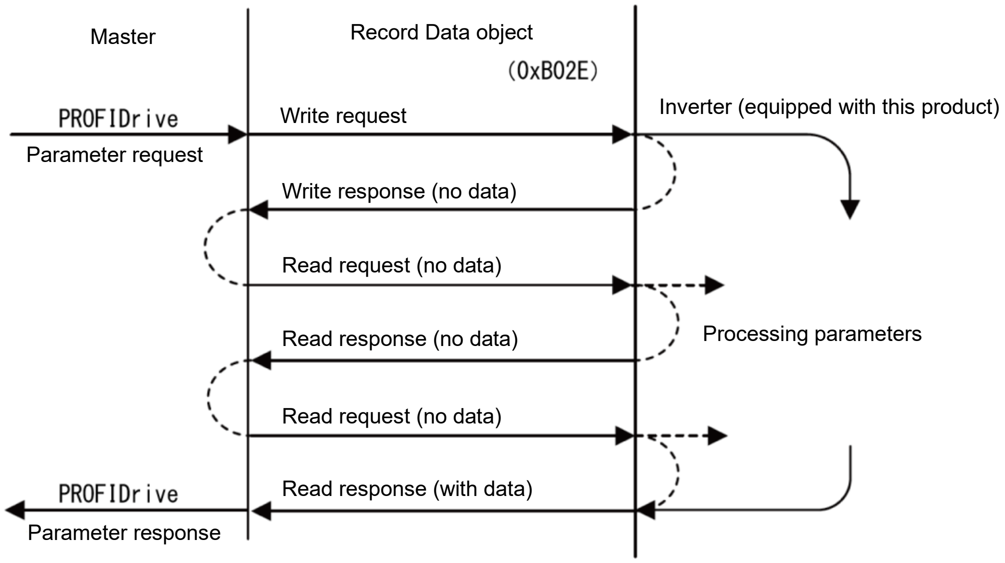
The function codes of the inverter can be read and written via acyclic (non-periodic) communication between the master and the inverter.

For acyclic communication to access the function codes, set 0xB02E (Base Mode Parameter Access Local) in the INDEX of the Record Data object in sub-slot No.1 of slot No.1.

The master sends function code access request data (Write request) as a write request, and the inverter returns a write response.

Then the master sends a read request, and the inverter returns the parameter access response data as a read response.

Flow of aperiodic communication



Note: When the function code of the inverter is changed by acyclic communication, the storage area of the written value follows the setting for function code y97.

Request formats for base mode parameter access

Block Definition	Byte N	Byte N+1	Remarks
Request header (4Byte)	Request reference 1 to 255	Request ID 0x01: Parameter read 0x02: Write parameter	
	Axis-No./DO-ID (Fixed at 1)	Number of parameters (0 or 1)	
Parameter address (6Byte)	Attribute 0x10: Parameter value	Number of elements of the array (Fixed at 1)	
	Parameter number (PNU)		
	Subindex		
Parameter written value (4Byte or 6Byte)	Format 0x42: WORD 0x43: Double WORD	Number of write data (Fixed at 1)	Set when writing parameters
	Data value (WORD)		
	Data value (Double WORD)		

Response formats for base mode parameter access

Block definition	Byte N	Byte N+1	Supplement
Response header (4Byte)	Request reference 1 to 255	Response ID 0x01: Read parameter OK 0x02: Write parameter OK 0x81: Parameter read NAK 0x82: Parameter write NAK	
	Axis-No./DO-ID (Fixed at 1)	Number of parameters (0 or 1)	
Parameter Read value (4Byte or 6Byte)	Format*1 0x42: WORD 0x43: Double WORD 0x44: Error code	Number of read data (Fixed at 1)	Response is 0x02: Appended when parameter write is not OK.
	Data value (WORD)	Or error code*2	
	Data value (Double WORD)		

*1 Format Sample

Value	Description
0x06 (6)	Unsignd16
0x07 (7)	Unsignd32
0x42 (66)	WORD
0x43 (67)	Double WORD
0x44 (68)	Error code

*2 Error Codes

Error code	Description
0x00 (0)	A parameter that does not exist is specified.
0x01 (1)	Parameter write disabled
0x02 (2)	The value set to parameter is out of the range.
0x03 (3)	Invalid Subindex is specified
0x0B (11)	Impossible to write parameter (during operation)
0x65 (101)	Error caused by link priority
0x68 (104)	Busy during parameter writing
0xC9 (201)	Protected with password

(7) PROFIDrive parameters

Parameters specified in PROFIDrive can be accessed from the host by asynchronous messaging as shown in the table below.

<u>PNU code list</u>

PNU	Subindex Data Type	Description	Attribute	Remarks
915	[0] to [31] Unsignd16	Output data (Setpoint)	R	Same as output-data (master → inverter) PNU915 [0] : o221 … PNU915 [31] : o252
916	[0] to [31] Unsignd16	Input data (Actual value)	R	Same as input-data (inverter → master) PNU916 [0] : o253 … PNU916 [31] : o284
922	— Unsignd16	Telegram selection (Read Only)	R	Telegram1=1 Telegram100=100 Telegram101=101 (reflects the I/O setting received from the master)
930	— Unsignd16	Operation mode ("1" for speed control) (Read Only)	R	Fixed at 1
944	— Unsignd16	Fault Counter (Read Only): Number of abnormal occurrences	R	Counts the alarms generated by the inverter and responds with the value. When more than one abnormality occurs at the same timing, the count is +1.
947	[0] to [3] Unsignd16	Fault Number (Read Only): Error code	R	Returns the response based on the data obtained by accessing the function code related to the alarm of the inverter. PNU947 [0] : M16 PNU947 [1] : M17 PNU947 [2] : M18 PNU947 [3] : M19
964	Array [6] Unsigned16	Drive Unit identification	R	PNU964 [0] : Manufacturer PNU964 [1] : Vendor-specific PNU964 [2] : SW-Version PNU964 [3] : Firmware date (year) PNU964 [4] : Firmware date (day/month) PNU964 [5] : PROFINET Number of Drive Object
965	— OctetString2	Profile ID	R	Byte1: Profile = 3, Byte 2: PROFIDrive Version = 42(4.2)
975	[0] to [9] Unsignd16	DO Identification	R	Drive Object identity PNU975 [0] : Manufacturer Fuji Electric Co., Ltd. (0015h) PNU975 [1] : DO type (0) PNU975 [2] : Firmware version PNU975 [3] : Firmware date (year)

				PNU975 [4] : Firmware date (day/month) PNU975 [5] : DO type class Axis (1) PNU975 [6] : DO type sub class1 AC1 (1) PNU975 [7] : Drive Object ID (1) PNU975 [8] to [9] : Reserve (0)
980 to 989	Array [n] Unsigned16	Defined parameter number list	R	List of parameter numbers defined by the device.
60000	Float32	Velocity reference value	R	The velocity reference value is set to 100% of the speed value of the N2/N4 normalized speed signals (NIST, NSOLL).

(8) Fuji Electric inverter-specific function codes

By specifying PNUs and Subindex based on the function code numbers, Read/Write access to the function codes specific to Fuji Electric inverters can be realized. Refer to the following equations for how to specify PNUs. A list of typical PNUs is shown on the next page.

PNU/Subindex computation for accessing Fuji Electric-specific function codes

PNU = Type code + 100

Subindex = Function code lower 2 digits (0 to 99)

Example: For function code E01, the PNU and Subindex are shown as follows.
Parameter number (PNU) = 105, Subindex = 1

For details, refer to “9.3.7 Setting inverter function codes.”

Fuji Electric-specific PNU codes

PNU	Subindex	Type Code	Attribute	Process
102	[0] to [99]	Function code S (2)	R/W	Command/Function Data
103	[0] to [99]	Function code M (3)	R/W	Monitor Data
104	[0] to [99]	Function code F (4)	R/W	Basic Functions
105	[0] to [99]	Function code E (5)	R/W	Terminal Functions
106	[0] to [99]	Function code C (6)	R/W	Control Functions
107	[0] to [99]	Function code P (7)	R/W	Motor 1 Parameters
108	[0] to [99]	Function code H (8)	R/W	High Performance Functions
109	[0] to [99]	Function code A (9)	R/W	Motor 2/Speed Control 2 Parameters
110	[0] to [99]	Function code o (10)	R/W	Optional Functions
112	[0] to [99]	Function code r (12)	R/W	Motor 4/Speed Control 4 Parameters
113	[0] to [99]	Function code U (13)	R/W	Customized Logic Functions
114	[0] to [99]	Function code J (14)	R/W	Application Functions
115	[0] to [99]	Function code y (15)	R/W	Link Functions
116	[0] to [99]	Function code W (16)	R/W	Monitor Data 2
117	[0] to [99]	Function code X (17)	R/W	Alarm Data
118	[0] to [99]	Function code Z (18)	R/W	Alarm Data 2
119	[0] to [99]	Function code b (19)	R/W	Motor 3/Speed Control 3 Parameters
120	[0] to [99]	Function code d (20)	R/W	Application Functions 2
123	[0] to [99]	Function code W1(23)	R/W	Monitor Data 2
126	[0] to [99]	Function code X1(26)	R/W	Alarm Data
129	[0] to [99]	Function code K (29)	R/W	Keypad Functions
132	[0] to [99]	Function code H1(32)	R/W	High Performance Functions
134	[0] to [99]	Function code U1(34)	R/W	Customized Logic Functions
135	[0] to [99]	Function code M1(35)	R/W	Monitor Data
136	[0] to [99]	Function code J1(36)	R/W	Application Functions
142	[0] to [99]	Function code d1(42)	R/W	Application Functions 2
162	[0] to [99]	Function code o2(62)	R/W	Optional Functions

* All data types are "WORD" size.

(9) I&M

I&M (Identification and Maintenance) provides equipment identification for user maintenance.

I&M0 provides identification information about the product. During configuration, you can write equipment identification information and installation locations to I&M1, installation dates to I&M2, and comments to I&M3.

I&M0 Content

Content	Size Byte	Description
MANUFACTURER_ID	2	Fuji Electric : 0x0015 (21)
ORDER_ID	20	FRENIC-Ace (E3N)
SERIAL_NUMBER	16	Same as MAC address
HARDWARE_REVISION	2	Hardware version
SOFTWARE_REVISION	4	Software version
REVISION_COUNTER	2	Update count 0x0000 to build No.
PROFILE_ID	2	PROFIDrive : 0x3A00
PROFILE_SPECIFIC_TYPE	2	PROFIDrive : 0x0000
IM_VERSION	2	0x0101 (I&M Ver1.1)
IM_SUPPORTED	2	0x000E

I&M1 Content

Content	Size Byte	Description
TAG_FUNCTION	32	Function name, equipment number, etc. 0x20 (Space) when not in use
TAG_LOCATION	32	Installation location information 0x20 (Space) when not in use

I&M2 Content

Content	Size Byte	Description
INSTALLATION_DATE	16	Date (YYYY-MM-DD hh: mm)

I&M3 Content

Content	Size Byte	Description
DESCRIPTOR	54	Comments 0x20 (Space) when not in use

COMMUNICATION FUNCTIONS

Chap 9

[3] Modbus TCP

The Modbus TCP server function communicates with the master devices (up to 8) with Client functions.The supported Modbus function codes are shown in Table 9.3-1 List of supported function codes".

Table 9.3-1 List of supported function codes

Function Code	Command	Remarks
1(0x01)	Read Coil	
2(0x02)	Read Discrete Inputs	Note 1
3(0x03)	Read Holding Registers	
4(0x04)	Read Input Registers	Note 2
5(0x05)	Write Single Coil	
6(0x06)	Write Single Register	
15(0x0F)	Write Multiple Coils	
16(0x10)	Write Multiple registers	

Note 1) Although the meanings of Read Discrete Inputs data for 1-bit access input and Coil read/write data for 1-bit access output differ in the Modbus specifications, the inverter data is handled without distinction with this product.

Note 2) Although the meanings of Read Input Registers data for 16-bit access input and Internal/Output Register read/write data for 16-bit access output differ in the Modbus specifications, the inverter data is handled without distinction with this product.

Description of the functions

Read Coil: 1 (0x01)

This function reads multiple successive coils. Read the start address of the coil and specify the number of coils in the request frame.

Coil number	+7	+6	+5	+4	+3	+2	+1	+0	Remarks
1	X6	X5	X4	X3	X2	X1	REV	FWD	S06: Operation command R/W
9	RST	XR	XF	—	—	X9	X8	X7	
17	VL	TL	NUV	BRK	INT	EXT	REV	FWD	M14: Operation status R
25	BUSY	WR		RL	ALM	DEC	ACC	IL	
33	FAN	KP	OL	IPF	SWM2	RDY	FDT	FAR	M70: Operation status 2 R
41	-	-	IDL	ID	OPL	LIFE	OH	TRY	
49	X6	X5	X4	X3	X2	X1	REV	FWD	M13: Operation command (Final command) R
57	RST	XR	XF	Res	Res	X9	X8	X7	
65	-	-	-	Y5	Y4	Y3	Y2	Y1	M15: General-purpose output terminal information R
73	-	-	-	-	-	-	-	30	

* The “-” symbol in the above table indicates “Reserved,” and is always set to “0.”
* The address can be specified in the 0 to 79 (coil number 1 to 80) range.
* No error will result if the sum of the coil address and the number of coils exceeds the coil range.

[Request]

Byte (Decimal)	Name	Data Length (Byte)	Description	Remarks
0	Function code	1	Function code	0x01
1 2	Start address	2	Start address (high) Start address (low)	0x0000 to 0xFFFF
3 4	Number of coils	2	Read register number (high) Read register number (low)	Read register number (N): 1 to 2000 (0x7D0)

[Response (Normal)]

Byte (Decimal)	Name	Data Length (Byte)	Description	Remarks
0	Function code	1	Function code	0x01
1	Byte count	1	Following number of data bytes	N
2 3 : :	Coil value	N	Start coil number to N coil value	With a bit configuration of “1” = ON and “0” = OFF, indicates the start coil number on the LSB side.

[Response (Error)]

Byte (Decimal)	Name	Data Length (Byte)	Description	Remarks
0	Error code	1	Error code	0x81
1	Extension code	1	Extension code	0x01: Function not supported 0x02: “Start address + number of coils” is out of range 0x03: Invalid number of coils (0 or exceeding number)

Read Discrete Inputs: 2 (0x02)

This function reads multiple successive inputs. Read the start address and specify the number of inputs in the request frame. In the request and response frames, the function code is 0x02 and the error code is 0x82 as with Read Coil:1.

Read Holding Registers: 3 (0x03)

This function reads multiple successive holding registers. Read the start address of the register and specify the number of registers in the request frame.

Real examples of start address specification are shown below.

Example 1) With the function code E15, specify E = 0x01 Number = 0x0F(15) for the start address.
Start address (high) = 0x01, start address (low) = 0x0F.

Example 2) With the internal free-assignment register 5010, specify 0x1392 (5010) in hexadecimal for the start address.
Start address (high) = 0x13, start address (low) = 0x92.
The free-assignment register addresses and their corresponding function codes are shown in the table below.

Free-assignment register address	Corresponding function code
5000	o221
5001	o222
:	:
5062	o283
5063	o284

[Request]

Byte (Decimal)	Name	Data Length (Byte)	Description	Remarks
0	Function code	1	Function code	0x03
1 2	Start address	2	Start address (high) Start address (low)	0x0000 to 0xFFFF
3 4	Number of registers	2	Read register number (high) (0x00) Read register number (low)	Read register number (N): 1 to 125 (0x007D)

[Response (Normal)]

Byte (Decimal)	Name	Data Length (Byte)	Description	Remarks
0	Function code	1	Function code	0x03
1	Byte count	1	Following number of data bytes	N× 2
2 3 : :	Register value	Nx2	Register value of start address N	Register value [start address] (high) Register value [start address] (low) Register value [start address +1] (high) Register value [start address +1] (low) : : Register value [start address + (N-1)] (high) Register value [start address + (N-1)] (low)

[Response (Error)]

Byte (Decimal)	Name	Data Length (Byte)	Description	Remarks
0	Error code	1	Error code	0x83
1	Extension code	1	Extension code	0x01: Function not supported 0x02: “Start address + number of registers” is out of range 0x03: Invalid number of registers (0 or exceeding number)

Read Input Registers: 4 (0x04)

This function reads multiple successive input registers. Read the start address of the register and specify the number of registers in the request frame. In the request and response frames, the function code is 0x04 and the error code is 0x84 as with Read Holding Registers:3.

Write Single Coil: 5 (0x05)

This function writes the ON/OFF output value to a single coil. Specify the coil address and the ON/OFF output value in the request frame.

Coil number	+7	+6	+5	+4	+3	+2	+1	+0	Remarks
1	X6	X5	X4	X3	X2	X1	REV	FWD	S06: Operation command R/W
9	RST	XR	XF	-	-	X9	X8	X7	

* The "-" symbol in the above table indicates "Reserved," and is always set to "0."
* The address can be specified in the 0 to 15 (coil number 1 to 16) range.

[Request]

Byte (Decimal)	Name	Data Length (Byte)	Description	Remarks
0	Function code	1	Function code	0x05
1 2	Output address	2	Address (high) Address (low)	0x0000 to 0xFFFF
3 4	Output value	2	Output value (high) Output value (low) (0x00)	ON = 0xFF, OFF = 0x00

[Response (Normal)]

Byte (Decimal)	Name	Data Length (Byte)	Description	Remarks
0	Function code	1	Function code	0x05
1 2	Output address	2	Address (high) Address (low)	0x0000 to 0xFFFF
3 4	Output value	2	Output value (high) Output value (low) (0x00)	ON = 0xFF, OFF = 0x00

[Response (Error)]

Byte (Decimal)	Name	Data Length (Byte)	Description	Remarks
0	Error code	1	Error code	0x81
1	Extension code	1	Extension code	0x01: Function not supported 0x02: Address is out of range 0x03: Invalid output value

Write Single Register: 6 (0x06)

This function writes the register value to a single holding register. Specify the holding register address and the register value in the request frame.

Real examples of start address specification are shown below.

Example 1) With the function code E15, specify E = 0x01 Number = 0x0F(15) for the start address.
Start address high = 0x01, start address low = 0x0F.

Example 2) With the internal free-assignment register 5010, specify 0x1392 (5010) in hexadecimal for the start address.
Start address high = 0x13, start address low = 0x92.
For details on free-assignment register addresses, refer to “Read Holding Registers.”

[Request]

Byte (Decimal)	Name	Data Length (Byte)	Description	Remarks
0	Function code	1	Function code	0x06
1 2	Address	2	Address (high) Address (low)	0x0000 to 0xFFFF
3 4	Register value	2	Register value (high) Register value (low)	0x0000 to 0xFFFF

[Response (Normal)]

Byte (Decimal)	Name	Data Length (Byte)	Description	Remarks
0	Function code	1	Function code	0x06
1 2	Address	2	Address (high) Address (low)	0x0000 to 0xFFFF
3 4	Register value	2	Register value (high) Register value (low)	0x0000 to 0xFFFF

[Response (Error)]

Byte (Decimal)	Name	Data Length (Byte)	Description	Remarks
0	Error code	1	Error code	0x81
1	Extension code	1	Extension code	0x01: Function not supported 0x02: Address is out of range 0x03: Invalid register value

Write Multiple Coils: 15 (0x0F)

This function writes the ON/OFF output value to multiple successive coils. Specify the coil start address, the number of coils to which to write, and the ON/OFF output value in the request frame.

* Data is stored from its LSB, beginning from the smallest coil number.
The data becomes “1” when the coil is ON, and “0” when the coil is OFF. All remaining bits are ignored.

The following example shows the settings for a request in which the start address is “0,” the number of coils is “16,” X1 is ON, and all other coils are OFF.

Adress	0	1	2	3	4	5	6	7
Description	FC	Start address		Number of coils		Byte count	Write data	
		[H]	[L]	[H]	[L]		[L]	[H]
Data	0x0F	0x00	0x00	0x00	0x10	0x02	0x04	0x00

[Request]

Byte (Decimal)	Name	Data Length (Byte)	Description	Remarks
0	Function code	1	Function code	0x0F
1 2	Start address	2	Start address(high) Start address (low)	0x0000 to 0xFFFF
3 4	Number of coils	2	Number of coils (high) Number of coils (low)	Number of coils to write (K):1 to 1968 (0x7B0)
5	Byte count	1	Following number of data bytes	N
6 :	Coil value	N	Coil value of start coil number K	With a bit configuration of “1” = ON and “0” = OFF, the LSB side indicates the start coil number.

[Response (Normal)]

Byte (Decimal)	Name	Data Length (Byte)	Description	Remarks
0	Function code	1	Function code	0x0F
1 2	Start address	2	Start address (high) Start address (low)	0x0000 to 0xFFFF
3 4	Number of coils	2	Number of coils (high) Number of coils (low)	Number of coils to write (K): 1 to 1968 (0x7B0)

[Response (Error)]

Byte (Decimal)	Name	Data Length (Byte)	Description	Remarks
0	Error code	1	Error code	0x8F
1	Extension code	1	Extension code	0x01: Function not supported 0x02: “Start address + number of coils” is out of range 0x03: Invalid number of coils (0 or exceeding number) or the number of coils ÷ number of bytes using 8 bits does not match the byte count.

Write Multiple Registers: 16 (0x10)

This function writes to successive holding registers. Specify the coil start address, the number of registers to which to write, and the register value in the request frame.

Real examples of start address specification are shown below.

Example 1) With the function code E15, specify E = 0x01 Number = 0x0F(15) for the start address.
Start address high = 0x01, start address low = 0x0F.

Example 2) With the internal free-assignment register 5010, specify 0x1392 (5010) in hexadecimal for the start address.
Start address high = 0x13, start address low = 0x92.
For details on free-assignment register addresses, refer to “Read Holding Registers.”

[Request]

Byte (Decimal)	Name	Data Length (Byte)	Description	Remarks
0	Function code	1	Function code	0x10
1 2	Start address	2	Start address (high) Start address (low)	0x0000 to 0xFFFF
3 4	Number of registers	2	Number of registers to write (high) (0x00) Number of registers to write (low)	Number of registers to write (N):1 to 123 (0x007B)
5	Byte count	1	Following number of data bytes	Nx2
6 : :	Register value	N×2	Start address to N register value	Register value [start address] (high) Register value [start address] (low) Register value [start address +1] (high) Register value [start address +1] (low) : : Register value [start address + (N-1)] (high) Register value [start address + (N-1)] (low)

[Response (Normal)]

Byte (Decimal)	Name	Data Length (Byte)	Description	Remarks
0	Function code	1	Function code	0x10
1 2	Start address	2	Start address (high) Start address(low)	0x0000 to 0xFFFF
3 4	Number of registers	2	Number of registers to write (high) (0x00) Number of registers to write (low)	Number of registers to write (N):1 to 123 (0x007B)

[Response (Error)]

Byte (Decimal)	Name	Data Length (Byte)	Description	Remarks
0	Error code	1	Error code	0x90
1	Extension code	1	Extension code	0x01: Function not supported 0x02: "Start address + number of registers" is out of range 0x03: Invalid number of registers (0 or exceeding number) or the byte count is not the double of the number of registers

9.3.6 Specifications (Ethernet)

[1] Ethernet specifications

The table below lists the common Ethernet specifications of this product.

Item	Description
Connector Type	RJ-45 connector with shielding,
Ethernet Cable	CAT5e or higher UTP or STP cable For details, refer to the following websites. • ODVA (Open DeviceNet Vendor Association, Inc.) https://www.odva.org/ • PROFIBUS & PROFINET International (PI) https://www.profibus.com/
Physical Layer Type	IEEE 802.3
Communication Speed	10Mbps/100Mbps (Automatic detection)
Duplex	Half-duplex/Full-duplex (Automatic detection)
Auto MDI-X	Supported (Automatic recognition of straight/cross cables)
Auto Polarity	Supported (Automatic polarity recognition)
Cable Length	Max. 100 m (328 ft) per segment
IP Address	Static (Specified with the inverter function codes), Hardware switch, DHCP (Other than PROFINET), DCP (PROFINET)
MAC Address	Configured

[2] Ethernet/IP specifications

The table below lists Ethernet/IP specifications supported by this product.

Item	Specifications
Conformance Tested	ODVA Ethernet/IP Declaration of Conformity (CT-19)
Vendor ID	319
Product Code	0x2432
Product Type Code	2 (AC Drive)
UCMM	Supported
Class 3 (Explicit) Messaging	Supported
Class 1 (Implicit I/O) Messaging	Supported
Class 1 Unicast T→ O	Supported
Class 1 Multicast T→O	Supported
Number of Connections	Class1: 8, Class3: 8
Requested Packet Interval (RPI)	Min. 4 ms
I/O Input Size	Max. 32 input words, user configurable
I/O Output Size	Max. 32 output words, user configurable
Generic (User Configurable) Assembly Instances	100 (input) and 150 (output)
AC/DC Drive Profile Assembly Instances	20 (input) and 70 (output), 21 (input) and 71 (output)
Data Table Read/Write	Not supported
Device Level Ring (DLR)	Not supported
Communication Profile Object	AC Drive Profile Objects - Identity Objects (Class Code 0x01) - Assembly Objects (Class Code 0x04) - Connection Manager Objects (Class Code 0x06) - Motor Data Objects (Class Code 0x28) - Control Supervisor Objects (Class Code 0x29) - AC/DC Drive Objects (Class Code 0x2A) - QoS Objects (Class Code 0x48) - Fuji Vendor-Specific Objects (Class Code 0x64) - Fuji Vendor-Specific Objects (Class Code 0xA2) - TCP/IP Interface Objects (Class Code 0xF5) - Ethernet Link Objects (Class Code 0xF6)

[3] PROFINET IO specifications

The table below lists PROFINET specifications supported by this product.

Item	Description
Conformance Tested	PROFINET V2.43 Certificate Certified by PI PROFIBUS • PROFINET
Vendor ID	0x0015
Device ID	0x2432
Device Type	PROFINET IO Device
Device Name	Unassigned (Factory default setting)
Protocol Level	RT (Real-Time)
RT Conformance Class	Class B
Netload Class	I
I/O Cycle Time	Min. 4 ms
I/O Input Size	Max. 32 input words, user configurable
I/O Output Size	Max. 32 output words, user configurable
Media Redundancy Protocol (MRP)	Supported
DCP	Supported
LLDP	Supported
I&M	I&M0 to I&M3
Communication Profile	PROFIDrive - Standard Telegram 1 - Telegram 100 - Telegram 101

[4] Modbus TCP specifications

The table below lists the Modbus TCP communication specifications supported by this product.

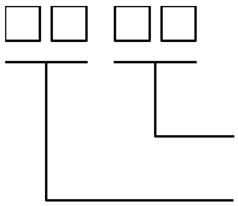
Table 9.3-2 Modbus TCP communication specifications

Item	Specifications	Remarks
Number of Connections	8	
Max Read Register Size	125 registers	Reads up to 100 registers (100 registers for one function code)
Max Write Register Size	125 registers	Writes up to 100 registers
Register Data Type	16-bit integer	
Unit (Follower) ID	Ignored, echoed in response	
TCP Port	502	

9.3.7 Setting inverter function codes

Specify the function code type (refer to the table below) and number with four hexadecimal digits as shown below to access the function codes using the 0x64 class of EtherNet/IP.

However, it is ignored when there is no function code in the inverter.



Function code number (In hexadecimal)

Function code group (According to appendix in the table below.)

Function code type (EtherNet/IP 0x64 class)

Type	Type Code		Function Code Name	Type	Type Code		Function Code Name
S	2	02_H	Command/Function Data	Z	18	12_H	Alarm Data 2
M	3	03_H	Monitor Data	b	19	13_H	Motor 3/Speed Control 3 Parameters
F	4	04_H	Fundamental Functions	d	20	14_H	Application Functions 2
E	5	05_H	Terminal Functions	W1	23	17_H	Monitor Data 2
C	6	06_H	Control Functions	X1	26	$1A_H$	Alarm Data
P	7	07_H	Motor 1 Parameters	K	29	$1D_H$	Keypad Functions
H	8	08_H	High Performance Functions	H1	32	20_H	High Performance Functions
A	9	09_H	Motor 2/Speed Control 2 Parameters	o1	33	21_H	Optional Functions
o	10	$0A_H$	Optional Functions	U1	34	22_H	Customized Logic Functions
r	12	$0C_H$	Motor 4/Speed Control 4 Parameters	M1	35	23_H	Monitor Data
U	13	$0D_H$	Customized Logic Functions	J1	36	24_H	Application Functions
J	14	$0E_H$	Application Functions	d1	42	$2A_H$	Application Functions 2
y	15	$0F_H$	Link Functions	d2	55	37_H	Application Functions 2
W	16	10_H	Monitor Data 2	o2	62	$3E_H$	Optional Functions
X	17	11_H	Alarm Data				

Example: For F26 F ⇒ Type code 04
26 ⇒ 1A (Hexadecimal notation) } "041A"

Use the table below when accessing the function codes using EtherNet/IP class 0xA2 or Modbus TCP.

Function code type (EtherNet/IP 0xA2 class, Modbus TCP)

Type	Type Code		Function Code Name	Type	Type Code		Function Code Name
S	7	07_H	Command/Function Data	Z	17	11_H	Alarm Data 2
M	8	08_H	Monitor Data	b	18	12_H	Motor 3/Speed Control 3 Parameters
F	0	00_H	Basic Functions	d	19	13_H	Application Functions 2
E	1	01_H	Terminal Functions	W1	22	16_H	Monitor Data 2
C	2	02_H	Control Functions	X1	25	19_H	Alarm Data
P	3	03_H	Motor 1 Parameters	K	28	$1C_H$	Keypad Functions
H	4	04_H	High Performance Functions	H1	31	$1F_H$	High Performance Functions
A	5	05_H	Motor 2/Speed Control 2 Parameters	o1	37	25_H	Optional Functions
o	6	06_H	Optional Functions	U1	39	27_H	Customized Logic Functions
r	10	$0A_H$	Motor 4/Speed Control 4 Parameters	M1	41	29_H	Monitor Data
U	11	$0B_H$	Customized Logic Functions	J1	48	30_H	Application Functions
J	13	$0D_H$	Application Functions	d1	54	36_H	Application Functions 2
y	14	$0E_H$	Link Functions	d2	55	37_H	Application Functions 2
W	15	$0F_H$	Monitor Data 2	o2	38	26_H	Optional Functions
X	16	10_H	Alarm Data				

Example: For F26 F ⇒ Type code 00
26 ⇒ 1A (Hexadecimal notation)
"001A"

9.3.8 About the display content of Ethernet built-in type (E3N)

[1] Explanations of each display section

The monitor display section on the front of the E3N displays the inverter and communication status.

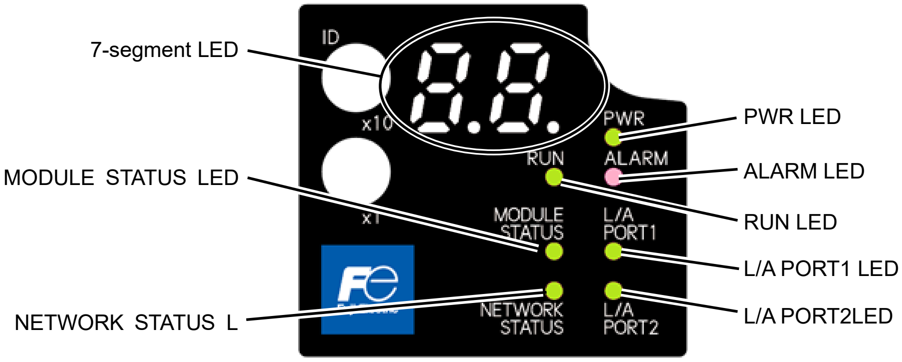


Fig. 9.3-1 Appearance and part names of the LED display section

Table 9.3-3 Names of each keypad part and overview of functions

Item	LED Monitor and Keys	Functions
7-segment LED indicators		This is a 2-digit, 7-segment LED monitor. It displays the inverter status.
LED display section	PWR (green)	Lights up when the inverter unit is energized.
	ALARM (red)	Lights up when an alarm has occurred and flashes when a warning has occurred.
	RUN (green)	Lights up when the inverter is running.
	MODULE STATUS (green/red)	The LED that lights up differs depending on the protocol. Refer to the explanations on the status LED for each protocol.
	NETWORK STATUS (green/red)	
	L/A PORT1 LED	
	L/A PORT2 LED	

[2] LED status (Ethernet/IP)

LED Name	Color	LED Status	Description	Remarks
MS (MODULE STATUS)	Green/Red	OFF	Power OFF	
		Alternate blinking	During self-diagnosis test at startup Each LED turns on for 0.25 seconds for indicator tests at startup MS (Green) ON→MS (Red) →NS (Green) →NS (Red) → OFF	Test performed for 1 second
	Green	ON	Operating normally	
		Blinking	IP address is not set when using DHCP.	
	Red	OFF	No failure	
		Blinking	Minor failure (recoverable)	Incorrect communication settings, etc.
		ON	Mounting failure or hardware failure (unrecoverable) *1	Er4 occurs in the inverter
NS (NETWORK STATUS)	Green/Red	Alternate blinking	During self-diagnosis test at startup	Test performed for 1 second
	Green	OFF	Connection with scanner not established (IP address is not set)	
		Blinking	Waiting for connection establishment with scanner (IP address is set)	Waiting for a communication connection request from the scanner.
		ON	Normally communicating with the scanner	
	Red	OFF	Normally communicating with the scanner	
		Blinking	A timeout occurred during communication with the scanner. - The communication cycle time is short.	*2
		ON	There is a problem with the Ethernet cable or the settings. - Duplicate IP address	*2
L/A PORT 1 L/A PORT 2	Green	OFF	Not connected	
		Blinking	Linking (in communication)	
		ON	Linking (not in communication)	

*1: Hardware failure status indicates an error that cannot continue operation such as a hard watchdog timeout, memory error, or exception interrupt.

*2: Er5 may occur in the inverter. However, it is not displayed before starting IO communication.
Er5 may not be displayed according to the setting of o27.

[3] LED status (PROFINET)

LED Name	Color	LED Status	Description	Remarks
MS (MODULE STATUS)	Green/ Red	OFF	Power OFF	
		Alternate blinking	During self-diagnosis test at startup Each LED turns on for 0.25 seconds for indicator tests at startup MS (Green) ON→MS (Red) →NS (Green) →NS (Red) → OFF	Test performed for 1 second
	Green	ON	Operating normally	
	Red	OFF	Operating normally	
		Blinking	MAC address error	
		ON	Mounting failure or hardware failure (unrecoverable) *1	Er4 occurs in the inverter
NS (NETWORK STATUS)	Green/ Red	Alternate blinking	During self-diagnosis test at startup	Test performed for 1 second
	Green	OFF	Connection with master not established.	
		Blinking	Identifying the device. (The LED test with diagnostic tool)	Waiting for a communication connection request from the master
		Single flash	Waiting for connection establishment with master.	
		ON	Normally communicating with the master.	
	Red	OFF	Normally communicating with the master.	
		Single flash	Device Name is not registered.	*3
		Double flash	IP address is not registered.	
L/A PORT 1 L/A PORT 2	Green	OFF	Not connected	
		Blinking	Linking (in communication)	
		ON	Linking (not in communication)	

*1: Hardware failure status indicates an error that cannot continue operation such as a hard watchdog timeout, memory error, or exception interrupt.

*3: It occurs when communication is disconnected after the start of communication or the Device Name is deleted during communication.
It does not occur before communication, or if there is no Device Name.

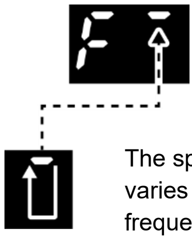
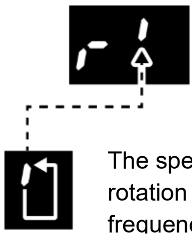
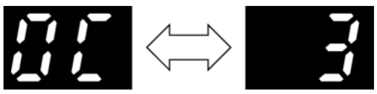
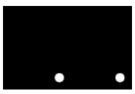
[4] LED status (Modbus TCP)

LED Name	Color	LED Status	Description	Remarks
MS (MODULE STATUS)	Green/Red	OFF	Power OFF	
		Alternate blinking	During self-diagnosis test at startup Each LED turns on for 0.25 seconds for indicator tests at startup MS (Green) ON→MS (Red) →NS (Green) →NS (Red) → OFF	Test performed for 1 second
	Green	ON	Operating normally	
		Blinking	IP address is not set when using DHCP.	
	Red	OFF	No failure	
		Blinking	Minor failure (recoverable)	Incorrect communication settings, etc.
		ON	Mounting failure or hardware failure (unrecoverable) *1	Er4 occurs in the inverter
NS (NETWORK STATUS)	Green/Red	Alternate blinking	During self-diagnosis test at startup	Test performed for 1 second
	Green	OFF	-	
	Red	OFF	-	
L/A PORT 1 L/A PORT 2	Green	OFF	Not connected	
		Blinking	Linking (in communication)	
		ON	Linking (not in communication)	

*1: Hardware failure status indicates an error that cannot continue operation such as a hard watchdog timeout, memory error, or exception interrupt.

[5] 7-segment LED display

The front display of the display section changes depending on the inverter status. Details of descriptions are as follows.

Status	Code
When the power to the inverter is turned ON.	FE is displayed 1s after power on. 
Stop status	
Running	When the device is running in the forward direction, F is displayed on the left digit and the right digit rotates clockwise.  The speed of the clockwise rotation varies depending on the operating frequency. When the device is running in the reverse direction, r is displayed on the left digit and the right digit rotates counterclockwise.  The speed of the counterclockwise rotation varies depending on the operating frequency.
Alarm occurring	The alarm code display alternates.  For details of alarm codes, refer to Chapter 6 “6.3.1 Alarm code list”.
Insufficient voltage (with run command)	
STO (with run command)	
Measuring the main capacitor capacity	
DC output	

9.4 Communications-dedicated Function Codes

Communications dedicated function codes are available to monitor the operation and status of the inverter via communications. They are classified into the groups shown in Table 9.4-1 below:

Table 9.4-1 Types of communications-dedicated function codes

<table>
<tr><th>Communications-dedicated Function Code Group</th><th>Function</th></tr>
<tr><td>S</td><td>Command Data</td></tr>
<tr><td>M</td><td>Monitor Data 1 (for reading only)</td></tr>
<tr><td>M1</td><td>Monitor Data 1 (for reading only)</td></tr>
<tr><td>W</td><td>Monitor Data 2 (for reading only)</td></tr>
<tr><td>W1</td><td>Monitor Data 2 (for reading only)</td></tr>
<tr><td>X</td><td rowspan="3">Alarm Information (for reading only)</td></tr>
<tr><td>X1</td></tr>
<tr><td>Z</td></tr>
</table>

The sections that follow describe communications-dedicated function codes of each group. For how to use each function code and more detailed information on them, refer to the RS-485 Communication User's Manual.

9.4.1 Command data

The table below shows the function codes (S codes) for the command data.

Table 9.4-2 List of command data

Code	Name	Function	Permissible Setting Range	Unit	E3S/E3E	E3N	R/W *1
S01	Reference frequency (p.u.) *2	Frequency command issued through communications (the reference value for maximum frequency)	-32768 to 32767 (Max frequency: at +/- 20000)	-	Y	Y	R/W
S02	Torque command	Torque command through communication	-327.68 to 327.67	%	Y	Y	R/W
S03	Torque current command	Torque current command through communication	-327.68 to 327.67	%	Y	Y	R/W
S05	Reference frequency *2	Frequency command issued through communication (in units of 0.01 Hz)	0.00 to 655.35	Hz	Y	Y	R/W
S06	Operation command	Operation command issued through communication (general input terminal functions (X1 to X9, XF (FWD), R (REV)) and FWD, REV, RST only through communications]	0000_H to $FFFF_H$	-	Y	Y	R/W
S07	Universal DO	Command issued to DO terminal through communication	0000_H to $FFFF_H$	-	Y	Y	R/W
S08	Acceleration time	Each data is set with the code or communications format common to all the inverter types.	0.0 to 6000.0	s	Y	Y	R/W
S09	Deceleration time		0.0 to 6000.0	s	Y	Y	R/W
S10	Torque limit level 1 F40		-300.00 to 300.00, 999	%	Y	Y	R/W
S11	Torque limit level 2 F41		-300.00 to 300.00, 999 (The value is rounded down after the decimal point.)	%	Y	Y	R/W
S12	Universal AO	Command issued to AO terminal through communication	-32768 to 32767 (Full scale: at +/- 20,000)	-	Y	Y	R/W
S13	PID command	PID command issued through communication	-32768 to 32767 (+/- 20000 corresponds to +/- 100%)	-	Y	Y	R/W
S14	Alarm reset command	Alarm reset command issued through communication	0 or 1	-	Y	Y	R/W
S15	Torque bias command	Torque bias command through communication	-327.68 to 327.67	%	Y	Y	R/W
S19	Speed command *2	Speed command issued through communications	-32768 to 32767	min^{-1}	Y	Y	R/W
S20	Positioning data (higher order digits)	Positioning data through communication	-9999 to 9999	-	Y	N	R/W
S21	Positioning data (lower order digits)		0 to 9999	-	Y	N	R/W

*1 Legends in R/W column...R: Readable, W: Write-enable, R/W: Read/write possible

*2 If values for S01, S05 and S19 have been set, these commands operate in the following order: S01>S05>S19.

9.4.2 Monitor Data 1

Function codes for Monitor Data 1 (M codes) are described below.
These function codes are for reading only.

Table 9.4-3 Monitor Data 1 function codes

Code	Name	Description	Monitor Range	Unit	E3S/E3E	E3N
M01	Frequency command (p.u.) (Final command)	Frequency command based on the maximum frequency	-32768 to 32767 (±20,000 = maximum frequency)	-	Y	Y
M02	Torque command (Final command)	Torque command based on the motor rated torque (100%)	-327.68 to 327.67	%	Y	Y
M03	Torque current command (Final command)	Torque current command based on the motor rated torque current (100%)	-327.68 to 327.67	%	Y	Y
M04	Flux command	Flux command based on the rated motor flux (100%)	-327.68 to 327.67	%	Y	Y
M05	Frequency command (Final command)	Frequency command with min. step 0.01Hz	0.00 to 655.35	Hz	Y	Y
M06	Output frequency 1 (p.u.)	Output frequency based on the maximum frequency (before slip compensation)	-32768 to 32767 (±20,000 = maximum frequency)	-	Y	Y
M07	Torque real value	Motor output torque based on the motor's rated torque (100%)	-327.68 to 327.67	%	Y	Y
M08	Torque current	Torque current based on the rated torque current of the motor (100%)	-327.68 to 327.67	%	Y	Y
M09	Output frequency 1	Output frequency with min. step 0.01Hz	FGI: -655.35 to 655.35 RTU: 0.00 to 655.35	Hz	Y	Y
M10	Input power	Power consumption value based on the "nominal applicable motor output" (100%)	0.00 to 399.99	%	Y	Y
M11	Output current effective value	Output current effective value based on the inverter rated current	0.00 to 399.99 (100% = inverter rated current)	%	Y	Y
M12	Output voltage effective value	Output voltage effective value (min. step: 1.0V)	0.0 to 1000.0	V	Y	Y
M13	Operation command (Final command)	Displays the final command created by information from the keypad, terminal block, and communications, and transmitted to the inverter inside.	0000_H to $FFFF_H$	-	Y	Y
M14	Operation status	Displays the operation status in the form of a bit signal.	0000_H to $FFFF_H$	-	Y	Y
M15	General-purpose output terminal information	General-purpose output terminal information is monitored.	0000_H to $FFFF_H$	-	Y	Y
M16	Latest alarm contents	Display alarm contents in the form of code.	0 to 254	-	Y	Y
M17	Last alarm contents				Y	Y
M18	Second last alarm contents				Y	Y
M19	Third last alarm contents				Y	Y

*1 Since M12 does not have any data after the decimal point, the minimum step is 1.0.

Table 9.4-3 Monitor Data 1 function codes (cont'd)

Code	Name	Description	Monitor Range	Unit	E3S/E3E	E3N
M20	Cumulative run time	-	0 to 65535	h	Y	Y
M21	DC link circuit voltage	Displays the DC link circuit voltage of the inverter.	0 to 1000	V	Y	Y
M23	Model code	Displays the series, generation, model, destination and voltage series in four-digit hexadecimal data.	0000_H to $FFFF_H$	-	Y	Y
M24	Capacity code	Displays the capacity of the inverter.	0 to 65535	-	Y	Y
M25	ROM version	Displays the ROM version used in the inverter.	0 to 9999	-	Y	Y
M26	Transmission error transaction code	Communications error code of RS-485	0 to 127	-	Y	Y
M27	Frequency command on alarm (p.u.) (Final command)	Data equivalent to M01 on alarm	-32768 to 32767 (±20,000 = maximum frequency)	-	Y	Y
M28	Torque command on alarm (Final command)	Data equivalent to M02 on alarm	-327.68 to 327.67	%	Y	Y
M29	Torque current command on alarm (Final command)	Data equivalent to M02 on alarm	-327.68 to 327.67	%	Y	Y
M30	Flux command on alarm (Final command)	Data equivalent to M04 on alarm	-327.68 to 327.67	%	Y	Y
M31	Frequency command on alarm (Final command)	Data equivalent to M05 on alarm	0.00 to 655.35	Hz	Y	Y
M32	Output frequency 1 on alarm (p.u.)	Data equivalent to M06 on alarm	-32768 to 32767 (±20,000 = maximum frequency)	-	Y	Y
M33	Torque real value on alarm	Data equivalent to M07 on alarm	-327.68 to 327.67	%	Y	Y
M34	Torque current on alarm	Data equivalent to M08 on alarm	-327.68 to 327.67	%	Y	Y
M35	Output frequency on alarm 1	Data equivalent to M09 on alarm	FGI: -655.35 to 655.35 RTU: 0.00 to 655.35	Hz	Y	Y
M36	Input power on alarm	Data equivalent to M10 on alarm	0.00 to 399.99	%	Y	Y
M37	Output current effective value on alarm	Data equivalent to M11 on alarm	0.00 to 399.99 (100% = inverter rated current)	%	Y	Y
M38	Output voltage effective value on alarm	Data equivalent to M12 on alarm	0.0 to 1000.0	V	Y	Y
M39	Operation command on alarm	Data equivalent to M13 on alarm	0000_H to $FFFF_H$	-	Y	Y

Table 9.4-3 Monitor Data 1 function codes (cont'd)

Code	Name	Description	Monitor Range	Unit	E3S/E3E	E3N
M40	Running status on alarm	Data equivalent to M14 on alarm	0000_H to $FFFF_H$	-	Y	Y
M41	General-purpose output terminal information on alarm	Data equivalent to M15 on alarm	0000_H to $FFFF_H$	-	Y	Y
M42	Cumulative run time on alarm	Data equivalent to M20 on alarm	0 to 65535	h	Y	Y
M43	DC link circuit voltage on alarm	Data equivalent to M21 on alarm	0 to 1000	V	Y	Y
M44	Inverter internal air temperature on alarm	Air temperature inside the inverter on alarm	0 to 255	°C	Y	Y
M45	Heat sink temperature on alarm	Data equivalent to M62 on alarm	0 to 255	°C	Y	Y
M46	Life of DC link bus capacitor	The capacity of the DC link bus capacitor is 100% when delivered from the factory	0.0 to 100.0	%	Y	Y
M47	Life of PCB electrolytic capacitor	Cumulative operation time of the capacitor packaged on the PCB	0 to 65535	h	Y	Y
M48	Life of cooling fan	Cumulative run time of cooling fan	0 to 65535	h	Y	Y
M49	Input terminal voltage [12]	Input voltage of terminal [12] (-20,000/-10 V, 20,000/10 V)	-32768 to 32767	-	Y	Y
M50	Input terminal current [C1]	Input current of terminal [C1] (0/0 mA, 20,000/20 mA)	0 to 32767	-	Y	Y
M52	Input terminal voltage [32]	Input voltage of terminal [32] (-20,000/-10 V, 20,000/10 V)	-32768 to 32767	-	Y	N
M53	Input terminal current [C2]	Input current of terminal [C1] (0/0 mA, 20,000/20 mA)	0 to 32767	-	Y	N
M54	Input terminal voltage ([C1] (V2 function))	Input voltage of terminal [C1] (V2 function) (-20000/10V to 20000/10V)	-32768 to 32767	-	Y	Y
M56	Input terminal voltage ([C1] (PTC function))	C1(PTC function) terminal input voltage (0/0 V to 20000/10 V)	0 to 32767	-	Y	Y
M57	Electrical angle	Inverter output electrical angle	0.0 to 359.9	°	Y	Y
M58	Rotor angle	Synchronous motor rotor phase angle	0.0 to 359.9	°	Y	Y
M59	Electronic thermal monitor	Electronic thermal integrated value	0 to 100	%	Y	Y
M61	Inverter internal air temperature	Current temperature inside the inverter	0 to 255	°C	Y	Y
M62	Heat sink temperature	Current temperature of the heat sink within the inverter	0 to 255	°C	Y	Y
M63	Load factor	Load rate based on the motor rating	-327.68 to 327.67	%	Y	Y

Table 9.4-3 Monitor Data 1 function codes (cont'd)

Code	Name	Description	Monitor Range	Unit	E3S/E3E	E3N
M64	Motor output	Motor output based on the motor's rated output (kW)	-327.68 to 327.67	%	Y	Y
M65	Motor output on alarm	Data equivalent to M64 on alarm	-20000 to 20000	%	Y	Y
M66	Speed detection	Speed detection value based on the maximum output frequency (F03, etc.) (±20000/100%)	-20000 to 20000	-	Y	Y
M67	Transmission error processing code	Error processing code for data transfer	0 to 127	-	Y	Y
M68	PID final command	±20000/±100%	-32768 to 32767	-	Y	Y
M69	Inverter rated current	FGI	0.00 to 9999	A	Y	Y
		RTU (inverter capacity 22 kW (30HP) or less *1)	0.00 to 655.35	A	Y	Y
		RTU (inverter capacity 30kW (40HP) or more)	0.0 to 6553.5	A	Y	Y
M70	Operation status 2	Displays the operation status in the form of a bit signal.	0000_H to $FFFF_H$	-	Y	Y
M71	Input terminal information	Operation command information from the terminal block and communications	0000_H to $FFFF_H$	-	Y	Y
M72	PID feedback value	PID feedback based on 100% of analog input (±20000/100%)	-32768 to 32767	-	Y	Y
M73	PID output	PID output based on the maximum frequency (F03) (±20000/100%)	-32768 to 32767	-	Y	Y
M74	Operation status 2	Displays the operation status in the form of a bit signal.	0000_H to $FFFF_H$	-	Y	Y
M75	Frequency command (p.u.)	Frequency command based on the maximum frequency	-32768 to 32767 (±20,000 = maximum frequency)	-	Y	Y
M76	DC link bus capacitor life (elapsed time)	DC link bus capacitor use time	0 to 65535 (in units of 10 hours)	10 h	Y	Y
M77	DC link bus capacitor life (remaining time)	DC link bus capacitor remaining life	0 to 65535 (in units of 10 hours)	10 h	Y	Y
M78	Rotation speed command	Rotation speed command in 1 min^{-1}	-32768 to 32767	min^{-1}	Y	Y
M79	Motor speed	Output rotation speed in 1 min^{-1}	-32768 to 32767	min^{-1}	Y	Y
M81	Remaining time before maintenance (M1)	Time before the next maintenance	0 to 65535 (in units of 10 hours)	10 h	Y	Y
M85	No. of starting times before maintenance (M1)	Allowable starting times before the next maintenance	0 to 65535	times	Y	Y

*1 The standard applicable motor capacity with the inverter default settings.

Table 9.4-3 Monitor Data 1 function codes (cont'd)

Code	Name	Description	Monitor Range	Unit	E3S/E3E	E3N
M86	Warning (latest)	Latest warning indicated with a code	0 to 254	-	Y	Y
M87	Warning (last)	Last warning indicated with a code	0 to 254	-	Y	Y
M88	Warning (second last)	Second last warning indicated with a code	0 to 254	-	Y	Y
M89	Warning (third last)	Third last warning indicated with a code	0 to 254	-	Y	Y
M98	Warning status	"1" when a warning has occurred.	0 to 1	-	Y	Y
M101	Frequency/speed command (with symbol)	Frequency command with min. step 0.01 Hz	-327.68 to 327.67 *1	Hz	Y	Y
M102	Frequency command (absolute value) *2	Last frequency command in 0.01 Hz	0.00 to 655.35	Hz	Y	Y
M103	Frequency command (with symbol) *2	Last frequency command in 0.01 Hz	-327.68 to 327.67 *1	Hz	Y	Y
M105	Output frequency before slip compensation (with symbol)	Output frequency before slip compensation in 0.01 Hz	-327.68 to 327.67 *1	Hz	Y	Y
M107	Output frequency after slip compensation (with symbol)	Output frequency after slip compensation in 0.01 Hz	-327.68 to 327.67 *1	Hz	Y	Y
M108	Detection speed (absolute value) *3	Detection speed in 0.01 Hz	0.00 to 655.35	Hz	Y	Y
M109	Detection speed (with symbol) *3	Detection speed in 0.01 Hz	-327.68 to 327.67 *1	Hz	Y	Y
M110	Output frequency	Output frequency before slip compensation with the maximum frequency at 100%	-100.00 to 100.00	%	Y	Y
M111	Output current (no filter)	Output current value in min. 0.01 A	0.00 to 9999	A	Y	Y
M112	Analog input monitor (no filter)	Inverter's analog input converted by E40 and E41	-999 to 9990	-	Y	Y
M113	Current for torque limiter	Output torque current in relation to the rated current	-327.68 to 327.67	%	Y	Y
M117	Output torque (4 quadrants)	Output torque value with a symbol corresponding to the conditions below. + symbol: forward rotation drive, reverse rotation brake - symbol: forward rotation brake, reverse rotation drive	-327.68 to 327.67	%	Y	Y

*1 When the current value exceeds the setting range, the value limited to the setting range max./min. value is displayed.
*2 The last reference frequency limited by the upper limit frequency, etc. is displayed.
*3 The estimated speed when sensorless control is selected.

Table 9.4-3 Monitor Data 1 function codes (cont'd)

Code	Name	Description	Monitor Range	Unit	E3S/E3E	E3N
M123	Extension model code	Displays the model and the generation with four-digit hexadecimal data.	0000_H to $FFFF_H$	-	Y	Y
M125	IP address monitor 1	OPC-ECT IPv4 address	0 to 255	-	Y	Y
M126	IP address monitor 2	OPC-ECT IPv4 address	0 to 255	-	Y	Y
M127	IP address monitor 3	OPC-ECT IPv4 address	0 to 255	-	Y	Y
M128	IP address monitor 4	OPC-ECT IPv4 address	0 to 255	-	Y	Y
M129	Subnet mask monitor 1	OPC-ECT subnet mask	0 to 255	-	Y	Y
M130	Subnet mask monitor 2	OPC-ECT subnet mask	0 to 255	-	Y	Y
M131	Subnet mask monitor 3	OPC-ECT subnet mask	0 to 255	-	Y	Y
M132	Subnet mask monitor 4	OPC-ECT subnet mask	0 to 255	-	Y	Y
M133	Gateway address monitor 1	OPC-ECT default gateway	0 to 255	-	Y	Y
M134	Gateway address monitor 2	OPC-ECT default gateway	0 to 255	-	Y	Y
M135	Gateway address monitor 3	OPC-ECT default gateway	0 to 255	-	Y	Y
M136	Gateway address monitor 4	OPC-ECT default gateway	0 to 255	-	Y	Y
M137	MAC address monitor 1	OPC-ECT MAC address	0000_H to $FFFF_H$	-	Y	Y
M138	MAC address monitor 2	OPC-ECT MAC address	0000_H to $FFFF_H$	-	Y	Y
M139	MAC address monitor 3	OPC-ECT MAC address	0000_H to $FFFF_H$	-	Y	Y
M141	d-axis current	d-axis during vector control based on the motor ratings	-327.68 to 327.67	%	Y	Y
M142	q-axis current	q-axis during vector control based on the motor ratings	-327.68 to 327.67	%	Y	Y

9.4.3 Monitor Data 2

Function codes for Monitor Data 2 (W codes) are described below.
Monitor Data 2 is linked to the keypad display. All of these function codes are for read only.

Note For the E3N type, replace all instances of [FM1] in the table below with [FM].

Table 9.4-4 Monitor Data 2 (W codes)

Code	Name	Monitor Range	Unit	E3S/E3E	E3N	Remarks
W01	Operation status	0000_H to $FFFF_H$	-	Y	Y	
W02	Frequency command	0.00 to 655.35	Hz	Y	Y	
W03	Output frequency (before slip compensation)	0.00 to 655.35	Hz	Y	Y	
W04	Output frequency (after slip compensation)	0.00 to 655.35	Hz	Y	Y	
W05	Output current	0.00 to 9999	A	Y	Y	
W06	Output voltage	0.0 to 1000.0	V	Y	Y	
W07	Torque	-999 to 999	%	Y	Y	
W08	Rotation speed	0.00 to 99990	min^{-1}	Y	Y	
W09	Load rotation speed	0.00 to 99990	min^{-1}	Y	Y	
W10	Line speed	0.00 to 99990	m/min	Y	Y	
W11	PID process command	-999 to 9990	-	Y	Y	PID command value or PID feedback value converted to the physical quantity of the control target by E40 and E41
W12	PID feedback value	-999 to 9990	-	Y	Y	
W13	Level of torque value A	0 to 1000	%	Y	Y	
W14	Level of torque value B	0 to 1000	%	Y	Y	
W15	Ratio value	0.00 to 655.35	%	Y	Y	
W16	Rotation speed set value	0.00 to 99990	min^{-1}	Y	Y	
W17	Load speed set value	0.00 to 99990	min^{-1}	Y	Y	
W18	Line speed set value	0.00 to 99990	min^{-1}	Y	Y	
W19	Constant feed time set value	0.00 to 999.9	min	Y	Y	
W20	Constant feed time	0.00 to 999.9	min	Y	Y	
W21	Input power	0.00 to 9999	kW	Y	Y	
W22	Motor output	0.00 to 9999	kW	Y	Y	
W23	Load rate	-999 to 999	%	Y	Y	
W24	Torque current	-999 to 999	%	Y	Y	
W25	Output current (unit: 0.1 A)	0.0 to 3276.7	A	Y	Y	
W26	Flux command value	-999 to 999	%	Y	Y	
W27	Timer operation remaining time	0 to 9999	s	Y	N	
W28	Operation command source	0 to 23	-	Y	Y	
W29	Frequency and PID command source	0 to 36	-	Y	Y	
W30	Speed set value at percentage	0.00 to 100.00	%	Y	Y	
W31	Speed set value at percentage	0.00 to 100.00	%	Y	Y	

Table 9.4-4 Monitor Data 2 (W codes) (cont'd)

Code	Name	Monitor Range	Unit	E3S/E3E	E3N	Remarks
W32	PID output	0 to 150.0	%	Y	Y	PID output expressed by a percentage with setting the maximum frequency (F03) to 100%
W33	Analog input monitor	-999 to 9990	-	Y	Y	Inverter's analog input converted by E40 and E41
W35	Terminal [32] input voltage	-12.0 to 12.0	V	Y	N	
W36	Terminal [C2] input current	0.0 to 30.0	mA	Y	N	
W37	Terminal [A0] output voltage	-12.0 to 12.0	V	Y	N	
W38	Terminal [CS] output current	0.0 to 30.0	mA	Y	N	
W39	[X] pulse input monitor*	-327.68 to 327.67	-	Y	N	Unit: kp/s
W40	Control circuit terminal (input)	0000_H to $FFFF_H$	-	Y	Y	
W41	Control circuit terminal (output)	0000_H to $FFFF_H$	-	Y	Y	
W42	Communications control signal (input)	0000_H to $FFFF_H$	-	Y	Y	
W43	Communications control signal (output)	0000_H to $FFFF_H$	-	Y	Y	
W44	Terminal [12] input voltage	0.0 to 12.0	V	Y	Y	
W45	Terminal [C1] input current	0.0 to 30.0	mA	Y	Y	
W46	FM1 output voltage	0.0 to 12.0	V	Y	Y	
W47	FM2 output voltage	0.0 to 12.0	V	Y	N	
W48	FM1 output frequency	0 to 6000	p/s	Y	Y	The output pulse rate of terminal FM1 expressed by (p/s)
W49	C1(V2 function) terminal input voltage	0.0 to 12.0	V	Y	Y	
W50	FM1 output current	0.0 to 30.0	mA	Y	Y	The read value is "32767" when F29=3.
W51	Situation of input terminals on DIO option	0000_H to $FFFF_H$	-	Y	N	
W52	Situation of output terminals on DIO option	0000_H to $FFFF_H$	-	Y	N	
W53	Pulse input (Master - side A/B phase)	-327.68 to 327.67	-	Y	N	Unit: kp/s
W54	Pulse input (Master - side Z phase)	0 to 6000	p/s	Y	N	
W55	Pulse input (Follower - side A/B phase)	-327.68 to 327.67	-	Y	N	Unit: kp/s
W56	Pulse input (Follower - side Z phase)	0 to 6000	p/s	Y	N	
W57	Current Position Pulse (Upper column)	-999 to 999	-	Y	N	
W58	Current Position Pulse (Lower column)	0 to 9999	-	Y	N	
W59	Stop Position Pulse (Upper column)	-999 to 999	-	Y	N	
W60	Stop Position Pulse (Lower column)	0 to 9999	-	Y	N	
W61	Difference Pulse of Position (Upper column)	-999 to 999	-	Y	N	
W62	Difference Pulse of Position (Lower column)	0 to 9999	-	Y	N	
W63	Positioning Status	0 to 10	-	Y	N	
W65	Terminal [FM2] output current	0.0 to 30.0	mA	Y	N	
W66	Deviation during SY synchronization	-999.9 to 999.9	deg	Y	Y	
W67	Cumulative operation time of electrolytic capacitor	0 to 9999	10h	Y	Y	

* The function availability and names vary depending on the model.

Table 9.4-4 Monitor Data 2 (W codes) (cont'd)

Code	Name	Monitor Range	Unit	E3S/E3E	E3N	Remarks
W68	Cumulative run time of cooling fan	0 to 9999	10h	Y	Y	
W70	Cumulative run time	0 to 65535	h	Y	Y	
W71	DC link circuit voltage	0 to 1000	V	Y	Y	
W72	Internal air highest temperature	0 to 255	° C	Y	Y	
W73	Heat sink maximum temperature	0 to 255	° C	Y	Y	
W74	Maximum effective current value	0.00 to 655.35	A	Y	Y	
W75	DC link bus capacitor's capacity	0.0 to 100.0	%	Y	Y	
W76	Cumulative run time of capacitor on PCB	0 to 65535	h	Y	Y	
W77	Cumulative run time of cooling fan	0 to 65535	h	Y	Y	
W78	Number of startups	0 to 65535	times	Y	Y	
W79	Cumulative run time of motor	0 to 65535	h	Y	Y	
W81	Integral power	0.0 to 999900	kWh	Y	Y	
W82	Data used for integral power	0.000 to 9999	-	Y	Y	Value calculated as integral power consumption (kWh) multiplied by function code E51
W83	Number of RS485 ch1 errors	0 to 9999	times	Y	N	
W84	Contents of RS485 ch1 error	0 to 127	-	Y	N	
W85	Number of RS485 ch2 errors	0 to 9999	times	Y	N	
W87	Inverter's ROM version	0 to 9999	-	Y	Y	
W88	Inverter ROM version (CPU2)	0 to 9999	-	Y	Y	
W89	Remote keypad's ROM version	0 to 9999	-	Y	N	
W90	Option1 ROM version	0 to 9999	-	Y	N	
W92	Option3 ROM version	0 to 9999	-	N	Y	
W94	Contents of RS485 ch2 error	0 to 127	-	Y	N	
W95	Number of communications errors	0 to 9999	times	Y	Y	
W96	Communications error content	0 to 9999	-	Y	Y	*1

*1 Indicates the content of a communications error between the inverter and an option card. For details, refer to the manual of each option.

Table 9.4-5 Keypad-related function codes (W1 codes)

Code	Name	Monitor Range	Unit	E3S/E3E	E3N	Remarks
W101	Current year and month	0000_H to $FFFF_H$	-	Y	N	Western calendar 2 digits (higher order bytes), year (lower order bytes)
W102	Current day and hour	0000_H to $FFFF_H$	-	Y	N	Day (higher order bytes), hour (lower order bytes)
W103	Current minutes and seconds	0000_H to $FFFF_H$	-	Y	N	Minutes (higher order bytes), seconds (lower order bytes)
W110	Motor speed	0.00 to 99990	r/min	Y	Y	
W111	Load rotation speed	0.00 to 99990	r/min	Y	Y	
W112	Feed speed	0.00 to 99990	m/min	Y	Y	
W113	Constant feed time (after filtering)	0.00 to 999.9	min	Y	Y	
W116	PG feedback value	0.00 to 655.35	Hz	Y	N	
W118	Torque bias monitor (unit: %)	0 to 100	%	Y	Y	
W119	Torque bias monitor (unit: 0.01%)	0.00 to 100.00	%	Y	Y	
W120	Speed deviation monitor	-327.68 to 327.67	%	Y	Y	
W124	Nameplate current type	0 to 65535	A	Y	Y	
W130	Customizable logic output monitor	0.00 to 9990	-	Y	Y	
W131	PID deviation	0.00 to 100.00	%	Y	Y	
W132	PID deviation (p.u. value)	-32768 to 32767	-	Y	Y	
W133	PID deviation (no filter)	0.00 to 100.00	%	Y	Y	
W142	Position control - Current position (higher order digits)	-9999 to 9999	-	Y	N	
W143	Position control - Current position (lower order digits)	0 to 9999	-	Y	N	
W144	Position control - Stop position (higher order digits)	-9999 to 9999	-	Y	N	
W145	Position control - Stop position (lower order digits)	0 to 9999	-	Y	N	
W146	Position control - Position deviation (higher order digits)	-9999 to 9999	-	Y	N	
W147	Position control - Position deviation (lower order digits)	0 to 9999	-	Y	N	
W152	Position control - Control mode	0000_H to $FFFF_H$	-	Y	N	
W153	Pulse input (Master - side A/B phase) *2	-327.68 to 327.67	-	Y	N	Unit: kp/s
W154	Pulse input (Master - side Z phase) *2	0 to 6000	p/s	Y	N	
W155	Pulse input (Follower - side A/B phase) *2	-327.68 to 327.67	-	Y	N	Unit: kp/s
W156	Pulse input (Follower - side Z phase) *2	0 to 6000	p/s	Y	N	
W161	Braking resistor thermal	0.0 to 100.0	%	Y	Y	100.0%: dbH trip level
W162	Inverter thermal 1	0.0 to 100.0	%	Y	Y	100.0%: OLU trip level
W163	Inverter thermal 2	0.0 to 100.0	%	Y	Y	100.0%: OLU trip level
W165	Regeneration load factor maximum value	0.0 to 100.0	%	Y	Y	
W166	Regeneration load factor	0.0 to 100.0	%	Y	Y	
W167	Pt board electrolytic capacitor cumulative approximate life expectancy	0 to 9999	10h	Y	Y	
W168	Cooling fan approximate life expectancy	0 to 9999	10h	Y	Y	
W169	IGBT lifetime	0 to 100	%	Y	Y	

*2 The values on the command side/feedback side after the change are displayed when the command input source was changed with the PG-SEL function.

Table 9.4-5 Keypad-related function codes (W1 codes) (cont'd)

Code	Name	Monitor Range	Unit	E3S/E3E	E3N	Remarks
W170	Cumulative run time (long-term)	0 to 9999	10h	Y	Y	
W171	Multi-function keypad thermistor temperature value	-30 to 200	° C	Y	N	
W172	Multi-function keypad battery voltage value	0.00 to 5.00	V	Y	N	
W180	Auto-tuning progression rate	0 to 100	%	Y	Y	
W181	Integrating electric power	0.00 to 99990	MWh	Y	Y	
W182	Bus option command	0000_H to $FFFF_H$	-	Y	Y	bit0: Q_STOP force to stop command bit1: BX coast to stop command
W183	Control power supply state	0000_H to $FFFF_H$	-	Y	Y	bit0: Main power supply/auxiliary power supply bit1: USB bus power bit2: 24 V power supply

9.4.4 Alarm Information

Function codes for alarm (X and Z codes) are described below. All of these function codes are for read only.

Table 9.4-6 Alarm-related function codes (X codes)

Code	Name	Monitor Range	Unit	E3S/E3E	E3N	Remarks
X00	Alarm history (latest)	0000$_H$ to FFFF$_H$	-	Y	Y	
X01	Multiple alarm 1 (latest)	0000$_H$ to FFFF$_H$	-	Y	Y	
X02	Multiple alarm 2 (latest)	0000$_H$ to FFFF$_H$	-	Y	Y	
X03	Sub code	0 to 9999	-	Y	Y	
X04	Multiple alarm 1 subcode (latest)	0 to 9999	-	Y	Y	
X05	Alarm history (last)	0000$_H$ to FFFF$_H$	-	Y	Y	
X06	Multiple alarm 1 (last)	0000$_H$ to FFFF$_H$	-	Y	Y	
X07	Multiple alarm 2 (last)	0000$_H$ to FFFF$_H$	-	Y	Y	
X08	Sub code	0 to 9999	-	Y	Y	
X09	Multiple alarm 1 subcode (second last)	0 to 9999	-	Y	Y	
X10	Alarm history (second last)	0000$_H$ to FFFF$_H$	-	Y	Y	
X11	Multiple alarm 1(second last)	0000$_H$ to FFFF$_H$	-	Y	Y	
X12	Multiple alarm 2 (second last)	0000$_H$ to FFFF$_H$	-	Y	Y	
X13	Sub code	0 to 9999	-	Y	Y	
X14	Multiple alarm 1 subcode (third last)	0 to 9999	-	Y	Y	
X15	Alarm history (third last)	0000$_H$ to FFFF$_H$	-	Y	Y	
X16	Multiple alarm 1 (third last)	0000$_H$ to FFFF$_H$	-	Y	Y	
X17	Multiple alarm 2 (third last)	0000$_H$ to FFFF$_H$	-	Y	Y	
X18	Sub code	0 to 9999	-	Y	Y	
X19	Multiple alarm 1 subcode (fourth last)	0 to 9999	-	Y	Y	
X20	Latest info. on alarm	0.00 to 655.35	Hz	Y	Y	
	(output frequency)			Y	Y	
X21	(output current)	0.00 to 655.35	A	Y	Y	
X22	(output voltage)	0 to 1000	V	Y	Y	
X23	(torque)	-999 to 999	%	Y	Y	
X24	(set frequency)	0.00 to 655.35	Hz	Y	Y	
X25	(operation status)	0000$_H$ to FFFF$_H$	-	Y	Y	
X26	(cumulative run time)	0 to 65535	h	Y	Y	
X27	(number of startups)	0 to 65535	times	Y	Y	

Table 9.4-6 Alarm-related function codes (X codes) (cont'd)

Code	Name	Monitor Range	Unit	E3S/E3E	E3N	Remarks
X28	(DC link circuit voltage)	0 to 1000	V	Y	Y	
X29	(internal air temperature)	0 to 255	°C	Y	Y	
X30	(heat sink temperature)	0 to 255	°C	Y	Y	
X31	(input terminal)	0000_H to $FFFF_H$	-	Y	Y	
X32	(output terminal)	0000_H to $FFFF_H$	-	Y	Y	
X33	(input terminal (com.))	0000_H to $FFFF_H$	-	Y	Y	
X34	(output terminal (com.))	0000_H to $FFFF_H$	-	Y	Y	
X35	(input power)	0.00 to 9999	kW	Y	Y	
X36	(operation status 2)	0000_H to $FFFF_H$	-	Y	Y	
X37	(speed detection)	-32768 to 32767	-	Y	Y	
X38	(operation status 3)	0000_H to $FFFF_H$	-	Y	Y	
X49	Error count monitor	0 to 65535	-	Y	Y	
X54	Warning factor (4th last)	4th last warning factor	1	Y	Y	
X55	Warning factor (5th last)	5th last warning factor	1	Y	Y	
X60	Last info. on alarm (output frequency)	0.00 to 655.35	Hz	Y Y	Y Y	
X61	(output current)	0.00 to 655.35	A	Y	Y	
X62	(output voltage)	0 to 1000	V	Y	Y	
X63	(torque)	-999 to 999	%	Y	Y	
X64	(set frequency)	0.00 to 655.35	Hz	Y	Y	
X65	(operation status)	0000_H to $FFFF_H$	-	Y	Y	
X66	(cumulative run time)	0 to 65535	h	Y	Y	
X67	(number of startups)	0 to 65535	times	Y	Y	
X68	(DC link circuit voltage)	0 to 1000	V	Y	Y	
X69	(internal air temperature)	0 to 255	°C	Y	Y	
X70	(heat sink temperature)	0 to 255	°C	Y	Y	
X71	(input terminal)	0000_H to $FFFF_H$	-	Y	Y	
X72	(output terminal)	0000_H to $FFFF_H$	-	Y	Y	
X73	(input terminal(com.))	0000_H to $FFFF_H$	-	Y	Y	
X74	(output terminal(com.))	0000_H to $FFFF_H$	-	Y	Y	
X76	(operation status 2)	0000_H to $FFFF_H$	-	Y	Y	
X77	(speed detection)	-32768 to 32767	-	Y	Y	
X78	(operation status 3)	0000_H to $FFFF_H$	-	Y	Y	
X89	Customizable logic (digital I/O)	0000_H to $FFFF_H$	-	Y	Y	
X90	(timer monitor)	0.00 to 600.00	-	Y	Y	
X91	(analog input 1)	-9990 to 9990	-	Y	Y	
X92	(analog input 2)	-9990 to 9990	-	Y	Y	
X93	(analog output)	-9990 to 9990	-	Y	Y	
X94	Relay output terminal information	0000_H to $FFFF_H$	-	Y	Y	
X97	Terminal (PTC) input voltage	-12.0 to 12.0	V	Y	Y	

Table 9.4-6 Alarm-related function codes (X codes) (cont'd)

Code	Name	Monitor Range	Unit	E3S/E3E	E3N	Remarks
X105	Alarm occurrence year and month (latest)	0000_H to $FFFF_H$	-	Y	Y	
X106	Alarm occurrence day and hour (latest)	0000_H to $FFFF_H$	-	Y	Y	
X107	Alarm occurrence minutes and seconds (latest)	0000_H to $FFFF_H$	-	Y	Y	
X115	Alarm occurrence year and month (2nd last)	0000_H to $FFFF_H$	-	Y	Y	
X116	Alarm occurrence day and hour (2nd last)	0000_H to $FFFF_H$	-	Y	Y	
X117	Alarm occurrence minutes and seconds (2nd last)	0000_H to $FFFF_H$	-	Y	Y	
X125	Alarm occurrence year and month (3rd last)	0000_H to $FFFF_H$	-	Y	Y	
X126	Alarm occurrence day and hour 3rd last)	0000_H to $FFFF_H$	-	Y	Y	
X127	Alarm occurrence minutes and seconds 3rd last)	0000_H to $FFFF_H$	-	Y	Y	
X135	Alarm occurrence year and month (4th last)	0000_H to $FFFF_H$	-	Y	Y	
X136	Alarm occurrence day and hour (4th last)	0000_H to $FFFF_H$	-	Y	Y	
X137	Alarm occurrence minutes and seconds (4th last)	0000_H to $FFFF_H$	-	Y	Y	
X140	Alarm history (5th last)	0000_H to $FFFF_H$	-	Y	Y	
X145	Alarm occurrence year and month (5th last)	0000_H to $FFFF_H$	-	Y	Y	
X146	Alarm occurrence day and hour (5th last)	0000_H to $FFFF_H$	-	Y	Y	
X147	Alarm occurrence minutes and seconds (5th last)	0000_H to $FFFF_H$	-	Y	Y	
X150	Alarm history (6th last)	0000_H to $FFFF_H$	-	Y	Y	
X155	Alarm occurrence year and month (6th last)	0000_H to $FFFF_H$	-	Y	Y	
X156	Alarm occurrence day and hour (6th last)	0000_H to $FFFF_H$	-	Y	Y	
X157	Alarm occurrence minutes and seconds (6th last)	0000_H to $FFFF_H$	-	Y	Y	
X160	Alarm history (7th last)	0000_H to $FFFF_H$	-	Y	Y	
X165	Alarm occurrence year and month (7th last)	0000_H to $FFFF_H$	-	Y	Y	
X166	Alarm occurrence day and hour (7th last)	0000_H to $FFFF_H$	-	Y	Y	
X167	Alarm occurrence minutes and seconds (7th last)	0000_H to $FFFF_H$	-	Y	Y	
X170	Alarm history (8th last)	0000_H to $FFFF_H$	-	Y	Y	
X175	Alarm occurrence year and month (8th last)	0000_H to $FFFF_H$	-	Y	Y	
X176	Alarm occurrence day and hour (8th last)	0000_H to $FFFF_H$	-	Y	Y	
X177	Alarm occurrence minutes and seconds (8th last)	0000_H to $FFFF_H$	-	Y	Y	
X180	Alarm history (9th last)	0000_H to $FFFF_H$	-	Y	Y	
X185	Alarm occurrence year and month (9th last)	0000_H to $FFFF_H$	-	Y	Y	
X186	Alarm occurrence day and hour (9th last)	0000_H to $FFFF_H$	-	Y	Y	
X187	Alarm occurrence minutes and seconds (9th last)	0000_H to $FFFF_H$	-	Y	Y	
X190	Alarm history (10th last)	0000_H to $FFFF_H$	-	Y	Y	
X195	Alarm occurrence year and month (10th last)	0000_H to $FFFF_H$	-	Y	Y	
X196	Alarm occurrence day and hour (10th last)	0000_H to $FFFF_H$	-	Y	Y	
X197	Alarm occurrence minutes and seconds (10th last)	0000_H to $FFFF_H$	-	Y	Y	

Table 9.4-7 Alarm-related function codes (Z codes)

Code	Name	Monitor Range	Unit	E3S/E3E	E3N	Remarks
Z00	Second last info. on alarm (output frequency)	0.00 to 655.35	Hz	Y	Y	
Z01	(output current)	0.00 to 655.35	A	Y	Y	
Z02	(output voltage)	0 to 1000	V	Y	Y	
Z03	(torque)	-999 to 999	%	Y	Y	
Z04	(set frequency)	0.00 to 655.35	Hz	Y	Y	
Z05	(operation status)	0000_H to $FFFF_H$	-	Y	Y	
Z06	(cumulative run time)	0 to 65535	h	Y	Y	
Z07	(number of startups)	0 to 65535	times	Y	Y	
Z08	(DC link circuit voltage)	0 to 1000	V	Y	Y	
Z09	(internal air temperature)	0 to 255	°C	Y	Y	
Z10	(heat sink temperature)	0 to 255	°C	Y	Y	
Z11	(input terminal)	0000_H to $FFFF_H$	-	Y	Y	
Z12	(output terminal)	0000_H to $FFFF_H$	-	Y	Y	
Z13	(input terminal(com.))	0000_H to $FFFF_H$	-	Y	Y	
Z14	(output terminal(com.))	0000_H to $FFFF_H$	-	Y	Y	
Z16	(operation status 2)	0000_H to $FFFF_H$	-	Y	Y	
Z17	(speed detection)	-32768 to 32767	-	Y	Y	
Z18	(operation status 3)	0000_H to $FFFF_H$	-	Y	Y	
Z40	Cumulative run time of motor (M1)	0 to 65535 (in units of 10 hours)	10h	Y	Y	
Z41	Cumulative run time of motor (M2)	0 to 65535 (in units of 10 hours)	10h	Y	Y	
Z44	Number of startups (M2)	0 to 65535	times	Y	Y	
Z48	Retry history (latest)	0000_H to $FFFF_H$	-	Y	Y	
Z49	Retry history (2nd last)	0000_H to $FFFF_H$	-	Y	Y	

Table 9.4-7 Alarm-related function codes (Z codes) (cont'd)

Code	Name	Monitor Range	Unit	E3S/E3E	E3N	Remarks
Z50	Third last info. on alarm (output frequency)	0.00 to 655.35	Hz	Y	Y	
Z51	(output current)	0.00 to 655.35	A	Y	Y	
Z52	(output voltage)	0 to 1000	V	Y	Y	
Z53	(torque)	-999 to 999	%	Y	Y	
Z54	(reference frequency)	0.00 to 655.35	Hz	Y	Y	
Z55	(operation status)	0000_H to $FFFF_H$	-	Y	Y	
Z56	(cumulative run time)	0 to 65535	h	Y	Y	
Z57	(number of startups)	0 to 65535	times	Y	Y	
Z58	(DC link circuit voltage)	0 to 1000	V	Y	Y	
Z59	(internal air temperature)	0 to 255	°C	Y	Y	
Z60	(heat sink temperature)	0 to 255	°C	Y	Y	
Z61	(input terminal)	0000_H to $FFFF_H$	-	Y	Y	
Z62	(output terminal)	0000_H to $FFFF_H$	-	Y	Y	
Z63	(input terminal(com.))	0000_H to $FFFF_H$	-	Y	Y	
Z64	(output terminal(com.))	0000_H to $FFFF_H$	-	Y	Y	
Z66	(operation status 2)	0000_H to $FFFF_H$	-	Y	Y	
Z67	(speed detection)	-32768 to 32767	-	Y	Y	
Z68	(operation status 3)	0000_H to $FFFF_H$	-	Y	Y	
Z78	Set speed (r/min)	-32768 to 32767	r/min	Y	Y	
Z79	Speed command (r/min)	-32768 to 32767	r/min	Y	Y	
Z80	Speed detection	-32768 to 32767	min^{-1}	Y	Y	
Z81	Torque real value	-327.68 to 327.67	%	Y	Y	
Z82	Load rate	-327.68 to 327.67	%	Y	Y	
Z83	Motor output	-327.68 to 327.67	%	Y	Y	
Z84	Output current	0.00 to 327.67	A	Y	Y	
Z85	PID feedback value	-999 to 9990	-	Y	Y	
Z86	Input power	0.00 to 9999	kW	Y	Y	
Z87	PID output	-150.0 to 150.0	%	Y	Y	
Z88	Integral power	0.000 to 9999	-	Y	Y	
Z90	Current Position Pulse (Upper column)	-999 to 999	-	Y	N	Effective at servo locking status
Z91	Current Position Pulse (Lower column)	0 to 9999	-	Y	N	
Z92	Stop Position Pulse (Upper column)	-999 to 999	-	Y	N	
Z93	Stop Position Pulse (Lower column)	0 to 9999	-	Y	N	
Z94	Difference Pulse of Position (Upper column)	-999 to 999	-	Y	N	
Z95	Difference Pulse of Position (Lower column)	0 to 9999	-	Y	N	

Chapter 10
SELECTING OPTIMAL MOTOR AND INVERTER CAPACITIES

This chapter describes the optimal motor and inverter capacities selection. This chapter provides you with information about the inverter output torque characteristics, capacity selection procedure, and equations for calculating capacities to help you select optimal motor and inverter models. It also helps to select the braking resistors, inverter mode (HD/ND/HHD/HND), and motor drive control.

Contents

When selecting a general-purpose inverter, select the motor, followed by the inverter.

(1) Key point for selecting a motor: Determine what kind of load machine is to be used, calculate its moment of inertia, and then select the appropriate motor capacity.

(2) Key point for selecting an inverter: Taking into account the operation requirements (e.g., acceleration time, deceleration time, and frequency of operation) of the load machine to be driven by the motor selected in (1) above, calculate the acceleration/deceleration/braking torque.

This section describes the selection procedure for (1) and (2) above. First, it explains the output torque characteristics obtained by using the motor driven by the inverter (FRENIC-Ace).

10.1 Motor Output Torque Characteristics

Figure 10.1-1 and Figure 10.1-2 graph the output torque characteristics of motors against the output frequency for 50 Hz and 60 Hz base frequencies. The horizontal and vertical axes show the output frequency and output torque (%), respectively. Curves (a) through (f) depend on the running conditions.

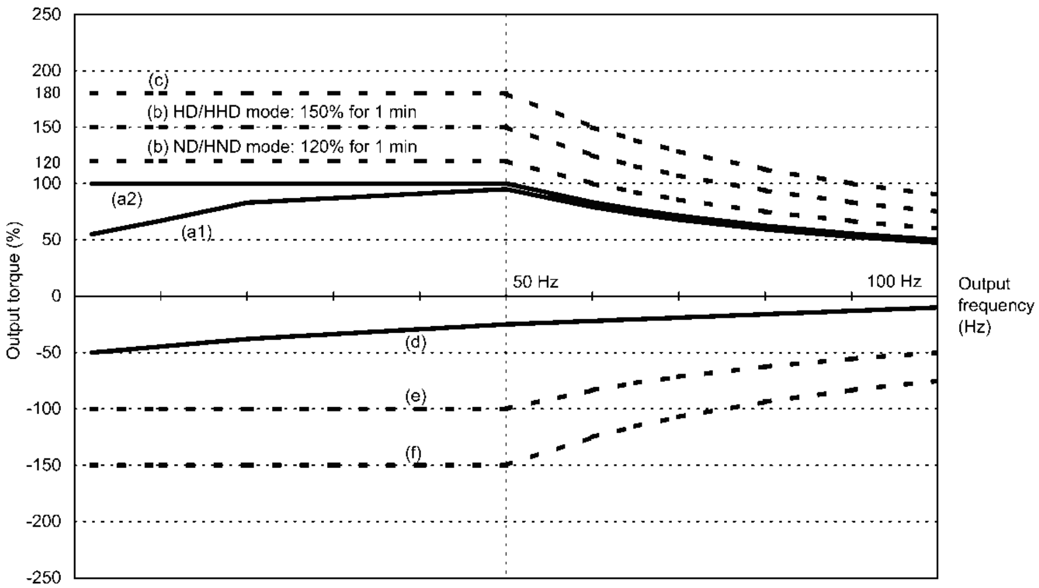


Figure 10.1-1 Output torque characteristics (base frequency: 50 Hz)

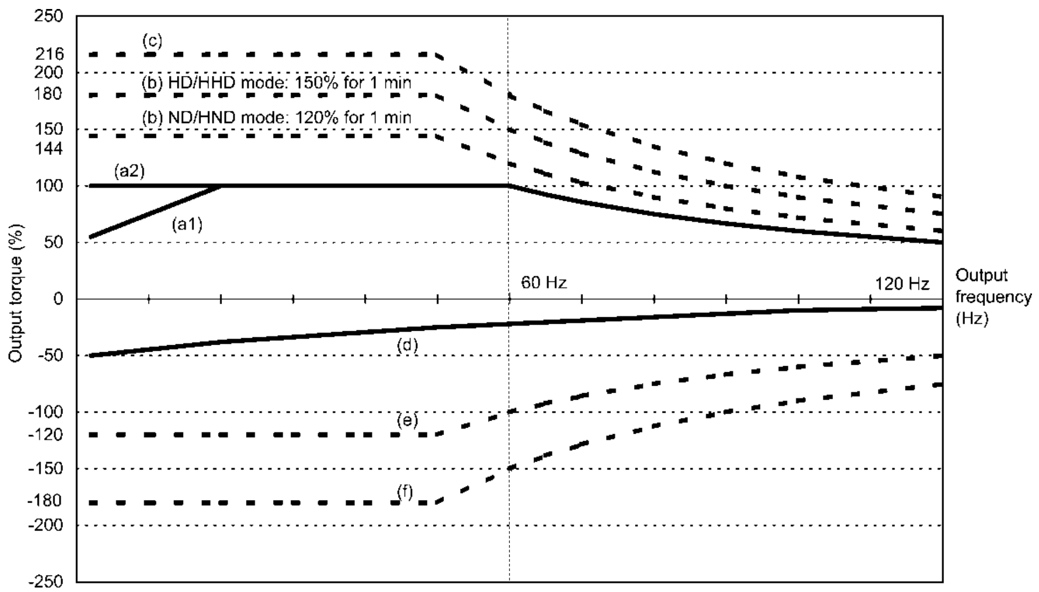


Figure 10.1-2 Output torque characteristics (base frequency: 60 Hz)

SELECTING OPTIMAL MOTOR AND INVERTER CAPACITIES

Chap 10

(1) Continuous allowable driving torque

1) Standard motor (Curve (a1) in Figure 10.1-1 and Figure 10.1-2)

Curve (a1) shows the torque that can be obtained in the range of the inverter's continuous rated current, where the standard motor's cooling characteristic is taken into consideration. When the motor runs at the base frequency of 60 Hz, 100 % output torque can be obtained; at 50 Hz, the output torque is somewhat lower than that in commercial power, and it further lowers at lower frequencies. The reduction of the output torque at 50 Hz is due to increased loss by inverter driving, and that at lower frequencies is mainly due to heat generation caused by the decreased ventilation performance of the motor cooling fan.

2) Motor exclusively designed for vector control (Curve (a2) in Figure 10.1-1 and Figure 10.1-2)

Curve (a2) shows the torque that can be obtained in the range of the inverter's continuous rated current, where the motor exclusively designed for vector control is connected. In the motor exclusively designed for vector control, the attached forced-cooling fan reduces heat generation from the motor, so that the torque does not drop in the low-speed range, compared to the standard motor.

(2) Maximum short-term driving torque (Curves (b) and (c) in Figure 10.1-1 and Figure 10.1-2)

Curve (b) shows the torque that can be obtained in the range of the inverter's short-term overload capability (HD/HHD modes: 150% for 1 minute, 200% for 0.5 seconds, ND/HND modes: 120% for 1 minute) when torque-vector control is enabled. In this case, the motor cooling characteristics have little effect on the output torque.

Curve (c) shows an example of the output torque when one class higher capacity inverter is used to increase the maximum short-term driving torque. In this case, the short-term torque is 20% to 30% greater than that when the standard capacity inverter is used.

(3) Starting torque (around the output frequency 0 Hz in Figure 10.1-1 and Figure 10.1-2)

The maximum short-term driving torque is the starting torque.

(4) Braking torque (Curves (d), (e), and (f) in Figure 10.1-1 and Figure 10.1-2)

In braking the motor, mechanical energy is converted to electrical energy and regenerated to the DC link bus capacitor (reservoir capacitor) of the inverter. Discharging this electrical energy to the braking resistor produces a large braking torque as shown in curve (e). If no braking resistor is provided, however, only the motor and inverter losses consume the regenerated braking energy so that the braking torque becomes smaller as shown in curve (d).

When optional braking resistors are used, the braking torque is allowable only for short-term braking. Its time ratings are given in this manual or in the catalog as allowable values (kW) based on the average discharge loss, and as allowable values (kWs) based on the discharge withstand capacity that can be discharged at one time.

Note that the braking torque % value varies according to the inverter capacity.

Optimal selection of these options enables a braking torque value to be selected in the range below the maximum short-term torque in the driving mode, as shown in curve (f).

For braking-related values in a standard configuration, refer to Chapter 11 "11.4 Braking Resistors (DBRs)."

10.2 Selection Procedure

Fig. 10.2-1 "Selection procedure" shows the general capacity selection procedure. Items numbered (1) through (5) are described on the following pages.

You may easily select inverter capacity if there are no restrictions on acceleration and deceleration times. If there are any restrictions on acceleration or deceleration time, or if acceleration and deceleration are frequent, then the selection procedure is more complex.

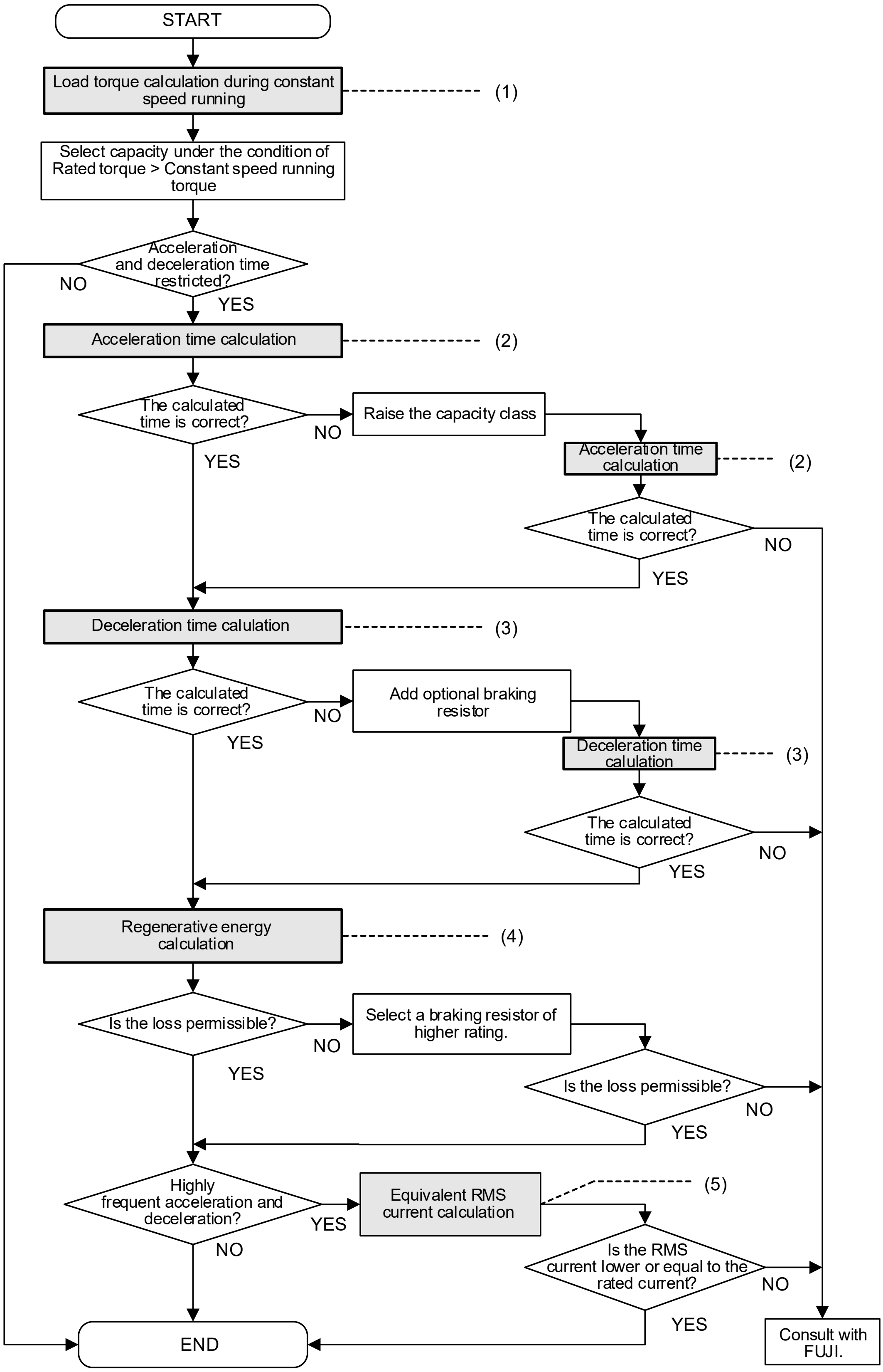


Fig. 10.2-1 Selection procedure

(1) Load torque calculation when running at constant speed (For detailed calculation, refer to Section 10.3.1)

It is essential to calculate the load torque for all loads when running at constant speed.

First calculate the load torque of the motor when running at constant speed and then select a tentative capacity so that the continuous rated torque of the motor when running at constant speed becomes higher than the load torque. To perform capacity selection efficiently, it is necessary to match the rated speeds (base speeds) of the motor and load. To do this, select an appropriate reduction-gear (mechanical transmission) ratio and number of motor poles.

If the acceleration or deceleration time is not restricted, the tentative capacity can apply as the selected capacity value.

(2) Calculation of the acceleration time (For detailed calculation, refer to Section 10.3.2 [2])

When there are some specified requirements for the acceleration time, calculate it according to the following procedure:

1) Calculate the **moment of inertia** for the load and motor.

   Calculate the moment of inertia for the load, referring to “10.3.2 Acceleration and deceleration time calculation.” For the moment of inertia for motors, refer to the related motor catalogs.

2) Calculate the **minimum acceleration torque** (Refer to Fig. 10.2-2.)

   The acceleration torque is the difference between the motor short-term output torque (base frequency: 60 Hz) explained in “10.1 (2) Maximum short-term driving torque and the load torque (τ_L / η_G) when running at constant speed calculated in (1) above. Calculate the minimum acceleration torque for the whole range of potential running speed patterns.

3) Calculate the **acceleration time**

   Assign the value calculated above to the equation ((Equation 10.3-15) in “10.3.2 Acceleration and deceleration time calculation”) to calculate the acceleration time. If the calculated acceleration time is longer than the desired time, select the inverter and motor having one class larger capacity and calculate it again.

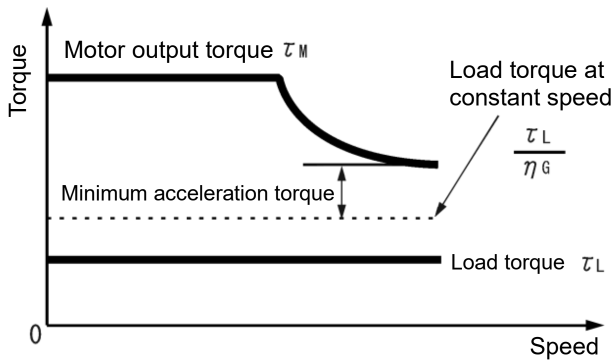


Fig. 10.2-2 Example study of minimum acceleration torque

(3) Calculation of the deceleration time (For detailed calculation, refer to Section 10.3.2 [3])

To calculate the deceleration time, check the motor deceleration torque characteristics for the whole range of potential speeds in the same way as for the acceleration time.

1) Calculate the **moment of inertia** for the load and motor.
   Same as for the acceleration time.
2) Calculate the **minimum deceleration torque.** (For details, refer to Fig. 10.2-3 and Fig. 10.2-4.)
   Same as for the deceleration time.
3) Calculate the **deceleration time**.
   Assign the value calculated above to the equation ((Equation 10.3-16) to calculate the deceleration time in the same way as for the acceleration time. If the calculated deceleration time is longer than the desired time, select the inverter and motor having one class larger capacity and calculate it again.

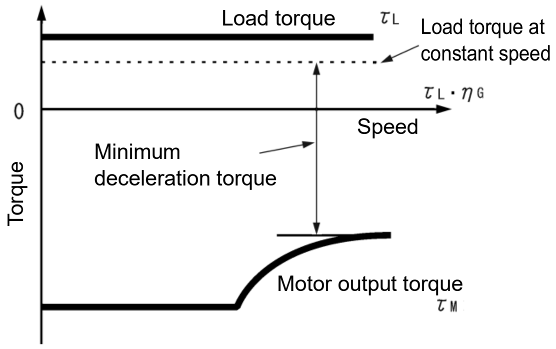


Fig. 10.2-3 Example study of minimum deceleration torque (1)

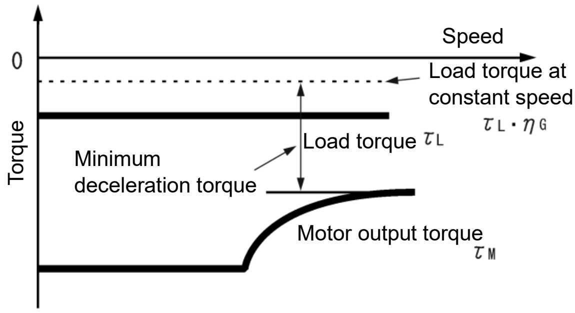


Fig. 10.2-4 Example study of minimum deceleration torque (2)

(4) Heat energy calculation of braking resistor (For detailed calculation, refer to Section 10.3.3)

All of the following selection conditions must be satisfied depending on the repetition cycle of the running pattern.

1) The required maximum braking torque must be equal to or less than the braking resistor specification value.

   Note: If the rotation speed is equal to or higher than the base frequency, also lower the braking resistor specification value to a value inversely proportional to the rotation speed.
2) The regenerative energy per braking attempt should be equal to or less than the “discharge withstand capacity kWs” in the braking resistor specifications.

   Refer to Chapter 10 “10.3.3 Heat energy calculation of braking resistor” for specific details on the calculation method.
3) The average loss obtained by dividing the regenerative energy for a single cycle by the number of cycles should be equal to or less than the “average loss” in the braking resistor specifications.

(5) Calculating the RMS rating of the motor (For detailed calculation, refer to Section 10.3.4)

In metal processing machines and carrier devices with positioning control, highly frequent running under short-term rated conditions is repeated. In this case, calculate the maximum equivalent RMS current value (effective current value), which is not to exceed the allowable value (rated current value) for the motor.

10.3 Equations for Selections

10.3.1 Load torque calculation when running at constant speed

[1] General equation

Loads carried horizontally must be driven by outputting a force corresponding to the frictional force acting on the load. The calculations for running a load linearly with the motor are shown below.

Where the force to run a load linearly at constant speed υ (m/s) is F (N) and the motor speed for driving this is N_M (r/min), the required motor output torque τ_M (N·m) is shown in the following equation (Equation 10.3-1):

$$\tau_M = \frac{60 \cdot \upsilon}{2\pi \cdot N_M} \cdot \frac{F}{\eta_G} \quad (\text{N·m}) \qquad \text{(Equation 10.3-1)}$$

where η_G is the reduction-gear efficiency.

When the motor is braking, efficiency works inversely, so the required motor torque τ_M (N·m) should be calculated as follows in (Equation 10.3-2):

$$\tau_M = \frac{60 \cdot \upsilon}{2\pi \cdot N_M} \cdot F \cdot \eta_G \quad (\text{N·m}) \qquad \text{(Equation 10.3-2)}$$

$(60 \cdot \upsilon) / (2\pi \cdot N_M)$ in the above equation is an equivalent turning radius corresponding to speed υ (m/s) around the motor shaft.

The value F(N) in the above equations depends on the load type.

[2] Obtaining the required force F

■ <u>Moving a load horizontally</u>

A simplified mechanical configuration is assumed as shown in Figure 10.3-1. If the mass of the carrier table is W_0 (kg), the mass of the load is W (kg), and the friction coefficient of the ball screw is μ, then the friction force F (N) is expressed as follows (Equation 10.3-3), which is equal to the required force for driving the load horizontally:

$$F = (W_o + W) \cdot g \cdot \mu \quad (\text{N}) \qquad \text{(Equation 10.3-3)}$$

where g is the gravity acceleration (≒ 9.8 (m/s^2)).

Then, the driving torque around the motor shaft is expressed with the following equation (Equation 10.3-4):

$$\tau_M = \frac{60 \cdot \upsilon}{2\pi \cdot N_M} \cdot \frac{(W_o + W) \cdot g \cdot \mu}{\eta_G} \quad (\text{N·m}) \qquad \text{(Equation 10.3-4)}$$

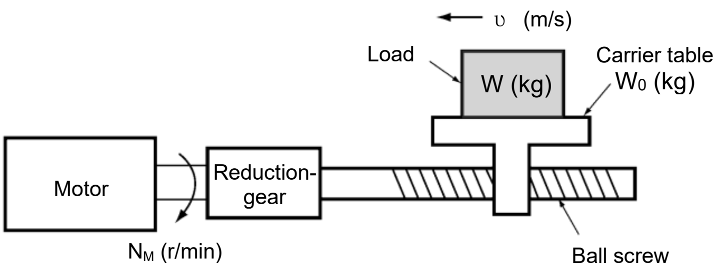


Figure 10.3-1 Moving a load horizontally

■ Vertical lift load

A simplified mechanical configuration is assumed as shown in Figure 10.3-2. If the mass of the cage is W_O (kg), the mass of the load is W (kg), and the mass of the balance weight is W_B (kg), then the forces F (N) required for lifting the load up and down are expressed as follows (Equation 10.3-5 and Equation 10.3-6).

For lifting

$$F = (W_0 + W - W_B) \cdot G \quad (N) \qquad \text{(Equation 10.3-5)}$$

For lowering

$$F = (W_B - W - W_0) \cdot G \quad (N) \qquad \text{(Equation 10.3-6)}$$

Assuming the maximum load is W_{max}, the mass of the balance weight W_B (kg) is generally obtained with the expression $W_B = W_O + W_{max}/2$. Depending on the mass of the load, the values of F (N) may be negative in both cases of lifting up and lowering, which means the lift is in braking mode. So, be careful in motor and inverter selection.

For calculation of the required torque τ around the motor shaft, apply the expression (Equation 10.3-1) or (Equation 10.3-2) depending on the driving or braking mode of the lift, that is, apply the expression (Equation 10.3-1) if the value of F (N) is positive, and (Equation 10.3-2) if negative.

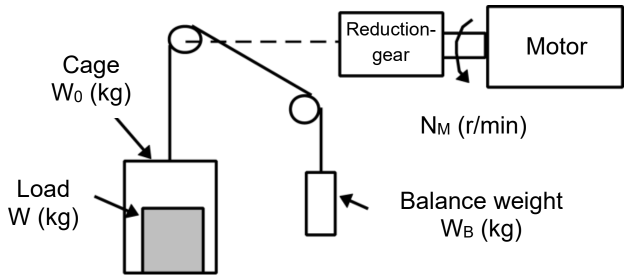


Figure 10.3-2 Vertical lift load

■ Inclined lift load

Although the mechanical configuration of an inclined lift load is similar to that of a vertical lift load, non-negligible friction force in the inclined lift makes a difference; in an inclined lift load, there is a slight difference between the expression to calculate the lift force F (N) for lifting and that for lowering. If the incline angle is θ, and the friction coefficient is μ, as shown in Figure 10.3-3, the required driving force F (N) is expressed as follows:

For lifting

$$F = ((W_0 + W)(\sin\theta + \mu \cdot \cos\theta) - W_B) \cdot g \quad (N) \qquad \text{(Equation 10.3-7)}$$

For lowering

$$F = (W_B - (W_0 + W)(\sin\theta + \mu \cdot \cos\theta)) \cdot g \quad (N) \qquad \text{(Equation 10.3-8)}$$

The braking mode applies to both lifting and lowering, depending on the mass of the load, as in the vertical lift load. And the calculation of the required torque τ around the motor shaft is also the same as in the vertical lift load; apply the expression (Equation 10.3-1) if the value of F (N) is positive, and (Equation 10.3-2) if negative.

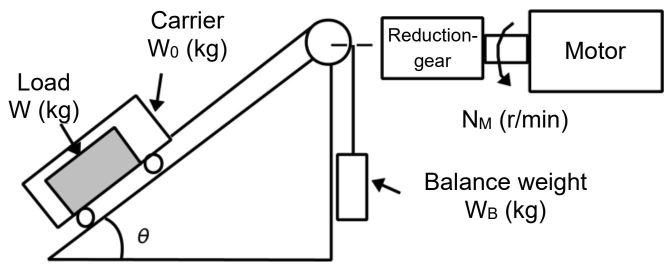


Figure 10.3-3 Inclined lift load

10.3.2 Acceleration and deceleration time calculation

When an object whose moment of inertia is J (kg·m^2) rotates at the speed N (min^{-1}), it has the following kinetic energy (Equation 10.3-9):

$$E = \frac{J}{2} \cdot \left(\frac{2\pi \cdot N}{60} \right)^2 \text{ (J)} \qquad \text{(Equation 10.3-9)}$$

To accelerate the above rotational object, the kinetic energy will be increased; to decelerate the object, the kinetic energy must be discharged. The torque required for acceleration and deceleration can be expressed as follows (Equation 10.3-10)):

$$\tau = J \cdot \frac{2\pi}{60} \left(\frac{dN}{dt} \right) \text{ (N·m)} \qquad \text{(Equation 10.3-10)}$$

This way, the mechanical moment of inertia is an important element in the acceleration and deceleration. First, the calculation method of moment of inertia is described, then the calculation methods for the acceleration and deceleration times are explained.

[1] Calculation of moment of inertia

For an object that rotates around a shaft, divide the object into small segments and square the distance from the shaft to each segment. Then, sum the squares of the distances and the masses of the segments to calculate the moment of inertia. The moment of inertia J can be expressed by the following equation:

$$J = \Sigma(W_i \cdot r_i^2) \quad \text{(kg·m}^2\text{)} \qquad \text{(Equation 10.3-11)}$$

The following describes equations to calculate moment of inertia for different-shaped loads or load systems.

(1) Hollow cylinder and solid cylinder

The common shape of a rotating body is a hollow cylinder. The moment of inertia J (kg·m^2) around the hollow cylinder center axis can be calculated as follows (Equation 10.3-12)), where the outer and inner diameters are D_1 and D_2 [m] and total mass is W (kg) as shown in Figure 10.3-4.

$$J = \frac{W \cdot (D_1^2 + D_2^2)}{8} \quad \text{(kg·m}^2\text{)} \qquad \text{(Equation 10.3-12)}$$

For a similar shape, a solid cylinder, calculate the moment of inertia where D_2 = 0.

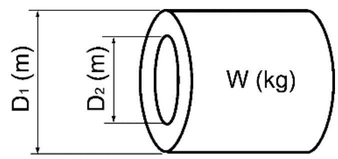
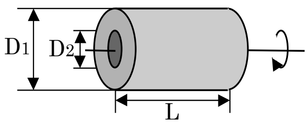
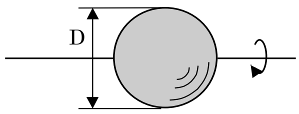
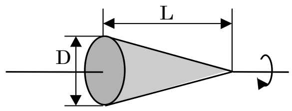
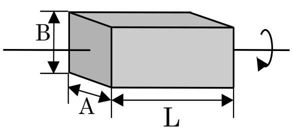
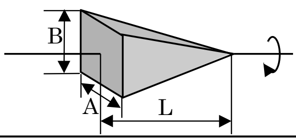
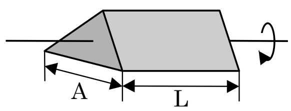
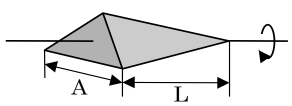


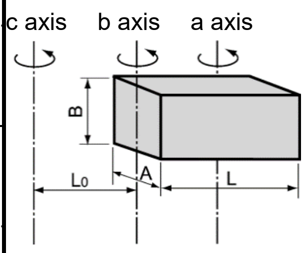
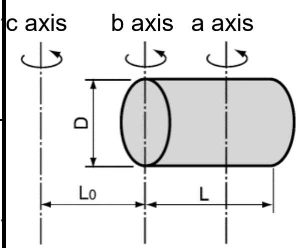
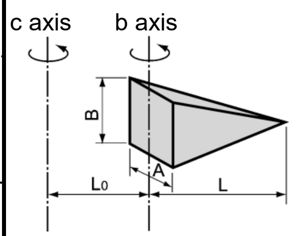
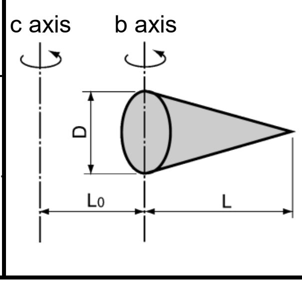
Figure 10.3-4 Hollow cylinder

(2) For a general rotating body

Table 10.3-1 lists the calculation equations of moment of inertia of various rotating bodies including the above cylindrical rotating body.

Table 10.3-1 Moment of inertia of various rotating bodies

Shape	Weight: W (kg) / Moment of inertia J ($kg \cdot m^2$)
Hollow cylinder 	$W = \frac{\pi}{4} \cdot (D_1{}^2 - D_2{}^2) \cdot L \cdot \rho$ $J = \frac{1}{8} \cdot W \cdot (D_1{}^2 + D_2{}^2)$
Sphere 	$W = \frac{\pi}{6} \cdot D^3 \cdot \rho$ $J = \frac{1}{10} \cdot W \cdot D^2$
Cone 	$W = \frac{\pi}{12} \cdot D^2 \cdot L \cdot \rho$ $J = \frac{3}{40} \cdot W \cdot D^2$
Rectangular prism 	$W = A \cdot B \cdot L \cdot \rho$ $J = \frac{1}{12} \cdot W \cdot (A^2 + B^2)$
Square cone (pyramid, rectangular base) 	$W = \frac{1}{3} \cdot A \cdot B \cdot L \cdot \rho$ $J = \frac{1}{20} \cdot W \cdot (A^2 + B^2)$
Triangular prism 	$W = \frac{\sqrt{3}}{4} \cdot A^2 \cdot L \cdot \rho$ $J = \frac{1}{3} \cdot W \cdot A^2$
Tetrahedron with an equilateral triangular base 	$W = \frac{\sqrt{3}}{12} \cdot A^2 \cdot L \cdot \rho$ $J = \frac{1}{5} \cdot W \cdot A^2$

Shape	Weight: W (kg) / Moment of inertia J ($kg \cdot m^2$)
	$W = A \cdot B \cdot L \cdot \rho$ $J_a = \frac{1}{12} \cdot W \cdot (L^2 + A^2)$ $J_b = \frac{1}{12} \cdot W \cdot (L^2 + \frac{1}{4} \cdot A^2)$ $J_c \fallingdotseq W \cdot (L_0{}^2 + L_0 \cdot L + \frac{1}{3} \cdot L^2)$
	$W = \frac{\pi}{4} \cdot D^2 \cdot L \cdot \rho$ $J_a = \frac{1}{12} \cdot W \cdot (L^2 + \frac{3}{4} \cdot D^2)$ $J_b = \frac{1}{3} \cdot W \cdot (L^2 + \frac{3}{16} \cdot D^2)$ $J_c \fallingdotseq W \cdot (L_0{}^2 + L_0 \cdot L + \frac{1}{3} \cdot L^2)$
	$W = \frac{1}{3} \cdot A \cdot B \cdot L \cdot \rho$ $J_b = \frac{1}{10} \cdot W \cdot (L^2 + \frac{1}{4} \cdot A^2)$ $J_c \fallingdotseq W \cdot (L_0{}^2 + \frac{3}{2} \cdot L_0 \cdot L + \frac{3}{5} \cdot L^2)$
	$W = \frac{\pi}{12} \cdot D^2 \cdot L \cdot \rho$ $J_b = \frac{1}{10} \cdot W \cdot (L^2 + \frac{3}{8} \cdot D^2)$ $J_c \fallingdotseq W \cdot (L_0{}^2 + \frac{3}{2} \cdot L_0 \cdot L + \frac{3}{5} \cdot L^2)$

*Main metal density (at 20°C) ρ(kg/m^3) Iron: 7860, Copper: 8940, Aluminum: 2700

(3) For a load running horizontally

Assume a carrier table driven by a motor as shown in Figure 10.3-1. If the table speed is υ (m/s) when the motor speed is NM (r/min), then an equivalent distance from the shaft is equal to 60·υ / (2π·NM) (m). The moment of inertia of the table and load in relation to the shaft is calculated as follows (Equation 10.3-13):

$$J = \left(\frac{60\upsilon}{2\pi\cdot N_M}\right)^2 \cdot (W_0 + W) \quad (\mathrm{kg\cdot m^2}) \qquad \text{(Equation 10.3-13)}$$

(4) For a vertical lift load

The moment of inertia J(kg·m^2) of the loads connected with a rope shown in Figure 10.3-2 and Figure 10.3-3 is calculated with the following equation (Equation 10.3-14) using the masses of the moving objects, although the motion directions of those loads are different.

$$J = \left(\frac{60\upsilon}{2\pi\cdot N_M}\right)^2 \cdot (W_0 + W + W_B) \quad (\mathrm{kg\cdot m^2}) \qquad \text{(Equation 10.3-14)}$$

[2] Calculation of the acceleration time

Figure 10.3-5 shows a general load model. Assume that a motor drives a load via a reduction-gear with efficiency η_G. The time required to accelerate this load in stop state to a speed of N_M (r/min) is calculated with the following equation (Equation 10.3-15):

$$t_{ACC} = \frac{J_1 + J_2/\eta_G}{\tau_M - \tau_L/\eta_G} \cdot \frac{2\pi\cdot(N_M - 0)}{60} \quad (\mathrm{s}) \qquad \text{(Equation 10.3-15)}$$

J_1: Motor shaft moment of inertia (kg·m^2)

J_2: Load shaft moment of inertia converted to motor shaft (kg·m^2)

τ_M: Minimum motor output torque in driving mode (N·m)

τ_L: Maximum load torque converted to motor shaft (N·m)

η_G: Reduction-gear efficiency

As clarified in the above equation, the equivalent moment of inertia becomes (J_1+J_2/η_G) by considering the reduction-gear efficiency.

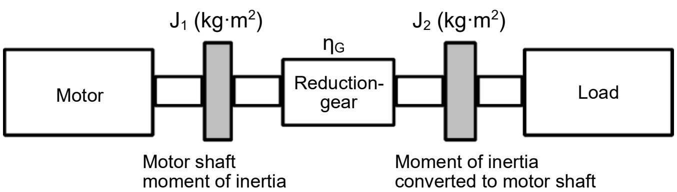


Figure 10.3-5 Load model including reduction-gear

[3] Calculation of the deceleration time

In a load system shown in Figure 10.3-5, the time needed to stop the motor rotating at a speed of N_M (r/min) is generally calculated with the following equation (Equation 10.3-16):

$$t_{DEC} = \frac{J_1 + J_2 \cdot \eta_G}{\tau_M - \tau_L \cdot \eta_G} \cdot \frac{2\pi \cdot (0 - N_M)}{60} \quad \text{(s)} \qquad \text{(Equation 10.3-16)}$$

J_1: Motor shaft moment of inertia ($kg \cdot m^2$)
J_2: Load shaft moment of inertia converted to motor shaft ($kg \cdot m^2$)
τ_M: Minimum motor output torque in braking (or decelerating) motor (N·m)
τ_L: Maximum load torque converted to motor shaft (N·m)
η_G: Reduction-gear efficiency

In the above equation, generally output torque τ_M is negative and load torque τ_L is positive. So, deceleration time becomes shorter.

Tip For lifting applications, calculate the deceleration time using the maximum negative value of τ_L (maximum load torque converted to motor shaft) to select the capacity.

[4] Calculating non-linear acceleration/deceleration time

For loads requiring frequent acceleration/deceleration, the inverter can accelerate/decelerate the motor in the shortest time utilizing the maximum torque capability. The inverter in vector control mode can easily perform this type of operation.

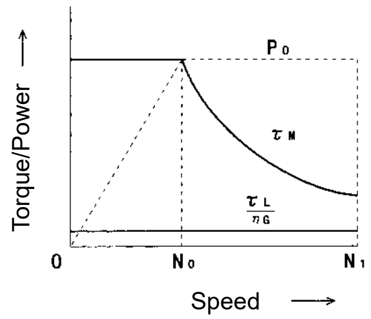


Figure 10.3-6 Example of driving characteristics with constant output

In this case, the acceleration/deceleration will form a non-linear curve, and the acceleration/deceleration time cannot be calculated by a single expression. Generally, the acceleration/deceleration time is obtained by calculating the acceleration/deceleration time of ΔN that is a difference of speed N broken into small parts, and then integrating it to obtain the total acceleration/deceleration time from start to end. Because the smaller ΔN provides higher accuracy, this numerical calculation needs an aid of a computer program.

The following is a guide for the numerical calculation method using a computer program. Figure 10.3-6 illustrates an example of driving equipment with constant output. In the figure, the range under N_O is of constant torque, and the range between N_O and N_1 is of constant output.

The expression (Equation 10.3-17) gives an acceleration time .

$$\Delta t_{ACC} = \frac{J_1 + J_2/\eta_G}{\tau_M - \tau_L/\eta_G} \cdot \frac{2\pi \cdot \Delta N}{60} \quad (s) \qquad \text{(Equation 10.3-17)}$$

Obtain the motor shaft moment of inertia J_1, the load shaft moment of inertia converted to motor shaft J_2, maximum load torque converted to motor shaft τ_L, and the reduction-gear efficiency η_G in advance. Apply the maximum motor output torque τ_M according to a speed range as follows:

[T_M in $N \leq N_0$]: Constant torque

$$\tau_M = \frac{60 \cdot P_0}{2\pi \cdot N_0} \quad \text{(N·m)} \qquad \text{(Equation 10.3-18)}$$

[T_M in $N_0 \leq N \leq N1$] Constant output power

$$\tau_M = \frac{60 \cdot P_o}{2\pi \cdot N} \quad (N\cdot m) \qquad \text{(Equation 10.3-19)}$$

If the result obtained by the above calculation does not satisfy the target value, select an inverter with one rank higher capacity.

[5] Calculating non-linear deceleration time

The calculation for deceleration time is the same as that for acceleration time.

$$\triangle t_{DEC} = \frac{J_1 + J_2 \cdot \eta_G}{T_M - \tau_L \cdot \eta_G} \cdot \frac{2\pi \cdot \triangle N}{60} \quad (s) \qquad \text{(Equation 10.3-20)}$$

In this expression, both τ_M, and ΔN are generally negative values so that the load torque τ_L serves to assist the deceleration operation. For a lift load, however, the load torque τ_L is a negative value in some modes. In this case, the τ_M, and τ_L will take polarity opposite to each other and the τ_L will actuate to hinder the deceleration operation.

10.3.3 Heat energy calculation of braking resistor

If the inverter brakes the motor, the mechanical energy is regenerated into the inverter circuit. This regenerative energy is often consumed in braking resistors as heat. The following explains how to calculate this energy.

[1] Calculation of regenerative energy

In inverter operation, one of the regenerative energy sources is the kinetic energy that is generated when an inertial object is rotating.

(1) Kinetic energy of an inertial object

When an object with moment of inertia J (kg·m²) rotates at a speed N_2 (min⁻¹), its kinetic energy is shown in (Equation 10.3-21).

$$E = \frac{J}{2} \cdot \left(\frac{2\pi \cdot N_2}{60} \right)^2 \ (J = Ws) \qquad \text{(Equation 10.3-21)}$$

$$\fallingdotseq \frac{1}{182.4} \cdot J \cdot N_2^2 \ (J) \qquad \text{(Equation 10.3-21')}$$

When this object is decelerated to a speed N_1 (min⁻¹), the discharged energy is as follows (Equation 10.3-22):

$$E = \frac{J}{2} \cdot \left[\left(\frac{2\pi \cdot N_2}{60} \right)^2 - \left(\frac{2\pi \cdot N_1}{60} \right)^2 \right] \ (J) \qquad \text{(Equation 10.3-22)}$$

$$\fallingdotseq \frac{1}{182.4} \cdot J \cdot (N_2^2 - N_1^2) \quad (J) \qquad \text{(Equation 10.3-22')}$$

The energy regenerated to the inverter as shown in Figure 10.3-5 is calculated from the reduction-gear efficiency η_G and motor efficiency η_M as follows (Equation 10.3-23):

$$E \fallingdotseq \frac{1}{182.4} \cdot (J_1 + J_2 \cdot \eta_G) \cdot \eta_M \cdot (N_2^2 - N_1^2) \quad (J) \qquad \text{(Equation 10.3-23)}$$

(2) Potential energy of a lift

When an object whose mass is W (kg) falls from the height h_2 (m) to the height h_1 (m), the discharged potential energy is as follows (Equation 10.3-24):

$$E = W \cdot g \cdot (h_2 - h_1) \quad (J = Ws) \qquad \text{(Equation 10.3-24)}$$

$$g \fallingdotseq 9.8065 \ (m/s^2)$$

The energy regenerated to the inverter is calculated from the reduction-gear efficiency η_G and motor efficiency η_M as follows (Equation 10.3-25):

$$E = W \cdot g \cdot (h_2 - h_1) \cdot \eta_G \cdot \eta_M \quad (J) \qquad \text{(Equation 10.3-25)}$$

10.3.4 Calculating the RMS rating of the motor

In case of a load which is repeatedly and frequently driven by a motor, the motor current fluctuates greatly and repeatedly enters the short-term rating range of the motor. Therefore, you must review the allowable thermal rating of the motor and take steps as necessary. The heat value is assumed to be approximately proportional to the square of the motor current.

If an inverter repeatedly drives a motor in duty cycles that are much shorter than the thermal time constant of the motor, calculate the “equivalent RMS current” as shown below, and select the motor so that this RMS current will not exceed the rated current of the motor.

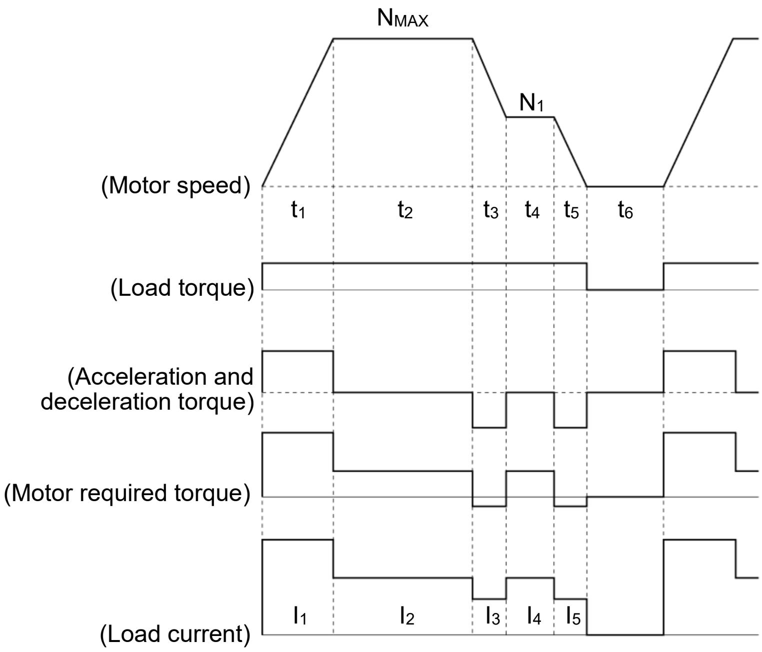


Fig. 10.3-7 Example of a repetitive operation

First, calculate the required torque of each part based on the motor speed. Then using the torque-current curve of the motor, convert the torque to the motor current. The equivalent RMS current (I eq) can be finally calculated by the following equation:

$$I\,eq = \sqrt{\frac{I_1^2 \cdot t_1 + I_2^2 \cdot t_2 + I_3^2 \cdot t_3 + I_4^2 \cdot t_4 + I_5^2 \cdot t_5}{t_1+t_2+t_3+t_4+t_5+t_6}} \quad (A) \qquad \text{(Equation 10.3-26)}$$

For the actual calculation, there is no torque-current curve for the motor. Therefore, calculate the motor current I from the load torque τ_1 using the following equation (Equation 10.3-27). Then, calculate the equivalent RMS current I eq:

$$I = \sqrt{\left(\frac{\tau_1}{100} \times It_{100}\right)^2 + Im_{100}^2} \quad (A) \qquad \text{(Equation 10.3-27)}$$

Where τ_1 is the load torque (%), It_{100} is the torque current, and Im_{100} is exciting current.

10.4 Selecting an Inverter Drive Mode (ND/HD/HND/HHD)

10.4.1 Precautions in making the selection

The FRENIC-Ace is available in four different drive modes—ND and HND modes for general loads and HD and HHD modes for heavy-duty loads, which allows users to switch the drive modes on site.

Select the inverter capacity appropriate to the user application, considering the motor capacity, overload characteristics, and ND/HD/HND/HHD mode, referring to “10.4.2 Guidelines for selecting inverter drive mode and capacity”

ND mode for general loads

Apply to equipment where the inverter’s load current in normal operations is less than the inverter rated current and the load current in overcurrent operation is less than 120% of the rated current for 1 minute. (fan, pump, etc.)
Ambient temperature is 40°C (104°F) or less.

HD mode for heavy-duty loads

Apply to equipment where the inverter’s load current in normal operations is less than the inverter rated current and the load current in overcurrent operation is less than 150% of the rated current for 1 minute. (wire drawing machine, etc.)
Ambient temperature is 40°C (104°F) or less.

HND mode for general loads

Apply to equipment where the inverter’s load current in normal operations is less than the inverter rated current and the load current in overcurrent operation is less than 120% of the rated current for 1 minute. This mode is for applications which require running the motor under low noise conditions or running the inverter with high responsibility. (fan, pump, centrifugal machine, etc.)

HHD mode for heavy-duty loads

Apply to equipment where the inverter’s load current in normal operations is less than the inverter rated current and the load current in overcurrent operation is less than 150% of the rated current for 1 minute and 200% for 0.5 second. This mode is for applications which require running the motor under low noise conditions or running the inverter with high responsibility. (compact hoist, winding machine, etc.)

10.4.2 Guidelines for selecting inverter drive mode and capacity

Table 10.4-1 lists the functional differences between ND, HD, HND, and HHD modes.

If the ND mode does not satisfy the requirements in your application in view of the overload capability and functionality, you need to select an inverter one or two ranks higher in capacity (HD/HND/HHD mode) than that of the motor rating.

To use the inverter under an ambient temperature or carrier frequency condition different from the factory default, the output current rating requires derating due to the ambient temperature or carrier frequency. It is, therefore, necessary to select the inverter unit by referring to Fig. 10.4-1 through Fig. 10.4-3.

Table 10.4-1 lists the functional differences between ND, HD, HND, and HHD modes.

Function	HHD mode	HND mode	HD mode	ND mode HND mode
Application	Heavy-duty load	General load	Heavy-duty load	General load
Data for function code F80	0	1	3	4
Continuous current rating level (inverter rated current level)	100% (Operating temperature: 50°C (122°F)) (Refer to Fig. 1.3 1)		100% (Operating temperature: 40°C (104°F)) (Refer to Fig. 1.3 1) *4	
Overload capability	150% 1 min 200% 0.5 s	120% 1 min	150% 1 min	120% 1 min
DC braking (Braking level) *1	Setting range: 0% to 100% (Based on the rated current level of HHD-mode inverter)	Setting range: 0% to 80% (Based on the rated current level of HND or HD-mode inverter)		Setting range: 0% to 60% (Based on the rated current level of ND or HND-mode inverter)
Motor sound (carrier frequency) *1	Setting range: 0.75 to 16 kHz All models	Setting range: 0.75 to 16 kHz FRN0001E3△-2 to FRN0010E3△-2G FRN0030E3△-2G to FRN0088E3△-2G FRN0002E3□-4G to FRN0059E3□-4G 0.75 to 10 kHz FRN0115E3△-2G, FRN0072E3□-4G	Setting range: 0.75 to 16 kHz FRN0002E3□-4G to FRN0059E3□-4G 0.75 to 10 kHz FRN0072E3□-4G	Setting range: <u>ND mode</u> 0.75 to 10 kHz FRN0002E3□-4G to FRN0059E3□-4G 0.75 to 6 kHz FRN0072E3□-4G <u>HND mode</u> 0.75 to 10 kHz FRN0012E3△-2G to FRN0020E3△-2G, FRN0001E3△-7G to FRN0012E3△-7G
Current limiter level (braking level) *2	Initial value: 160% or 180% *3	Initial value: 130%	Initial value: 160%	Initial value: 130%
Current indication and output	Based on the rated current level of HHD-mode inverter	Based on the rated current level of HND-mode inverter	Based on the rated current level of HD-mode inverter	Based on the rated current level of ND and HND -mode inverters

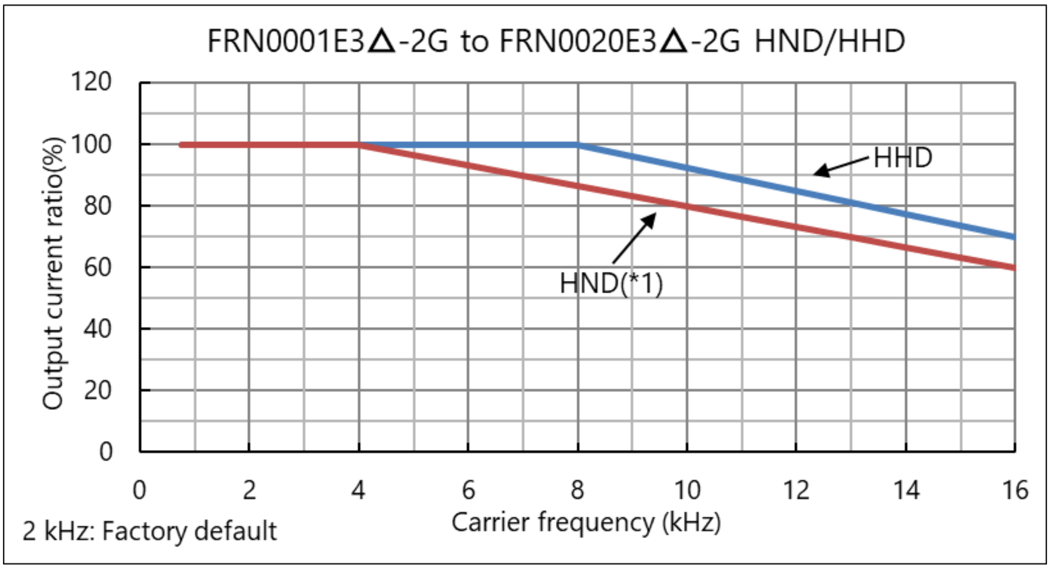
Note: A box (□) in the above table replaces S (Standard type) or N (Ethernet built-in type) or E (EMC filter built-in type) depending on the enclosure.
A triangle (△) in the above table replaces S (Standard type or N (Ethernet built-in type) depending on the enclosure.

*1: For ND/HD/HND-mode inverters, if the set values are outside the range of the ND/HD/HND modes, they are rewritten as the upper limit value for ND/HD/HND-mode inverters.

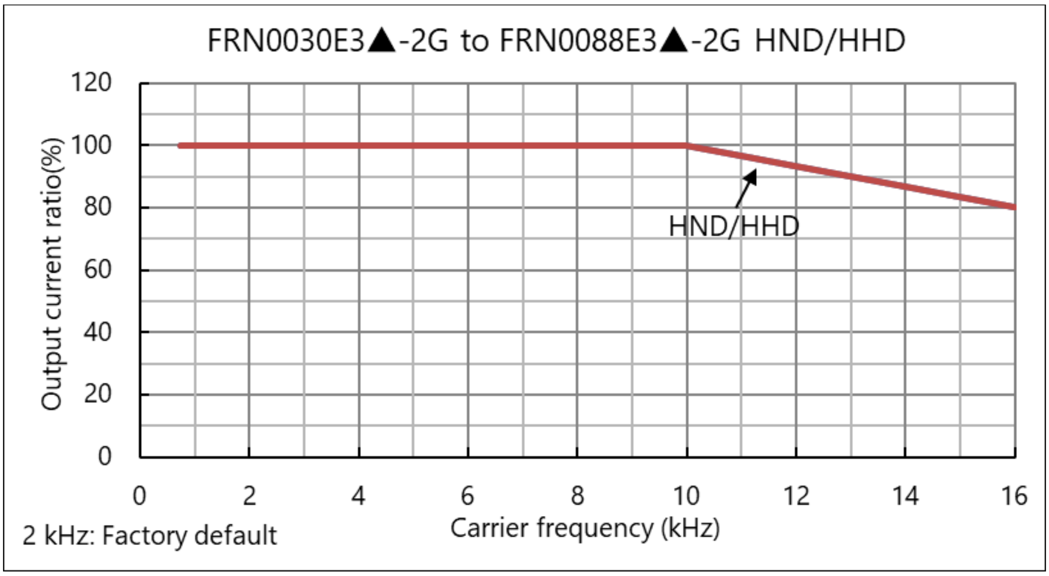
*2: Mode switching with function code F80 initializes the current limiter level.

*3: FRN0069E3△-2G / FRN0044E3□-4G / FRN0012E3□-7G or below is “180%”,FRN0088E3△-2G / FRN0059E3□-4G or above is “160%”

*4: For FRN0001E3△-7G/FRN0002E3△-7G HND modes, Operating temperature is 50°C (122°F).



(*1) FRN0012E3△-2G, FRN0020E3△-2G: Carrier frequency setting range: 0.75 ~ 10 kHz



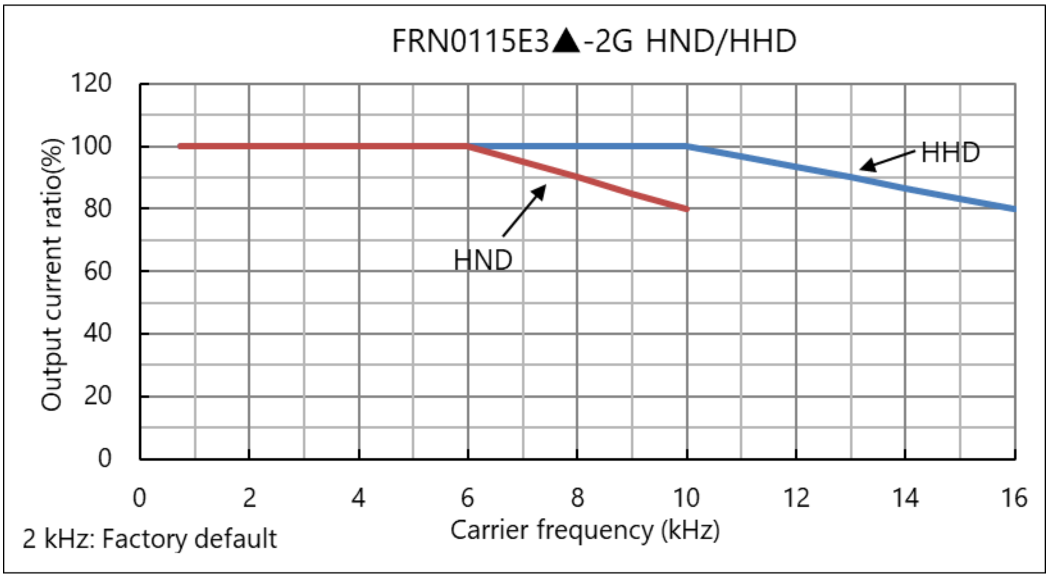
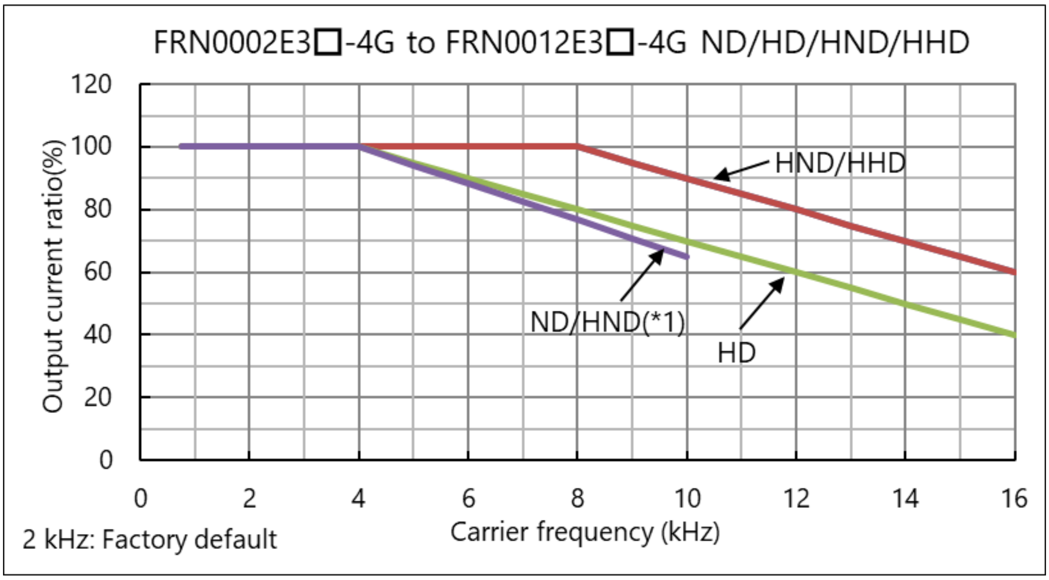
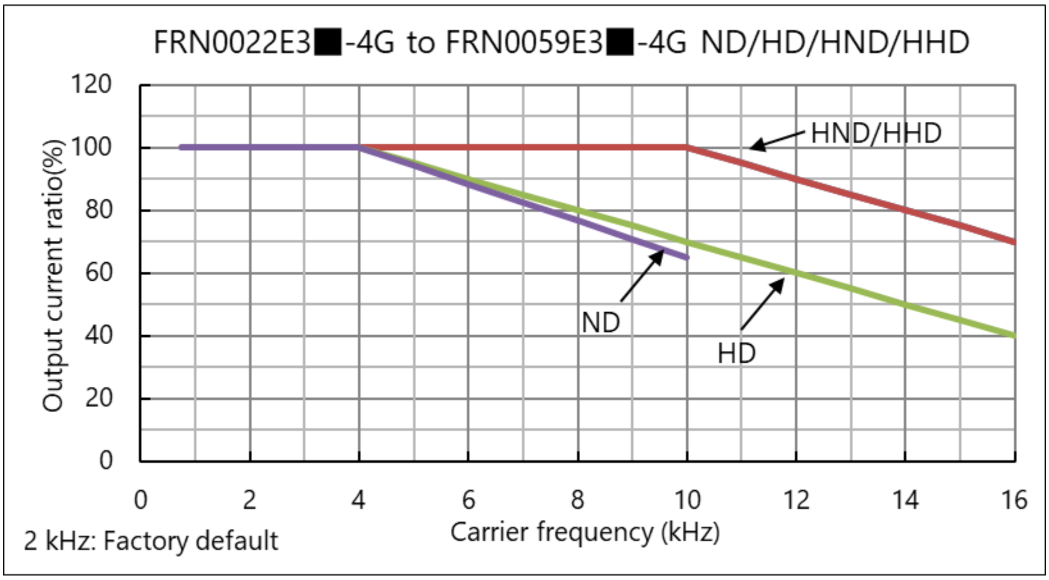


Fig. 10.4-1 Output current derating according to carrier frequency (three-phase 200 V)

SELECTING OPTIMAL MOTOR AND INVERTER CAPACITIES

Chap 10





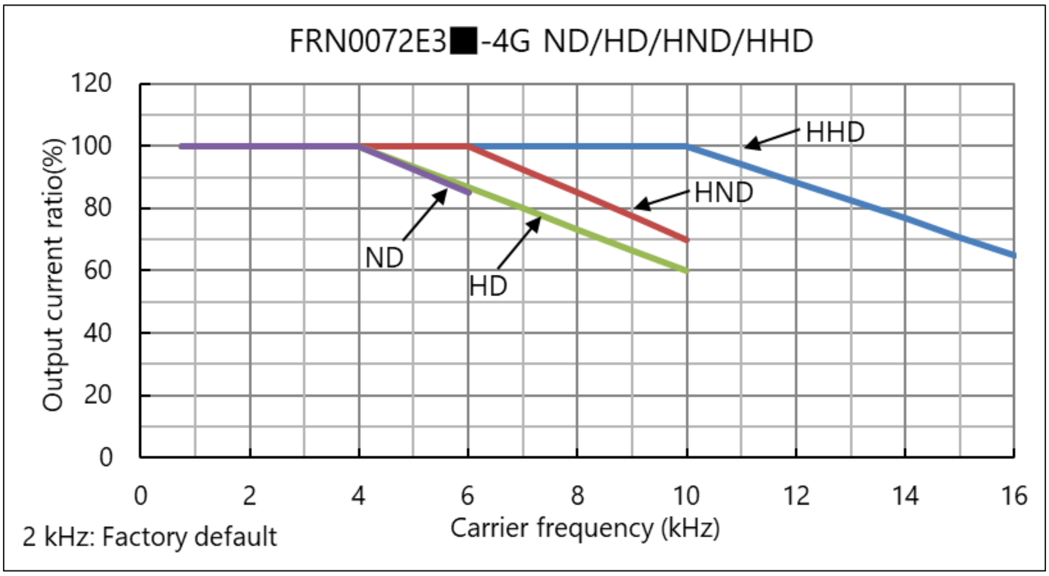
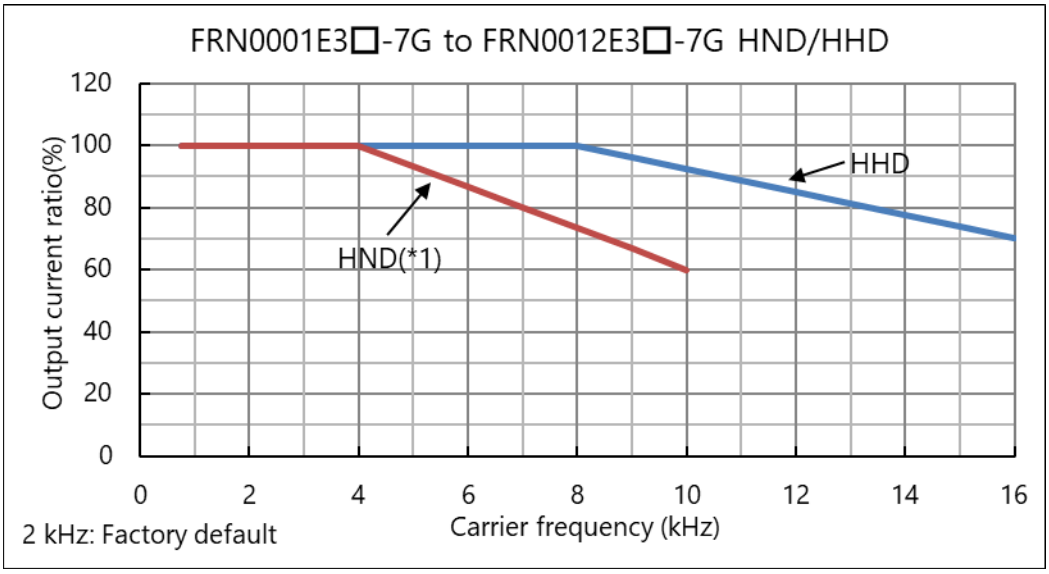


Fig. 10.4-2 Output current derating according to carrier frequency (three-phase 400 V)



(*1) FRN0001E3△-7G to FRN0012E3△-7G : HND mode

Fig. 10.4-3 Output current derating according to carrier frequency (single-phase 200 V)

Chapter 11
SELECTING PERIPHERAL EQUIPMENT

This chapter describes how to use a range of peripheral equipment and options, FRENIC-Ace's configuration with them, and requirements and precautions for selecting wires and crimp terminals.

Contents

11.1 Configuring the FRENIC-Ace

This section lists the names and features of peripheral equipment and options for the FRENIC-Ace as well as a configuration example.

Option

Connection and configuration

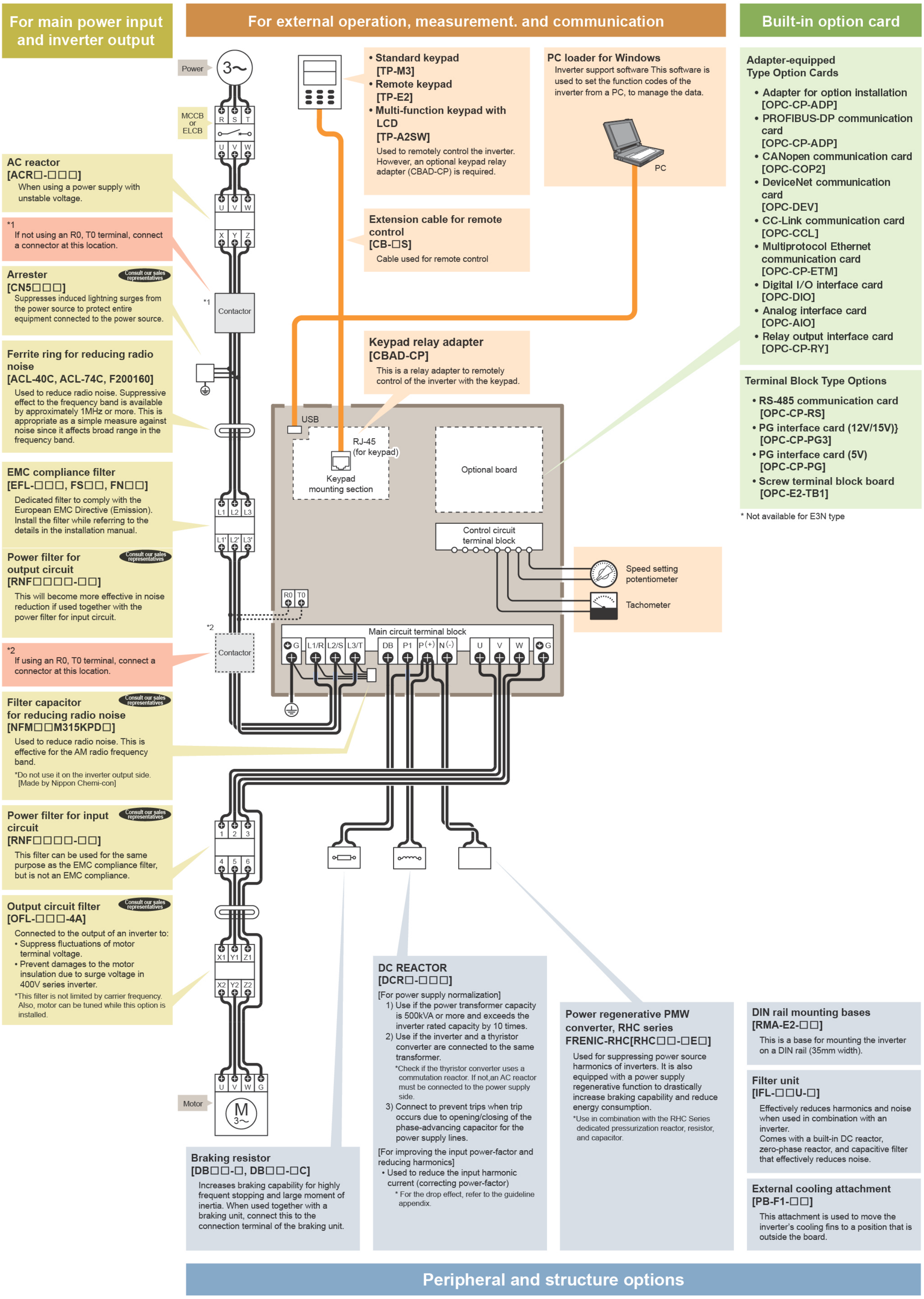


Fig. 11.1-1 Connection configuration diagram

11.2 Currents Flowing Across the Inverter Terminals

Table 11.2-1 summarizes average (effective) electric currents flowing across the terminals of each inverter model for ease of reference when selecting peripheral equipment and options for each inverter--including supplied power voltage and applicable motor rating.

Table 11.2-1 Currents flowing across the inverter terminals

ND mode (kW rating motor)

Power supply voltage	Standard applicable motor (kW)	Inverter type	50Hz, 400V			60Hz, 440V			Braking resistor circuit current (A)
			Input RMS current (A) DC reactors (DCRs)		DC link bus current (A)	Input RMS current (A) DC reactors (DCRs)		DC link bus current (A)	
			w/ DCR	w/o DCR		w/ DCR	w/o DCR		
Three-phase 400V/440 V	0.75	FRN0002E3☐-4G	1.5	2.7	1.8	1.4	2.7	1.7	0.80
	1.5	FRN0004E3☐-4G	2.9	4.8	3.6	2.6	4.8	3.2	1.1
	2.2	FRN0006E3☐-4G	4.2	7.3	5.1	3.8	7.1	4.7	1.8
	3.0	FRN0007E3☐-4G	5.8	11.3	7.1	5.3	10.2	6.5	1.8
	5.5	FRN0012E3☐-4G	10.1	16.8	12.4	9.1	15.7	11.1	2.1
	11	FRN0022E3☐-4G	21.1	33.0	25.9	19.0	29.8	23.3	3.2
	15	FRN0029E3☐-4G	28.8	43.8	35.3	26.0	39.5	31.9	3.1
	18.5	FRN0037E3☐-4G	35.5	52.3	43.5	32.0	47.1	39.2	4.5
	22	FRN0044E3☐-4G	42.2	60.6	51.7	38.0	54.6	46.6	5.7
	30	FRN0059E3☐-4G	57.0	77.9	69.9	51.4	70.2	63.0	7.2
	37	FRN0072E3☐-4G	68.5	94.3	83.9	61.8	85.0	75.7	7.7

ND mode (HP rating motor)

Power supply voltage	Standard applicable motor (HP)	Inverter type	60Hz, 460V			Braking resistor circuit current (A)
			Input RMS current (A) DC reactors (DCRs)		DC link bus current (A)	
			w/ DCR	w/o DCR		
Three-phase 460V	1	FRN0002E3☐-4G	1.3	2.7	1.6	0.80
	2	FRN0004E3☐-4G	2.5	4.7	3.1	1.1
	3	FRN0006E3☐-4G	3.6	7.0	4.4	1.8
	4	FRN0007E3☐-4G	5.0	9.8	6.1	1.8
	7.5	FRN0012E3☐-4G	8.9	15.0	10.9	2.1
	15	FRN0022E3☐-4G	18.8	28.6	23.0	3.2
	20	FRN0029E3☐-4G	25.1	38.0	30.7	3.1
	25	FRN0037E3☐-4G	31.3	45.4	38.3	4.5
	30	FRN0044E3☐-4G	36.3	52.6	44.5	5.7
	40	FRN0059E3☐-4G	50.2	67.7	61.5	7.2
	50	FRN0072E3☐-4G	60.2	82.0	73.7	7.7

Note: A box (☐) in the above table replaces S (Basic type) or N (Ethernet built-in type) or E (EMC filter built-in type) depending on the enclosure.

- Inverter efficiency is calculated using values suitable for each inverter model. The input route mean square current is calculated based on a power supply capacity of 500 kVA (or 10 times as large as the inverter's capacity when the inverter's capacity exceeds 50 kVA), and a power supply reactance of 5%.
- The input RMS current listed in the above table will vary in inverse proportion to the power supply voltage, such as 480 VAC.
- The braking current is always constant, independent of braking resistor specifications, including standard and 10% ED models.

Table 11.2-1 Currents flowing across the inverter terminals (cont'd)
HD mode (kW rating motor)

Power supply voltage	Standard applicable motor (kW)	Inverter type	50Hz, 400V Input RMS current (A) DC reactors (DCRs) w/ DCR	50Hz, 400V Input RMS current (A) DC reactors (DCRs) w/o DCR	50Hz, 400V DC link bus current (A)	60Hz, 440V Input RMS current (A) DC reactors (DCRs) w/ DCR	60Hz, 440V Input RMS current (A) DC reactors (DCRs) w/o DCR	60Hz, 440V DC link bus current (A)	Braking resistor circuit current (A)
Three-phase 400V/440V	0.75	FRN0002E3□-4G	1.5	2.7	1.8	1.4	2.7	1.7	0.80
	1.1	FRN0004E3□-4G	2.1	3.9	2.6	1.9	3.9	2.3	1.1
	2.2	FRN0006E3□-4G	4.2	7.3	5.1	3.8	7.1	4.6	1.8
	3.0	FRN0007E3□-4G	5.8	11.3	7.1	5.3	10.2	6.5	1.8
	5.5	FRN0012E3□-4G	10.1	16.8	12.4	9.1	15.7	11.1	2.1
	7.5	FRN0022E3□-4G	14.4	23.2	17.7	13.0	21.0	16.0	3.2
	11	FRN0029E3□-4G	21.1	33.0	25.9	19.0	29.8	23.3	3.1
	15	FRN0037E3□-4G	28.8	43.8	35.3	26.0	39.5	31.9	4.5
	18.5	FRN0044E3□-4G	35.5	52.3	43.5	32.0	47.1	39.2	5.7
	22	FRN0059E3□-4G	42.2	60.6	51.7	38.0	54.6	46.6	7.2
	30	FRN0072E3□-4G	57.0	77.9	69.9	51.4	70.2	63.0	7.7

HD mode (HP rating motor)

Power supply voltage	Standard applicable motor (HP)	Inverter type	60Hz, 460V Input RMS current (A) DC reactors (DCRs) w/ DCR	60Hz, 460V Input RMS current (A) DC reactors (DCRs) w/o DCR	60Hz, 460V DC link bus current (A)	Braking resistor circuit current (A)
Three-phase 460V	1	FRN0002E3□-4G	1.3	2.7	1.6	0.80
	1.5	FRN0004E3□-4G	1.8	3.8	2.2	1.1
	3	FRN0006E3□-4G	3.6	7.0	4.4	1.8
	4	FRN0007E3□-4G	5.0	9.8	6.1	1.8
	7.5	FRN0012E3□-4G	8.9	15.0	10.9	2.1
	10	FRN0022E3□-4G	12.5	20.1	15.3	3.2
	15	FRN0029E3□-4G	18.8	28.6	23.0	3.1
	20	FRN0037E3□-4G	25.1	38.0	30.7	4.5
	25	FRN0044E3□-4G	31.3	45.4	38.3	5.7
	30	FRN0059E3□-4G	36.3	52.6	44.5	7.2
	40	FRN0072E3□-4G	50.2	67.7	61.5	7.7

Note: A box (□) in the above table replaces S (Basic type) or N (Ethernet built-in type) or E (EMC filter built-in type) depending on the enclosure.

- Inverter efficiency is calculated using values suitable for each inverter model. The input route mean square current is calculated based on a power supply capacity of 500 kVA (or 10 times as large as the inverter's capacity when the inverter's capacity exceeds 50 kVA), and a power supply reactance of 5%.
- The input RMS current listed in the above table will vary in inverse proportion to the power supply voltage, such as 480 VAC.
- The braking current is always constant, independent of braking resistor specifications, including standard and 10% ED models.

Table 11.2-1 Currents flowing across the inverter terminals (cont'd)
HND mode (kW rating motor)

Power supply voltage	Standard applicable motor (kW)	Inverter type	50Hz, 200V/400V Input RMS current (A) DC reactors (DCRs) w/ DCR	50Hz, 200V/400V Input RMS current (A) DC reactors (DCRs) w/o DCR	50Hz, 200V/400V DC link bus current (A)	60Hz, 220V/440V Input RMS current (A) DC reactors (DCRs) w/ DCR	60Hz, 220V/440V Input RMS current (A) DC reactors (DCRs) w/o DCR	60Hz, 220V/440V DC link bus current (A)	Braking resistor circuit current (A)
Three-phase 200V/220V	0.2	FRN0001E3△-2G	0.93	1.8	1.1	0.85	1.7	1.0	0.82
	0.4	FRN0002E3△-2G	1.6	2.6	2.0	1.5	2.6	1.8	1.2
	0.75	FRN0004E3△-2G	3.0	4.9	3.7	2.8	4.9	3.4	1.2
	1.1	FRN0006E3△-2G	4.3	6.7	5.3	3.9	6.7	4.8	1.6
	2.2	FRN0010E3△-2G	8.3	12.8	10.2	7.6	12.3	9.3	3.6
	3.0	FRN0012E3△-2G	11.7	17.9	14.3	10.6	17.9	13	3.5
	5.5	FRN0020E3△-2G	19.9	28.5	24.4	19	28.4	23.3	4.1
	7.5	FRN0030E3△-2G	28.8	42.7	35.3	26.0	38.5	31.9	6.4
	11	FRN0040E3△-2G	42.2	60.7	51.7	38.0	54.7	46.6	6.1
	15	FRN0056E3△-2G	57.6	80.0	70.6	52.0	72.2	63.7	9.1
	18.5	FRN0069E3△-2G	71.0	97.0	87.0	64.0	87.4	78.4	11.0
	22	FRN0088E3△-2G	84.4	112	103	76.0	101	93.1	14
	30	FRN0115E3△-2G	114	151	140	103	136	126	15
Three-phase 400V/440V	0.75	FRN0002E3□-4G	1.5	2.7	1.8	1.4	2.7	1.7	0.80
	1.1	FRN0004E3□-4G	2.1	3.9	2.6	1.9	3.9	2.3	1.1
	2.2	FRN0006E3□-4G	4.2	7.3	5.1	3.8	7.1	4.6	1.8
	3.0	FRN0007E3□-4G	5.8	11.3	7.1	5.3	10.2	6.5	1.8
	5.5	FRN0012E3□-4G	10.1	16.8	12.4	9.1	15.7	11.1	2.1
	7.5	FRN0022E3□-4G	14.4	23.2	17.7	13.0	21.0	16.0	3.2
	11	FRN0029E3□-4G	21.1	33.0	25.9	19.0	29.8	23.3	3.1
	15	FRN0037E3□-4G	28.8	43.8	35.3	26.0	39.5	31.9	4.5
	18.5	FRN0044E3□-4G	35.5	52.3	43.5	32.0	47.1	39.2	5.7
	22	FRN0059E3□-4G	42.2	60.6	51.7	38.0	54.6	46.6	7.2
	30	FRN0072E3□-4G	57.0	77.9	69.9	51.4	70.2	63.0	7.7
Single-phase 200V	0.2	FRN0001E3△-7G	2.2	3.3	2.2	2.0	3.1	2.0	0.82
	0.4	FRN0002E3△-7G	3.7	4.9	3.7	3.4	4.6	3.4	1.2
	0.55	FRN0004E3△-7G	4.6	7.3	4.6	4.2	6.9	4.2	1.2
	1.1	FRN0006E3△-7G	9.4	13.8	9.4	8.5	13.0	8.5	1.6
	2.2	FRN0010E3△-7G	17.9	20.2	17.9	16.2	20.2	16.2	3.6
	3.0	FRN0012E3△-7G	25.0	25.4	25.0	23.0	26.0	23.0	3.5

Note: A box (□) in the above table replaces S (Basic type) or N (Ethernet built-in type) or E (EMC filter built-in type) depending on the enclosure.

A triangle (△) in the above table replaces S (Basic type) or N (Ethernet built-in type) depending on the enclosure.

- Inverter efficiency is calculated using values suitable for each inverter model. The input route mean square current is calculated based on a power supply capacity of 500 kVA (or 10 times as large as the inverter's capacity when the inverter's capacity exceeds 50 kVA), and a power supply reactance of 5%.
- The input RMS current listed in the above table will vary in inverse proportion to the power supply voltage, such as 480 VAC.
- The braking current is always constant, independent of braking resistor specifications, including standard and 10% ED models.

Table 11.2-1 Currents flowing across the inverter terminals (cont'd)
HND mode (HP rating motor)

Power supply voltage	Standard applicable motor (HP)	Inverter type	60Hz, 230V/460V Input RMS current (A) DC reactors (DCRs) w/ DCR	w/o DCR	DC link bus current (A)	Braking resistor circuit current (A)
Three-phase 230V	1/4	FRN0001E3△-2G	0.83	1.7	1.0	0.82
	1/2	FRN0002E3△-2G	1.4	2.5	1.7	1.2
	1	FRN0004E3△-2G	2.7	4.8	3.3	1.2
	1.5	FRN0006E3△-2G	3.8	6.5	4.7	1.6
	3	FRN0010E3△-2G	7.3	12	8.9	3.6
	4	FRN0012E3△-2G	10.2	17.6	12.5	3.5
	7.5	FRN0020E3△-2G	17.4	27.4	21.3	4.1
	10	FRN0030E3△-2G	25.1	38.6	30.7	6.4
	15	FRN0040E3△-2G	37.6	54.8	46.1	6.1
	20	FRN0056E3△-2G	50.2	72.4	61.5	9.1
	25	FRN0069E3△-2G	62.7	87.7	76.8	11.0
	30	FRN0088E3△-2G	72.5	96.4	88.8	14
	40	FRN0115E3△-2G	99.2	130	121.5	15
Three-phase 460V	1	FRN0002E3□-4G	1.3	2.7	1.6	0.80
	1.5	FRN0004E3□-4G	1.8	3.8	2.2	1.1
	3	FRN0006E3□-4G	3.6	7.0	4.4	1.8
	4	FRN0007E3□-4G	5.0	9.8	6.1	1.8
	7.5	FRN0012E3□-4G	8.9	15.0	10.9	2.1
	10	FRN0022E3□-4G	12.5	20.1	15.3	3.2
	15	FRN0029E3□-4G	18.8	28.6	23.0	3.1
	20	FRN0037E3□-4G	25.1	38.0	30.7	4.5
	25	FRN0044E3□-4G	31.3	45.4	38.3	5.7
	30	FRN0059E3□-4G	36.3	52.6	44.5	7.2
	40	FRN0072E3□-4G	50.2	67.7	61.5	7.7
Single-phase 200V	1/4	FRN0001E3△-7G	1.9	3.0	1.9	0.82
	1/2	FRN0002E3△-7G	3.3	4.4	3.3	1.2
	3/4	FRN0004E3△-7G	4.0	6.6	4.0	1.2
	1.1	FRN0006E3△-7G	8.1	12.4	8.1	1.6
	2.2	FRN0010E3△-7G	15.5	19.3	15.5	3.6
	3.0	FRN0012E3△-7G	22	25	22	3.5

Note: A box (□) in the above table replaces S (Basic type) or N (Ethernet built-in type) or E (EMC filter built-in type) depending on the enclosure.

A triangle (△) in the above table replaces S (Basic type) or N (Ethernet built-in type) depending on the enclosure.

- Inverter efficiency is calculated using values suitable for each inverter model. The input route mean square current is calculated based on a power supply capacity of 500 kVA (or 10 times as large as the inverter's capacity when the inverter's capacity exceeds 50 kVA), and a power supply reactance of 5%.
- The input RMS current listed in the above table will vary in inverse proportion to the power supply voltage, such as 480 VAC.
- The braking current is always constant, independent of braking resistor specifications, including standard and 10% ED model

Table 11.2-1 Currents flowing across the inverter terminals (cont’d)
HHD mode (kW rating motor)

Power supply voltage	Standard applicable motor (kW)	Inverter type	50Hz, 200V/400V			60Hz, 220V/440V			Braking resistor circuit current (A)
			Input RMS current (A) DC reactors (DCRs)		DC link bus current (A)	Input RMS current (A) DC reactors (DCRs)		DC link bus current (A)	
			w/ DCR	w/o DCR		w/ DCR	w/o DCR		
Three-phase 200V/220V	0.1	FRN0001E3△-2G	0.57	1.1	0.70	0.51	1.1	0.62	0.82
	0.2	FRN0002E3△-2G	0.93	1.8	1.1	0.85	1.7	1.0	1.2
	0.4	FRN0004E3△-2G	1.6	3.1	2.0	1.5	3.0	1.8	1.2
	0.75	FRN0006E3△-2G	3.0	5.3	3.7	2.8	5.0	3.4	1.6
	1.5	FRN0010E3△-2G	5.7	9.5	7.0	5.2	9.0	6.3	3.6
	2.2	FRN0012E3△-2G	8.3	13.2	10.2	7.6	12.3	9.3	3.5
	3.7	FRN0020E3△-2G	14.0	22.2	17.2	12.7	20.6	15.6	4.1
	5.5	FRN0030E3△-2G	21.1	31.5	25.9	19.0	28.4	23.3	6.4
	7.5	FRN0040E3△-2G	28.8	42.7	35.3	26.0	38.5	31.9	6.1
	11	FRN0056E3△-2G	42.2	60.7	51.7	38.0	54.7	46.6	9.1
	15	FRN0069E3△-2G	57.6	80.0	70.6	52.0	72.2	63.7	11
	18.5	FRN0088E3△-2G	71.0	97.0	87.0	64.0	87.4	78.4	14
	22	FRN0115E3△-2G	84.4	112	103	76.0	101	93.1	15
Three-phase 400V/440V	0.4	FRN0002E3□-4G	0.85	1.7	1.0	0.74	1.7	0.99	0.80
	0.75	FRN0004E3□-4G	1.6	3.1	1.8	1.4	3.0	1.7	1.1
	1.5	FRN0006E3□-4G	3.0	5.9	3.5	2.6	5.1	3.2	1.8
	2.2	FRN0007E3□-4G	4.4	8.2	5.1	3.8	7.1	4.6	1.8
	3.7	FRN0012E3□-4G	7.3	13.0	8.6	6.4	11.1	7.8	2.1
	5.5	FRN0022E3□-4G	10.6	17.3	13.0	9.6	15.7	11.8	3.2
	7.5	FRN0029E3□-4G	14.4	23.2	17.7	13.0	21.0	16.0	3.1
	11	FRN0037E3□-4G	21.1	33.0	25.9	19.0	29.8	23.3	4.5
	15	FRN0044E3□-4G	28.8	43.8	35.3	26.0	39.5	31.9	5.7
	18.5	FRN0059E3□-4G	35.5	52.3	43.5	32.0	47.1	39.2	7.2
	22	FRN0072E3□-4G	42.2	60.6	51.7	38.0	54.6	46.6	7.7
Single-phase 200V	0.1	FRN0001E3□-7G	1.1	1.8	1.1	1.0	1.8	1.0	0.61
	0.2	FRN0002E3□-7G	2.0	3.3	2.0	1.8	3.1	1.8	0.66
	0.4	FRN0003E3E-7G FRN0004E3△-7G	3.5	5.4	3.5	3.1	5.0	3.1	0.82
	0.75	FRN0005E3E-7G FRN0006E3△-7G	6.4	9.7	6.4	5.8	9.1	5.8	1.4
	1.5	FRN0008E3E-7G FRN0010E3△-7G	11.6	16.4	11.6	10.5	15.5	10.5	1.4
	2.2	FRN0011E3E-7G FRN0012E3△-7G	17.5	22.0	17.5	15.8	20.6	15.8	1.7

Note: A box (□) in the above table replaces S (Basic type) or N (Ethernet built-in type) or E (EMC filter built-in type) depending on the enclosure.

A triangle (△) in the above table replaces S (Basic type) or N (Ethernet built-in type) depending on the enclosure.

- Inverter efficiency is calculated using values suitable for each inverter model. The input route mean square current is calculated based on a power supply capacity of 500 kVA (or 10 times as large as the inverter’s capacity when the inverter’s capacity exceeds 50 kVA), and a power supply reactance of 5%.
- The input RMS current listed in the above table will vary in inverse proportion to the power supply voltage, such as 480 VAC.
- The braking current is always constant, independent of braking resistor specifications, including standard and 10% ED models.

Table 11.2-1 Currents flowing across the inverter terminals (cont'd)
HHD mode (HP rating motor)

Power supply voltage	Standard applicable motor (HP)	Inverter type	60Hz, 230V/460V Input RMS current (A) DC reactors (DCRs) w/ DCR	w/o DCR	DC link bus current (A)	Braking resistor circuit current (A)
Three-phase 230V	1/8	FRN0001E3△-2G	0.49	1.1	0.60	0.82
	1/4	FRN0002E3△-2G	0.82	1.7	1.0	1.2
	1/2	FRN0004E3△-2G	1.4	3.0	1.7	1.2
	1	FRN0006E3△-2G	2.7	4.9	3.3	1.6
	2	FRN0010E3△-2G	5.0	8.8	6.1	3.6
	3	FRN0012E3△-2G	7.3	12.0	8.9	3.5
	5	FRN0020E3△-2G	12.4	20.0	15.2	4.1
	7.5	FRN0030E3△-2G	18.5	28.4	22.7	6.4
	10	FRN0040E3△-2G	25.1	38.6	30.7	6.1
	15	FRN0056E3△-2G	37.6	54.8	46.1	9.1
	20	FRN0069E3△-2G	50.2	72.4	61.5	11.0
	25	FRN0088E3△-2G	62.7	87.7	76.8	14
	30	FRN0115E3△-2G	72.5	96.4	88.8	15
Three-phase 460V	1/2	FRN0002E3□-4G	0.72	1.7	0.90	0.80
	1	FRN0004E3□-4G	1.3	3.0	1.6	1.1
	2	FRN0006E3□-4G	2.5	4.9	3.1	1.8
	3	FRN0007E3□-4G	3.6	7.0	4.4	1.8
	5	FRN0012E3□-4G	6.1	10.7	7.5	2.1
	7.5	FRN0022E3□-4G	9.2	15.0	11.3	3.2
	10	FRN0029E3□-4G	12.5	20.1	15.3	3.1
	15	FRN0037E3□-4G	18.8	28.6	23.0	4.5
	20	FRN0044E3□-4G	25.1	38.0	30.7	5.7
	25	FRN0059E3□-4G	31.3	45.4	38.3	7.2
	30	FRN0072E3□-4G	36.3	52.6	44.5	7.7
Single-phase 200V	1/8	FRN0001E3□-7G	1.0	1.7	1.0	0.61
	1/4	FRN0002E3□-7G	1.7	3.0	1.7	0.66
	1/2	FRN0003E3E-7G FRN0004E3△-7G	3.0	4.8	3.0	0.82
	1	FRN0005E3E-7G FRN0006E3△-7G	5.5	8.7	5.5	1.4
	2	FRN0008E3E-7G FRN0010E3△-7G	10.0	14.8	10.0	1.4
	3	FRN0011E3E-7G FRN0012E3△-7G	15.1	19.7	15.1	1.7

Note: A box (□) in the above table replaces S (Basic type) or N (Ethernet built-in type) or E (EMC filter built-in type) depending on the enclosure.

A triangle (△) in the above table replaces S (Basic type) or N (Ethernet built-in type) depending on the enclosure.

- Inverter efficiency is calculated using values suitable for each inverter model. The input route mean square current is calculated based on a power supply capacity of 500 kVA (or 10 times as large as the inverter's capacity when the inverter's capacity exceeds 50 kVA), and a power supply reactance of 5%.
- The input RMS current listed in the above table will vary in inverse proportion to the power supply voltage, such as 480 VAC.
- The braking current is always constant, independent of braking resistor specifications, including standard and 10% ED models.

11.3 Molded Case Circuit Breaker (MCCB), Residual-current-operated Protective Device (RCD)/Earth Leakage Circuit Breaker (ELCB) and Magnetic Contactor (MC)

11.3.1 Function overview

MCCBs and RCDs/ELCBs* * With overcurrent protection

Molded case circuit breakers (MCCBs) are designed to protect the power circuits between the power supply and inverter's main circuit terminals ([L1/R], [L2/S] and [L3/T]) from overload or short-circuit, which in turn prevents secondary accidents caused by the broken inverter.

Residual-current-operated protective devices (RCDs)/earth leakage circuit breakers (ELCBs) function in the same way as MCCBs.

Built-in overcurrent/overload protective functions protect the inverter itself from failures related to its input/output lines.

Magnetic contactor

An MC can be used at both the power input and output sides of the inverter. On each side, the MC works as described below. Use it as necessary. When inserted in the output circuit of the inverter, the MC can also switch the motor drive power supply between the inverter output and commercial power lines.

On the power supply side

Insert an MC on the power supply side of the inverter in order to:

(1) Forcibly cut off the inverter from the power supply (generally, commercial/factory power lines) with the protective function built into the inverter, or with the external signal input.

(2) Stop the inverter operation in an emergency when the inverter cannot interpret the stop command due to internal/external circuit failures.

(3) Cut off the inverter from the power supply when the MCCB inserted on the power supply side cannot cut it off for maintenance or inspection purposes. For these purposes only, it is recommended that you use an MC capable of turning the MC ON/OFF manually.

Note Avoid frequent ON/OFF operation of the magnetic contactor (MC) in the input (primary) circuit; otherwise, inverter failure may result.

The frequency of the MC's ON/OFF should not be more than once per 30 minutes. To assure 10-year or longer service life of the inverter, it should not be more than once per hour.

If frequent start/stop of the motor is required, use FWD/REV terminal signals or the RUN/STOP keys on the inverter's keypad.

On the output side

Insert an MC on the power output side of the inverter in order to:

(1) Prevent externally reversed current from being applied to the inverter power output terminals ([U], [V], and [W]) unexpectedly. An MC should be used, for example, when a circuit that switches the motor driving power supply between the inverter output and commercial power lines is connected to the inverter.

Tip If a magnetic contactor (MC) is inserted on the inverter's output (secondary) circuit for switching the motor to a commercial power or for any other purposes, it should be switched on and off when both the inverter and motor are completely stopped. This prevents the contact point from getting rough due to a switching arc of the MC. The MC should not be equipped with any main circuit surge killer (Fuji SZ-ZM☐, etc.).

Applying a commercial power supply to the inverter's output circuit breaks the inverter. To avoid this, interlock the MC on the motor's commercial power line with the one in the inverter output circuit so that they are not switched ON at the same time.

(2) Drive more than one motor selectively by a single inverter.

(3) Selectively cut off the motor whose thermal overload relay or equivalent devices have been activated.

Driving the motor using commercial power lines

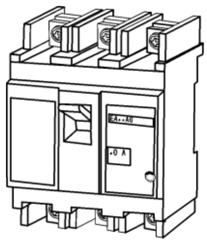
MCs can also be used to switch the power supply of the motor driven by the inverter to a commercial power supply.

Select the MC so as to satisfy the rated currents listed in Table 11.2-1, which are the most critical RMS currents for using the inverter (Refer to Table 11.3-1). For switching the motor drive source between the inverter output and commercial power lines, use the MC of class AC3 specified by JIS C8325 on the commercial line side.

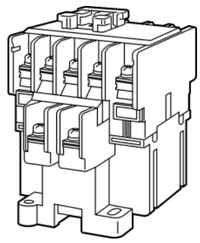
11.3.2 Connection example and criteria for selection of circuit breakers

Figure 11.3-1 shows a connection example for MCCB or RCD/ELCB (with overcurrent protection) and MC in the inverter input circuit. Table 11.3-1 lists the rated current for the MCCB and corresponding inverter models. Table 11.3-2 lists the applicable grades of RCD/ELCB sensitivity.

⚠WARNING
Insert an MCCB or RCD/ELCB (with overcurrent protection) recommended for each inverter for its input circuits. Do not use an MCCB or RCD/ELCB of a higher rating than recommended. **Doing so could result in a fire.**



Molded case circuit breaker or residual-current-operated protective device/ earth leakage circuit breaker



Magnetic contactor

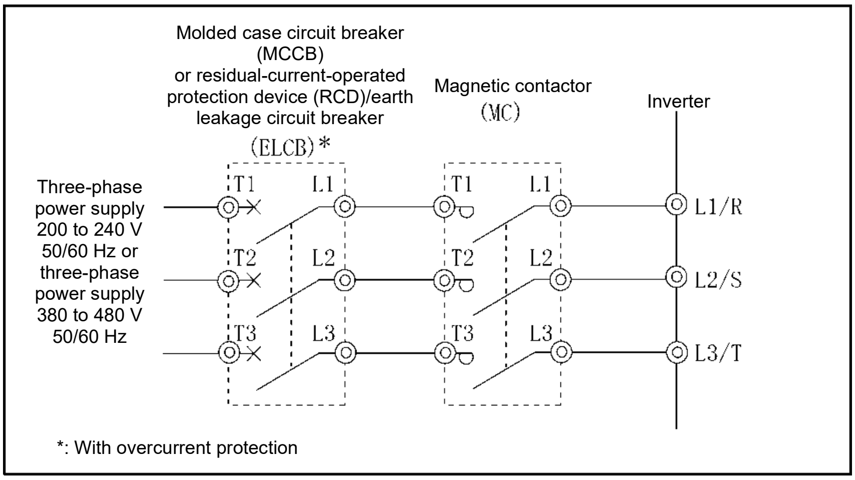


Figure 11.3-1 External views of MCCB or RCD/ELCB and MC and connection example

Chap 11 SELECTING PERIPHERAL EQUIPMENT

Table 11.3-1 Rated current of molded case circuit breaker (MCCB), residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) and magnetic contactor (MC)

ND mode (kW rating motor)

Power supply voltage	Standard applicable motor (kW)	Inverter type	MCCB, RCD/ELCB rated current (A)		Magnetic contactor (MC)		
			DC reactors (DCRs)		Input circuit		Output circuit
					DC reactors (DCRs)		
			w/ DCR	w/o DCR	w/ DCR	w/o DCR	
Three-phase 400V	0.75	FRN0002E3☐-4G	5	5	SC-05	SC-05	SC-05
	1.5	FRN0004E3☐-4G		10			
	2.2	FRN0006E3☐-4G	10	15			
	3.0	FRN0007E3☐-4G					
	5.5	FRN0012E3☐-4G	15	30			
	11	FRN0022E3☐-4G	30	50	SC-4-0	SC-N1	SC-4-0
	15	FRN0029E3☐-4G	40	60	SC-5-1		SC-5-1
	18.5	FRN0037E3☐-4G		75	SC-N1	SC-N2	SC-N1
	22	FRN0044E3☐-4G	50	100		SC-N2S	
	30	FRN0059E3☐-4G	75	125	SC-N2	SC-N3	SC-N2
	37	FRN0072E3☐-4G	100		SC-N2S	SC-N4	SC-N2S

HD mode (kW rating motor)

Power supply voltage	Standard applicable motor (kW)	Inverter type	MCCB, RCD/ELCB rated current (A)		Magnetic contactor (MC)		
			DC reactors (DCRs)		Input circuit		Output circuit
					DC reactors (DCRs)		
			w/ DCR	w/o DCR	w/ DCR	w/o DCR	
Three-phase 400V	0.75	FRN0002E3☐-4G	5	5	SC-05	SC-05	SC-05
	1.1	FRN0004E3☐-4G		10			
	2.2	FRN0006E3☐-4G	10	15			
	3.0	FRN0007E3☐-4G					
	5.5	FRN0012E3☐-4G	15	30			
	7.5	FRN0022E3☐-4G	20	40		SC-4-0	
	11	FRN0029E3☐-4G	30	50	SC-4-0	SC-N1	SC-4-0
	15	FRN0037E3☐-4G	40	60	SC-5-1		SC-5-1
	18.5	FRN0044E3☐-4G		75	SC-N1	SC-N2	SC-N1
	22	FRN0059E3☐-4G	50	100		SC-N2S	
	30	FRN0072E3☐-4G	75	125	SC-N2	SC-N3	SC-N2

Note: A box (☐) in the above table replaces S (Basic type) or N (Ethernet built-in type) or E (EMC filter built-in type) depending on the enclosure.

- Install the MCCB or RCD/ELCB on the input side of the inverter. They cannot be installed on the output side of the inverter.
- The above table lists the rated current of MCCBs and RCD/ELCBs to be used in the power control panel with an internal temperature of lower than 50°C (122°F). The rated current is factored by a correction coefficient of 0.85 as the RCDs'/MCCBs' and ELCBs' original rated current is specified when using them in an ambient temperature of 40°C (104°F) or lower. Select an MCCB and/or RCD/ELCB suitable for the actual short-circuit breaking capacity needed for your power systems.
- For the selection of the MC type, it is assumed that HIV (allowable ambient temperature: 75°C (167°F)) wires for the power input/output of the inverter are used. If an MC type for another class of wires is selected, the wire size suitable for the terminal size of both the inverter and the MC type should be taken into account.
- Use ELCBs with overcurrent protection.
- To protect your power systems from secondary accidents caused by the broken inverter, use an MCCB and/or RCD/ELCB with the rated current listed in the above table. Do not use an MCCB or RCD/ELCB with a rating higher than that listed.

Table 11.3-1 Rated current of molded case circuit breaker (MCCB), residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) and magnetic contactor (MC) (cont'd)

HND mode (kW rating motor)

<table>
<tr><th rowspan="3">Power supply voltage</th><th rowspan="3">Standard applicable motor (kW)</th><th rowspan="3">Inverter type</th><th colspan="2">MCCB, RCD/ELCB rated current (A)</th><th colspan="3">Magnetic contactor (MC)</th></tr>
<tr><th colspan="2">DC reactors (DCRs)</th><th colspan="2">Input circuit
DC reactors (DCRs)</th><th rowspan="2">Output circuit</th></tr>
<tr><th>w/ DCR</th><th>w/o DCR</th><th>w/ DCR</th><th>w/o DCR</th></tr>
<tr><td rowspan="13">Three-phase 200V</td><td>0.2</td><td>FRN0001E3△-2G</td><td rowspan="3">5</td><td rowspan="2">5</td><td rowspan="6">SC-05</td><td rowspan="6">SC-05</td><td rowspan="6">SC-05</td></tr>
<tr><td>0.4</td><td>FRN0002E3△-2G</td></tr>
<tr><td>0.75</td><td>FRN0004E3△-2G</td><td>10</td></tr>
<tr><td>1.1</td><td>FRN0006E3△-2G</td><td rowspan="2">10</td><td>15</td></tr>
<tr><td>2.2</td><td>FRN0010E3△-2G</td><td>20</td></tr>
<tr><td>3.0</td><td>FRN0012E3△-2G</td><td>20</td><td>30</td></tr>
<tr><td>5.5</td><td>FRN0020E3△-2G</td><td>30</td><td>40</td><td>SC-4-0</td><td>SC-N1</td><td>SC-4-0</td></tr>
<tr><td>7.5</td><td>FRN0030E3△-2G</td><td>40</td><td>75</td><td>SC-5-1</td><td>SC-N2</td><td>SC- N1</td></tr>
<tr><td>11</td><td>FRN0040E3△-2G</td><td>50</td><td>100</td><td>SC-N1</td><td>SC-N2S</td><td>SC-N1</td></tr>
<tr><td>15</td><td>FRN0056E3△-2G</td><td>75</td><td>125</td><td>SC-N2</td><td>SC-N3</td><td>SC-N2</td></tr>
<tr><td>18.5</td><td>FRN0069E3△-2G</td><td rowspan="2">100</td><td>150</td><td rowspan="2">SC-N2S</td><td>SC-N4</td><td>SC-N2S</td></tr>
<tr><td>22</td><td>FRN0088E3△-2G</td><td>175</td><td>SC-N5</td><td>SC-N3</td></tr>
<tr><td>30</td><td>FRN0115E3△-2G</td><td>150</td><td>200</td><td>SC-N4</td><td>SC-N7</td><td>SC-N4</td></tr>
<tr><td rowspan="11">Three-phase 400V</td><td>0.75</td><td>FRN0002E3□-4G</td><td rowspan="2">5</td><td>5</td><td rowspan="6">SC-05</td><td rowspan="5">SC-05</td><td rowspan="6">SC-05</td></tr>
<tr><td>1.1</td><td>FRN0004E3□-4G</td><td>10</td></tr>
<tr><td>2.2</td><td>FRN0006E3□-4G</td><td rowspan="2">10</td><td rowspan="2">15</td></tr>
<tr><td>3.0</td><td>FRN0007E3□-4G</td></tr>
<tr><td>5.5</td><td>FRN0012E3□-4G</td><td>15</td><td>30</td></tr>
<tr><td>7.5</td><td>FRN0022E3□-4G</td><td>20</td><td>40</td><td>SC-4-0</td></tr>
<tr><td>11</td><td>FRN0029E3□-4G</td><td>30</td><td>50</td><td>SC-4-0</td><td rowspan="2">SC-N1</td><td>SC-4-0</td></tr>
<tr><td>15</td><td>FRN0037E3□-4G</td><td rowspan="2">40</td><td>60</td><td>SC-5-1</td><td>SC-5-1</td></tr>
<tr><td>18.5</td><td>FRN0044E3□-4G</td><td>75</td><td rowspan="2">SC-N1</td><td>SC-N2</td><td rowspan="2">SC-N1</td></tr>
<tr><td>22</td><td>FRN0059E3□-4G</td><td>50</td><td>100</td><td>SC-N2S</td></tr>
<tr><td>30</td><td>FRN0072E3□-4G</td><td>75</td><td>125</td><td>SC-N2</td><td>SC-N3</td><td>SC-N2</td></tr>
<tr><td rowspan="6">Single-phase 200V</td><td>0.2</td><td>FRN0001E3△-7G</td><td rowspan="2">5</td><td>5</td><td rowspan="5">SC-05</td><td rowspan="4">SC-05</td><td rowspan="6">SC-05</td></tr>
<tr><td>0.4</td><td>FRN0002E3△-7G</td><td rowspan="2">10</td></tr>
<tr><td>0.55</td><td>FRN0004E3△-7G</td><td>10</td></tr>
<tr><td>1.1</td><td>FRN0006E3△-7G</td><td>15</td><td>20</td></tr>
<tr><td>2.2</td><td>FRN0010E3△-7G</td><td>20</td><td>30</td><td rowspan="2">SC-5-1</td></tr>
<tr><td>3.0</td><td>FRN0012E3△-7G</td><td>30</td><td>40</td><td>SC-4-0</td></tr>
</table>

Note: A box (□) in the above table replaces S (Basic type) or N (Ethernet built-in type) or E (EMC filter built-in type) depending on the enclosure.

A triangle (△) in the above table replaces S (Basic type) or N (Ethernet built-in type) depending on the enclosure.

- Install the MCCB or RCD/ELCB on the input side of the inverter. They cannot be installed on the output side of the inverter.
- The above table lists the rated current of MCCBs and RCD/ELCBs to be used in the power control panel with an internal temperature of lower than 50°C (122°F). The rated current is factored by a correction coefficient of 0.85 as the RCDs'/MCCBs' and ELCBs' original rated current is specified when using them in an ambient temperature of 40°C (104°F) or lower. Select an MCCB and/or RCD/ELCB suitable for the actual short-circuit breaking capacity needed for your power systems.
- For the selection of the MC type, it is assumed that the 600 V HIV (allowable ambient temperature: 75°C (167°F)) wires for the power input/output of the inverter are used. If an MC type for another class of wires is selected, the wire size suitable for the terminal size of both the inverter and the MC type should be taken into account.
- Use ELCBs with overcurrent protection.
- To protect your power systems from secondary accidents caused by the broken inverter, use an MCCB and/or RCD/ELCB with the rated current listed in the above table. Do not use an MCCB or RCD/ELCB with a rating higher than that listed.

Table 11.3-1 Rated current of molded case circuit breaker (MCCB), residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) and magnetic contactor (MC) (cont'd)

HHD mode (kW rating motor)

Power supply voltage	Standard applicable motor (kW)	Inverter type	MCCB, RCD/ELCB rated current (A)		Magnetic contactor (MC)		
			DC reactors (DCRs)		Input circuit DC reactors (DCRs)		Output circuit
			w/ DCR	w/o DCR	w/ DCR	w/o DCR	
Three-phase 200V	0.1	FRN0001E3△-2G	5	5	SC-05	SC-05	SC-05
	0.2	FRN0002E3△-2G					
	0.4	FRN0004E3△-2G					
	0.75	FRN0006E3△-2G		10			
	1.5	FRN0010E3△-2G	10	15			
	2.2	FRN0012E3△-2G		20			
	3.7	FRN0020E3△-2G	20	30		SC-4-0	
	5.5	FRN0030E3△-2G	30	50	SC-4-0	SC-5-1	SC-4-0
	7.5	FRN0040E3△-2G	40	75	SC-5-1	SC-N1	SC-N1
	11	FRN0056E3△-2G	50	100	SC-N1	SC-N2S	
	15	FRN0069E3△-2G	75	125	SC-N2	SC-N3	SC-N2
	18.5	FRN0088E3△-2G	100	150	SC-N2S	SC-N4	SC-N2S
	22	FRN0115E3△-2G		175		SC-N5	SC-N3
Three-phase 400V	0.4	FRN0002E3□-4G	5	5	SC-05	SC-05	SC-05
	0.75	FRN0004E3□-4G					
	1.5	FRN0006E3□-4G		10			
	2.2	FRN0007E3□-4G	10	15			
	3.7	FRN0012E3□-4G		20			
	5.5	FRN0022E3□-4G	15	30			
	7.5	FRN0029E3□-4G	20	40		SC-4-0	
	11	FRN0037E3□-4G	30	50	SC-4-0	SC-N1	SC-4-0
	15	FRN0044E3□-4G	40	60	SC-5-1		SC-5-1
	18.5	FRN0059E3□-4G		75	SC-N1	SC-N2	SC-N1
	22	FRN0072E3□-4G	50	100		SC-N2S	
Single-phase 200V	0.1	FRN0001E3□-7G	5	5	SC-05	SC-05	SC-05
	0.2	FRN0002E3□-7G					
	0.4	FRN0003E3E-7G FRN0004E3△-7G		10			
	0.75	FRN0005E3E-7G FRN0006E3△-7G	10	15			
	1.5	FRN0008E3E-7G FRN0010E3△-7G	15	20			
	2.2	FRN0011E3E-7G FRN0012E3△-7G	20	30		SC-5-1	

Note: A box (□) in the above table replaces S (Basic type) or N (Ethernet built-in type) or E (EMC filter built-in type) depending on the enclosure.

A triangle (△) in the above table replaces S (Basic type) or N (Ethernet built-in type) depending on the enclosure.

- Install the MCCB or RCD/ELCB on the input side of the inverter. They cannot be installed on the output side of the inverter.
- The above table lists the rated current of MCCBs and RCD/ELCBs to be used in the power control panel with an internal temperature of lower than 50°C (122°F). The rated current is factored by a correction coefficient of 0.85 as the RCDs'/MCCBs' and ELCBs' original rated current is specified when using them in an ambient temperature of 40°C (104°F) or lower. Select an MCCB and/or RCD/ELCB suitable for the actual short-circuit breaking capacity needed for your power systems.
- For the selection of the MC type, it is assumed that the 600 V HIV (allowable ambient temperature: 75°C (167°F)) wires for the power input/output of the inverter are used. If an MC type for another class of wires is selected, the wire size suitable for the terminal size of both the inverter and the MC type should be taken into account.
- Use ELCBs with overcurrent protection.
- To protect your power systems from secondary accidents caused by the broken inverter, use an MCCB and/or RCD/ELCB with the rated current listed in the above table. Do not use an MCCB or RCD/ELCB with a rating higher than that listed.

Table 11.3-1 Rated current of molded case circuit breaker (MCCB), residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) and magnetic contactor (MC) (cont'd)

ND, HD, HND, HHD mode (HP rating motor)

Voltage class	Standard applicable motor (HP)	Inverter type ND mode	Inverter type HD mode	Inverter type HND mode	Inverter type HHD mode	MCCB, RCD/ELCB rated current (A) DC reactors (DCRs)		Magnetic contactor (MC) Input circuit DC reactors (DCRs)		Magnetic contactor (MC) Output circuit
						w/ DCR	w/o DCR	w/ DCR	w/o DCR	
Three-pahse 230V class	1/8	-	-	-	FRN0001E3△-2G	5	5	SC-05	SC-05	SC-05
	1/4	-	-	FRN0001E3△-2G	FRN0002E3△-2G					
	1/2	-	-	FRN0002E3△-2G	FRN0004E3△-2G					
	1	-	-	FRN0004E3△-2G	FRN0006E3△-2G		10			
	1.5	-	-	FRN0006E3△-2G	-	10				
	2	-	-	-	FRN0010E3△-2G		15			
	3	-	-	FRN0010E3△-2G	FRN0012E3△-2G		20			
	4	-	-	FRN0012E3△-2G	-	20	30			
	5	-	-	-	FRN0020E3△-2G				SC-4-0	
	7.5	-	-	FRN0020E3△-2G	-	30	40	SC-4-0	SC-5-1	SC-4-0
				-	FRN0030E3△-2G		50			
	10	-	-	FRN0030E3△-2G	FRN0040E3△-2G	40	75	SC-5-1	SC-N1	SC-N1
	15	-	-	FRN0040E3△-2G	FRN0056E3△-2G	50	100	SC-N1	SC-N2S	
	20	-	-	FRN0056E3△-2G	FRN0069E3△-2G	75	125	SC-N2	SC-N3	SC-N2
	25	-	-	FRN0069E3△-2G	FRN0088E3△-2G	100	150	SC-N2S	SC-N4	SC-N2S
	30	-	-	FRN0088E3△-2G	FRN0115E3△-2G		175		SC-N5	SC-N3
	40	-	-	FRN0115E3△-2G	-	150	200	SC-N4	SC-N7	SC-N4
Three-pahse 460V class	1/2	-	-	-	FRN0002E3□-4G	5	5	SC-05	SC-05	SC-05
	1	FRN0002E3□-4G	FRN0002E3□-4G	FRN0002E3□-4G	FRN0004E3□-4G					
	1.5	-	FRN0004E3□-4G	FRN0004E3□-4G	-					
	2	FRN0004E3□-4G	-	-	FRN0006E3□-4G		10			
	3	FRN0006E3□-4G	FRN0006E3□-4G	FRN0006E3□-4G	FRN0007E3□-4G	10	15			
	4	FRN0007E3□-4G	FRN0007E3□-4G	FRN0007E3□-4G	-					
	5	-	-	-	FRN0012E3□-4G		20			
	7.5	FRN0012E3□-4G	FRN0012E3□-4G	FRN0012E3□-4G	FRN0022E3□-4G	15	30			
	10	-	FRN0022E3□-4G	FRN0022E3□-4G	FRN0029E3□-4G	20	40		SC-4-0	
	15	FRN0022E3□-4G	FRN0029E3□-4G	FRN0029E3□-4G	FRN0037E3□-4G	30	50	SC-4-0	SC-N1	SC-4-0
	20	FRN0029E3□-4G	FRN0037E3□-4G	FRN0037E3□-4G	FRN0044E3□-4G	40	60	SC-5-1		SC-5-1
	25	FRN0037E3□-4G	FRN0044E3□-4G	FRN0044E3□-4G	FRN0059E3□-4G		75	SC-N1	SC-N2	SC-N1
	30	FRN0044E3□-4G	FRN0059E3□-4G	FRN0059E3□-4G	FRN0072E3□-4G	50	100		SC-N2S	
	40	FRN0059E3□-4G	FRN0072E3□-4G	FRN0072E3□-4G	-	75	125	SC-N2	SC-N3	SC-N2
	50	FRN0072E3□-4G	-	-	-	100		SC-N2S	SC-N4	SC-N2S
SIngle-pahse 230V class	1/8	-	-	-	FRN0001E3□-7G	5	5	SC-05	SC-05	SC-05
	1/4	-	-	FRN0001E3△-7G	FRN0002E3□-7G					
	1/2	-	-	FRN0002E3△-7G	FRN0003E3E-7G FRN0004E3△-7G		10			
	3/4			FRN0004E3△-7G	-	10				
	1	-	-	-	FRN0005E3E-7G FRN0006E3△-7G		15			
	1.5			FRN0006E3△-7G	-	15	20			
	2	-	-	-	FRN0008E3E-7G FRN0010E3△-7G					
	3	-	-	FRN0010E3△-7G	FRN0012E3△-7G	20	30		SC-5-1	
	4	-	-	FRN0012E3△-7G	-	30	40	SC-4-0		

Note: A box (□) in the above table replaces S (Basic type) or N (Ethernet built-in type) or E (EMC filter built-in type) depending on the enclosure.

A triangle (△) in the above table replaces S (Basic type) or N (Ethernet built-in type) depending on the enclosure.

- Install the MCCB or RCD/ELCB on the input side of the inverter. They cannot be installed on the output side of the inverter.
- The above table lists the rated current of MCCBs and RCD/ELCBs to be used in the power control panel with an internal temperature of lower than 50°C (122°F). The rated current is factored by a correction coefficient of 0.85 as the RCDs'/MCCBs' and ELCBs' original rated current is specified when using them in an ambient temperature of 40°C (104°F) or lower. Select an MCCB and/or RCD/ELCB suitable for the actual short-circuit breaking capacity needed for your power systems.
- For the selection of the MC type, it is assumed that the 600 V HIV (allowable ambient temperature: 75°C (167°F)) wires for the power input/output of the inverter are used. If an MC type for another class of wires is selected, the wire size suitable for the terminal size of both the inverter and the MC type should be taken into account.
- Use ELCBs with overcurrent protection.
- To protect your power systems from secondary accidents caused by the broken inverter, use an MCCB and/or RCD/ELCB with the rated current listed in the above table. Do not use an MCCB or RCD/ELCB with a rating higher than that listed.

Table 11.3-2 lists the relationship between the rated leakage current sensitivity of RCDs/ELCBs (with overcurrent protection) and wiring length of the inverter output circuits. Note that the sensitivity levels listed in the table are estimated values based on the results obtained by the test setup in the Fuji laboratory where each inverter drives a single motor.

Table 11.3-2 Rated current sensitivity of residual-current-operated protective device (RCD)/ earth leakage circuit breakers (ELCBs)

Voltage class	Standard applicable motor (kW) [HP]	Wiring length and current sensitivity					
		10m (33ft)	30m (98ft)	50m (164ft)	100m (328ft)	200m (656ft)	300m (984ft)
Three-phase 200V class	0.1 [1/8]						
	0.2 [1/4]						
	0.4 [1/2]						
	0.75 [1]						
	1.1 [1.5]						
	1.5 [2]						
	2.2 [3]		30 mA		100 mA		200 mA
	3 [4]						
	3.7 [5]						
	5.5 [7.5]						
	7.5 [10]						
	11 [15]						
	15 [20]						
	18.5 [25]						
	22 [30]						
	30 [40]						500 mA
Three-phase 400V class	0.4 [1/2]						
	0.75 [1]						
	1.1 [1.5]						
	1.5 [2]						
	2.2 [3]						
	3 [4]						
	3.7 [5]	30 mA		100 mA		200 mA	500 mA
	5.5 [7.5]						
	7.5 [10]						
	11 [15]						
	15 [20]						
	18.5 [25]						
	22 [30]						
	30 [40]						
	37 [50]						

- Values listed above were obtained using Fuji ELCB applied to the test setup.
- The leakage current is calculated based on neutral grounding for 400 V class Y-connection power lines.
- Values listed above were obtained using Fuji ELCB applied to the test setup.
- Wiring length is the total length of wiring between the inverter and motor. If more than one motor is to be connected to a single inverter, the wiring length should be the total length of wiring between the inverter and motors.

11.4 Braking Resistors (DBRs)

11.4.1 Selecting a braking resistor

If the load inertia is high, or if accelerating or decelerating suddenly to rotate away from the load side, the inverter induces an overvoltage trip (0U) with regenerative energy from the load. Furthermore, if braking resistor overheating (dbH) occurs in models with built-in braking resistor, it means that the built-in braking resistor capacity is insufficient. In such cases, connect an external braking resistor.

[1] Selection procedure

Use within the specification values for the braking resistors indicated in the table in “11.4.3 Specifications” in accordance with “(4) Heat energy calculation of braking resistor” in Chapter 10 “10.2 Selection Procedure”.

[2] Notes on selection

The braking time T1, cyclic period T0, and duty cycle %ED are converted under deceleration braking conditions based on the rated torque as shown in Fig. 11.4-1. However, it is not necessary to consider these values in the selection of braking resistor capacity.

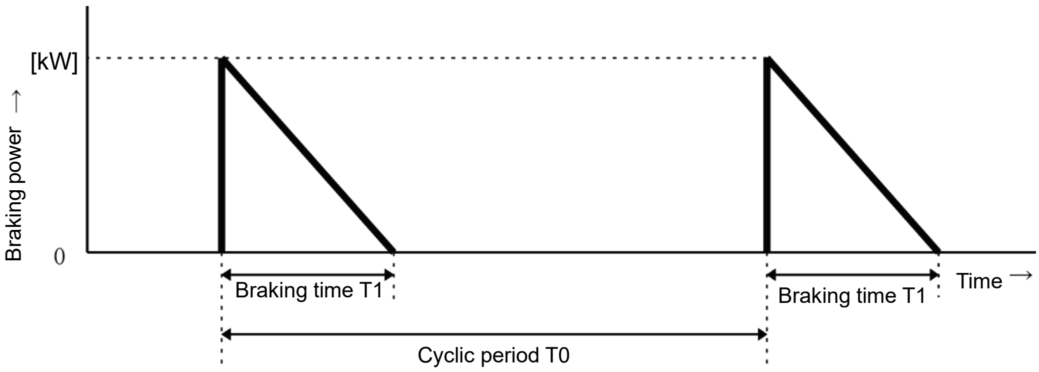


Fig. 11.4-1 Duty cycle

$$\text{Duty cycle (\% ED)} = \frac{T1}{T0} \times 100\ (\%)$$

11.4.2 Braking resistors (DBRs)

A braking resistor converts regenerative energy generated from the deceleration of the motor to heat. Use of a braking resistor results in improved deceleration performance of the inverter.

[1] Standard type

The standard type is equipped with a function for outputting temperature detection signals. To detect temperature detection signals with FRENIC-Ace, assign external alarm “THR” to terminal [X1] to [X5], and connect to braking resistor terminal 2 and terminal 1. Upon detection of the warning signal (preset detection level: 150°C (302°F)), the inverter displays alarm OH2 on the LED monitor and stops the alarm.

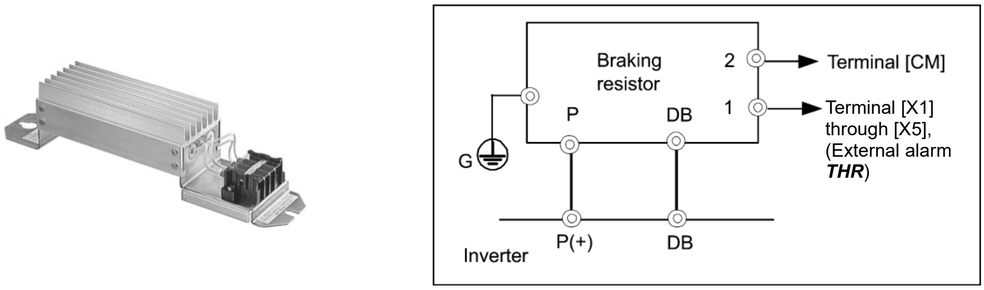


Figure 11.4-2 Braking resistor (standard type) and connection example

[2] 10% ED type

The 10% ED type is not equipped with a function for outputting temperature detection signals, and therefore it is necessary to specify electronic thermal overload relay function (function code F50, F51, F52) settings for braking resistor protection.

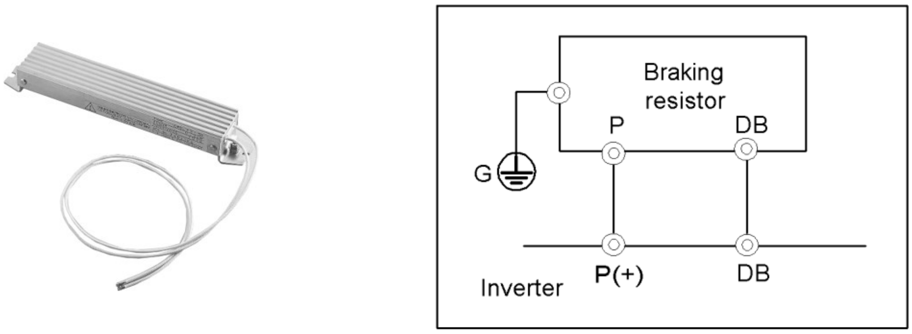


Figure 11.4-3 Braking resistor (10% ED type) and connection example

📖 For the specifications and external dimensions of the braking resistor, refer to “11.4.3 Specifications” and “11.4.4 External dimensions.”

11.4.3 Specifications

Table 11.4-1 Braking resistor (standard type)

ND mode (kW/HP rating motor)

Power supply voltage	Standard applicable motor		Inverter type	Selecting Options			Maximum braking torque			Continuous braking (100% braking torque)		Repetitive braking (each cycle is 100 s or less)	
				Braking resistor				50Hz	60Hz	Discharging capability	Braking time	Average allowable loss	Duty cycle
	(kW)	(HP)		Model	Q'ty	Resistance (Ω)		(N·m)	(N·m)	(kWs)	(s)	(kW)	(%ED)
Three-phase 400V	0.75	1	FRN0002E3☐-4G	DB0.75-4	1	200	75	3.79	3.13	9	24	0.044	12
	1.5	2	FRN0004E3☐-4G					7.50	6.20	17	22	0.068	9
	2.2	3	FRN0006E3☐-4G	DB2.2-4	1	160		11.0	9.10	34	30	0.075	6
	3.0	4	FRN0007E3☐-4G					15.0	12.4	33	22	0.077	5
	5.5	7.5	FRN0012E3☐-4G	DB3.7-4	1	130		27.2	22.5	37	13	0.093	3
	11	15	FRN0022E3☐-4G	DB5.5-4	1	80		54.0	44.8	55	10	0.138	2.5
	15	20	FRN0029E3☐-4G	DB7.5-4	1	60		73.5	61.0	38	5	0.188	2.5
	18.5	25	FRN0037E3☐-4G	DB11-4	1	40		91.0	75.5	55	5	0.275	3
	22	30	FRN0044E3☐-4G	DB15-4	1	34.4		108	89.5	75	6	0.375	3
	30	40	FRN0059E3☐-4G	DB18.5-4	1	27		146	121	93	6	0.463	3
	37	50	FRN0072E3☐-4G	DB22-4	1	22		180	150	88	4.7	0.55	3

Note: A box (☐) in the above table replaces S (Basic type) or N (Ethernet built-in type) or E (EMC filter built-in type) depending on the enclosure.

Table 11.4-2 Braking resistor (standard type)

HD mode (kW/HP rating motor)

Power supply voltage	Standard applicable motor		Inverter type	Selecting Options			Maximum braking torque			Continuous braking (100% braking torque)		Repetitive braking (each cycle is 100 s or less)	
				Braking resistor				50Hz	60Hz	Discharging capability	Braking time	Average allowable loss	Duty cycle
	(kW)	(HP)		Model	Q'ty	Resistance (Ω)		(N·m)	(N·m)	(kWs)	(s)	(kW)	(%ED)
Three-phase 400V	0.75	1	FRN0002E3☐-4G	DB0.75-4	1	200	100	5.05	4.17	9	24	0.044	12
	1.1	1.5	FRN0004E3☐-4G					7.33	6.06	17	30	0.068	12
	2.2	3	FRN0006E3☐-4G	DB2.2-4	1	160		14.7	12.1	34	30	0.075	7
	3.0	4	FRN0007E3☐-4G					20.1	16.5	33	22	0.077	5
	5.5	7.5	FRN0012E3☐-4G	DB3.7-4	1	130		36.2	30.0	37	13	0.093	3.5
	7.5	10	FRN0022E3☐-4G	DB5.5-4	1	80		49.6	41.0	55	15	0.138	3.5
	11	15	FRN0029E3☐-4G	DB7.5-4	1	60		72.0	59.7	38	7	0.188	3.5
	15	20	FRN0037E3☐-4G	DB11-4	1	40		98.1	81.4	55	7	0.275	3.5
	18.5	25	FRN0044E3☐-4G	DB15-4	1	34.4		121	100	75	8	0.375	4
	22	30	FRN0059E3☐-4G	DB18.5-4	1	27		144	119	93	8	0.463	4
	30	40	FRN0072E3☐-4G	DB22-4	1	22		195	162	88	6	0.55	3.5

Note: A box (☐) in the above table replaces S (Basic type) or N (Ethernet built-in type) or E (EMC filter built-in type) depending on the enclosure.

Table 11.4-3 Braking resistor (standard type)

HND mode (kW/HP rating motor)

Power supply voltage	Standard applicable motor		Inverter type	Selecting Options			Maximum braking torque			Continuous braking (100% braking torque)		Repetitive braking (each cycle is 100 s or less)	
				Braking resistor				50Hz	60Hz	Discharging capability	Braking time	Average allowable loss	Duty cycle
	(kW)	(HP)		Model	Q'ty	Resistance (Ω)		(N·m)	(N·m)	(kWs)	(s)	(kW)	(%ED)
Three-phase 200V	0.2	1/4	FRN0001E3△-2G	DB0.75-2	1	100	100	1.34	1.11	9	90	0.037	37
	0.4	1/2	FRN0002E3△-2G					2.68	2.21	9	45	0.037	18
	0.75	1	FRN0004E3△-2G					5.04	4.18	9	24	0.044	12
	1.1	1.5	FRN0006E3△-2G					7.33	6.06	17	30	0.068	12
	2.2	3	FRN0010E3△-2G	DB2.2-2	1	40		14.7	12.1	34	30	0.075	7
	3.0	4	FRN0012E3△-2G					20	16.5	33	20	0.077	5
	5.5	7.5	FRN0020E3△-2G	DB3.7-2	1	33		36.2	30.0	37	13	0.093	3.5
	7.5	10	FRN0030E3△-2G	DB5.5-2	1	20		49.1	41.0	55	15	0.138	3.5
	11	15	FRN0040E3△-2G	DB7.5-2	1	15		72.0	59.7	37	7	0.188	3.5
	15	20	FRN0056E3△-2G	DB11-2	1	10		98.1	81.4	55	7	0.275	3.5
	18.5	25	FRN0069E3△-2G	DB15-2	1	8.6		121	100	75	8	0.375	4
	22	30	FRN0088E3△-2G	DB18.5-2	1	6.8		144	119	92	8	0.463	4
	30	40	FRN0115E3△-2G	DB22-2	1	5.8		216	179	88	6	0.55	3.5
Three-phase 400V	0.75	1	FRN0002E3□-4G	DB0.75-4	1	200	100	5.04	4.18	9	24	0.044	12
	1.1	1.5	FRN0004E3□-4G					7.33	6.06	17	30	0.068	12
	2.2	3	FRN0006E3□-4G	DB2.2-4	1	160		14.7	12.1	34	30	0.075	7
	3.0	4	FRN0007E3□-4G					20	16.5	33	20	0.077	5
	5.5	7.5	FRN0012E3□-4G	DB3.7-4	1	130		36.2	30.0	37	13	0.093	3.5
	7.5	10	FRN0022E3□-4G	DB5.5-4	1	80		49.1	41.0	55	15	0.138	3.5
	11	15	FRN0029E3□-4G	DB7.5-4	1	60		72.0	59.7	38	7	0.188	3.5
	15	20	FRN0037E3□-4G	DB11-4	1	40		98.1	81.4	55	7	0.275	3.5
	18.5	25	FRN0044E3□-4G	DB15-4	1	34.4		121	100	75	8	0.375	4
	22	30	FRN0059E3□-4G	DB18.5-4	1	27		144	119	93	8	0.463	4
	30	40	FRN0072E3□-4G	DB22-4	1	22		195	162	88	6	0.55	3.5
Single-phase 200V	0.2	1/4	FRN0001E3△-7G	DB0.75-2	1	100	100	1.34	1.11	9	90	0.037	37
	0.4	1/2	FRN0002E3△-7G					2.68	2.21	9	45	0.037	18
	0.55	3/4	FRN0004E3△-7G					3.69	3.04	9	32	0.041	15
	1.1	2	FRN0006E3△-7G					7.35	6.07	17	30	0.068	12
	2.2	3	FRN0010E3△-7G	DB2.2-2	1	40		14.7	12.1	34	30	0.075	7
	3.0	4	FRN0012E3△-7G					20.1	16.5	33	22	0.077	5

Note: A box (□) in the above table replaces S (Basic type) or N (Ethernet built-in type) or E (EMC filter built-in type) depending on the enclosure.

A triangle (△) in the above table replaces S (Basic type) or N (Ethernet built-in type) depending on the enclosure.

Table 11.4-4 Braking resistor (standard type)

HHD mode (kW/HP rating motor)

Power supply voltage	Standard applicable motor		Inverter type	Selecting Options			Maximum braking torque			Continuous braking (100% braking torque)		Repetitive braking (each cycle is 100 s or less)	
				Braking resistor				50Hz	60Hz	Discharging capability	Braking time	Average allowable loss	Duty cycle
	(kW)	(HP)		Model	Q'ty	Resistance (Ω)		(N·m)	(N·m)	(kWs)	(s)	(kW)	(%ED)
Three-phase 200V	0.1	1/8	FRN0001E3△-2G	DB0.75-2	1	100	150	1.01	0.83	9	90	0.037	37
	0.2	1/4	FRN0002E3△-2G					2.01	1.66	9	90	0.037	37
	0.4	1/2	FRN0004E3△-2G					4.02	3.32	9	45	0.044	22
	0.75	1	FRN0006E3△-2G					7.57	6.25	17	45	0.068	18
	1.5	2	FRN0010E3△-2G	DB2.2-2	1	40		15.0	12.4	34	45	0.075	10
	2.2	3	FRN0012E3△-2G					22.0	18.2	33	30	0.077	7
	3.7	5	FRN0020E3△-2G	DB3.7-2	1	33		37.1	30.5	37	20	0.093	5
	5.5	7.5	FRN0030E3△-2G	DB5.5-2	1	20		54.3	45.0	55	20	0.138	5
	7.5	10	FRN0040E3△-2G	DB7.5-2	1	15		73.6	61.6	38	10	0.188	5
	11	15	FRN0056E3△-2G	DB11-2	1	10		108	89.5	55	10	0.275	5
	15	20	FRN0069E3△-2G	DB15-2	1	8.6		147	122	75	10	0.375	5
	18.5	25	FRN0088E3△-2G	DB18.5-2	1	6.8		182	151	92	10	0.463	5
	22	30	FRN0115E3△-2G	DB22-2	1	5.8		216	179	88	8	0.55	5
Three-phase 400V	0.4	1/2	FRN0002E3□-4G	DB0.75-4	1	200	150	4.02	3.32	9	45	0.044	22
	0.75	1	FRN0004E3□-4G					7.57	6.25	17	45	0.068	18
	1.5	2	FRN0006E3□-4G	DB2.2-4	1	160		15.0	12.4	34	45	0.075	10
	2.2	3	FRN0007E3□-4G					22.0	18.2	33	30	0.077	7
	3.7	5	FRN0012E3□-4G	DB3.7-4	1	130		37.1	30.5	37	20	0.093	5
	5.5	7.5	FRN0022E3□-4G	DB5.5-4	1	80		54.3	45.0	55	20	0.138	5
	7.5	10	FRN0029E3□-4G	DB7.5-4	1	60		73.6	61.6	38	10	0.188	5
	11	15	FRN0037E3□-4G	DB11-4	1	40		108	89.5	55	10	0.275	5
	15	20	FRN0044E3□-4G	DB15-4	1	34.4		147	122	75	10	0.375	5
	18.5	25	FRN0059E3□-4G	DB18.5-4	1	27		182	151	93	10	0.463	5
	22	30	FRN0072E3□-4G	DB22-4	1	22		216	179	88	8	0.55	5
Single-phase 200V	0.1	1/8	FRN0001E3△-7G	DB0.75-2	1	100	150	1.01	0.83	9	90	0.037	37
	0.2	1/4	FRN0002E3△-7G					2.01	1.66	9	90	0.037	37
	0.4	1/2	FRN0004E3△-7G					4.02	3.32	9	45	0.044	22
	0.75	1	FRN0006E3△-7G					7.57	6.25	17	45	0.068	18
	1.5	2	FRN0010E3△-7G	DB2.2-2	1	40		15.0	12.4	34	45	0.075	10
	2.2	3	FRN0012E3△-7G					22.0	18.2	33	30	0.077	7

Note: A box (□) in the above table replaces S (Basic type) or N (Ethernet built-in type) or E (EMC filter built-in type) depending on the enclosure.

A triangle (△) in the above table replaces S (Basic type) or N (Ethernet built-in type) depending on the enclosure.

Table 11.4-5 Braking resistors (10% ED type)

ND mode (kW/HP rating motor)

Power supply voltage	Standard applicable motor		Inverter type	Selecting Options			Maximum braking torque			Continuous braking (100% braking torque)		Repetitive braking (each cycle is 100 s or less)	
				Braking resistor				50Hz	60Hz	Discharging capability	Braking time	Average allowable loss	Duty cycle
	(kW)	(HP)		Model	Q'ty	Resistance (Ω)		(N·m)	(N·m)	(kWs)	(s)	(kW)	(%ED)
Three-phase 400V	0.75	1	FRN0002E3□-4G	DB0.75-4C	1	200	75	3.79	3.13	50	133	0.075	20
Three-phase 400V	1.5	2	FRN0004E3□-4G	DB0.75-4C	1	200	75	7.50	6.20	50	66	0.075	10
Three-phase 400V	2.2	3	FRN0006E3□-4G	DB2.2-4C	1	160	75	11.0	9.10	55	50	0.11	10
Three-phase 400V	3.0	4	FRN0007E3□-4G	DB2.2-4C	1	160	75	15.0	12.4	55	36	0.11	7
Three-phase 400V	5.5	7.5	FRN0012E3□-4G	DB3.7-4	1	130	75	27.2	22.5	140	50	0.185	7
Three-phase 400V	11	15	FRN0022E3□-4G	DB5.5-4C	1	80	75	54.0	44.8	55	15	0.275	10
Three-phase 400V	15	20	FRN0029E3□-4G	DB7.5-4C	1	60	75	73.5	61.0	37	7	0.375	10
Three-phase 400V	18.5	25	FRN0037E3□-4G	DB11-4C	1	40	75	90.8	75.5	55	7	0.55	10
Three-phase 400V	22	30	FRN0044E3□-4G	DB15-4C	1	34.4	75	108	89.5	75	7	0.75	7
Three-phase 400V	30	40	FRN0059E3□-4G	DB22-4C	1	22	75	146	121	93	6	0.925	6
Three-phase 400V	37	50	FRN0072E3□-4G	DB22-4C	1	22	75	180	150	110	6	1.1	6

HD mode (kW/HP rating motor)

Power supply voltage	Standard applicable motor		Inverter type	Selecting Options			Maximum braking torque			Continuous braking (100% braking torque)		Repetitive braking (each cycle is 100 s or less)	
				Braking resistor				50Hz	60Hz	Discharging capability	Braking time	Average allowable loss	Duty cycle
	(kW)	(HP)		Model	Q'ty	Resistance (Ω)		(N·m)	(N·m)	(kWs)	(s)	(kW)	(%ED)
Three-phase 400V	0.75	1	FRN0002E3□-4G	DB0.75-4C	1	200	100	5.05	4.17	50	133	0.075	20
Three-phase 400V	1.1	1.5	FRN0004E3□-4G	DB0.75-4C	1	200	100	7.33	6.06	50	90	0.075	13
Three-phase 400V	2.2	3	FRN0006E3□-4G	DB2.2-4C	1	160	100	14.7	12.1	55	50	0.11	10
Three-phase 400V	3.0	4	FRN0007E3□-4G	DB2.2-4C	1	160	100	20.1	16.5	55	36	0.11	7
Three-phase 400V	5.5	7.5	FRN0012E3□-4G	DB3.7-4C	1	130	100	36.2	30.0	140	50	0.185	7
Three-phase 400V	7.5	10	FRN0022E3□-4G	DB5.5-4C	1	80	100	49.6	41.0	55	15	0.275	10
Three-phase 400V	11	15	FRN0029E3□-4G	DB7.5-4C	1	60	100	72.0	59.7	37	7	0.375	10
Three-phase 400V	15	20	FRN0037E3□-4G	DB11-4C	1	40	100	98.1	81.4	55	7	0.55	10
Three-phase 400V	18.5	25	FRN0044E3□-4G	DB15-4C	1	34.4	100	121	100	75	7	0.75	7
Three-phase 400V	22	30	FRN0059E3□-4G	DB22-4C	1	22	100	144	119	93	7	0.925	7
Three-phase 400V	30	40	FRN0072E3□-4G	DB22-4C	1	22	100	195	162	110	7	1.1	7

Note: A box (□) in the above table replaces S (Basic type) or N (Ethernet built-in type) or E (EMC filter built-in type) depending on the enclosure.

Note The 10% ED type is not equipped with a function for outputting temperature detection signals, and therefore it is necessary to specify electronic thermal overload relay function (function code F50, F51, F52) settings for braking resistor protection.

HND mode (kW/HP rating motor)

Power supply voltage	Standard applicable motor		Inverter type	Selecting Options			Maximum braking torque			Continuous braking (100% braking torque)		Repetitive braking (each cycle is 100 s or less)	
				Braking resistor				50Hz	60Hz	Discharging capability	Braking time	Average allowable loss	Duty cycle
	(kW)	(HP)		Model	Q'ty	Resistance (Ω)		(N·m)	(N·m)	(kWs)	(s)	(kW)	(%ED)
Three-phase 200V	0.2	1/4	FRN0001E3△-2G	DB0.75-2C	1	100	100	1.34	1.11	50	500	0.075	75
	0.4	1/2	FRN0002E3△-2G					2.68	2.21	50	250	0.075	37
	0.75	1	FRN0004E3△-2G					5.04	4.16	50	133	0.075	20
	1.1	1.5	FRN0006E3△-2G					7.33	6.06	50	90	0.075	14
	2.2	3	FRN0010E3△-2G	DB2.2-2C	1	40		14.7	12.1	55	50	0.11	10
	3.0	4	FRN0012E3△-2G					20	16.5	55	33	0.11	10
	5.5	7.5	FRN0020E3△-2G	DB3.7-2C	1	33		36.2	30.0	140	50	0.185	10
	7.5	10	FRN0030E3△-2G	DB5.5-2C	1	20		49.6	41.0	55	10	0.275	10
	11	15	FRN0040E3△-2G	DB7.5-2C	1	15		72.0	59.7	37	5	0.375	10
	15	20	FRN0056E3△-2G	DB11-2C	1	10		98.1	81.4	55	5	0.55	10
	18.5	25	FRN0069E3△-2G	DB15-2C	1	8.6		121	100	75	5	0.75	7
	22	30	FRN0088E3△-2G	DB22-2C	1	5.8		144	119	92	5	0.925	7
	30	40	FRN0115E3△-2G					195	162	110	5	1.1	7
Three-phase 400V	0.75	1	FRN0002E3□-4G	DB0.75-4C	1	200	100	5.04	4.16	50	133	0.075	20
	1.1	1.5	FRN0004E3□-4G					7.33	6.06	50	90	0.075	13
	2.2	3	FRN0006E3□-4G	DB2.2-4C	1	160		14.7	12.1	55	50	0.11	10
	3.0	4	FRN0007E3□-4G					20	16.5	55	36	0.11	7
	5.5	7.5	FRN0012E3□-4G	DB3.7-4C	1	130		36.2	30.0	140	50	0.185	7
	7.5	10	FRN0022E3□-4G	DB5.5-4C	1	80		49.6	41.0	55	10	0.275	10
	11	15	FRN0029E3□-4G	DB7.5-4C	1	60		72.0	59.7	37	5	0.375	10
	15	20	FRN0037E3□-4G	DB11-4C	1	40		98.1	81.4	55	5	0.55	10
	18.5	25	FRN0044E3□-4G	DB15-4C	1	34.4		121	100	75	5	0.75	7
	22	30	FRN0059E3□-4G	DB22-4C	1	22		144	119	92	5	0.925	7
	30	40	FRN0072E3□-4G					195	162	110	5	1.1	7
Single-phase 200V	0.2	1/4	FRN0001E3△-7G	DB0.75-2C	1	100	100	1.34	1.11	50	500	0.075	75
	0.4	1/2	FRN0002E3△-7G					2.68	2.21	50	250	0.075	37
	0.55	3/4	FRN0004E3△-7G					3.69	3.04	50	181	0.075	27
	1.5	2	FRN0006E3△-7G					7.35	6.07	50	90	0.075	14
	2.2	3	FRN0010E3△-7G	DB2.2-2C	1	40		14.7	12.1	55	50	0.11	10
	3.7	5	FRN0012E3△-7G					20.1	16.5	55	36	0.11	7

Note: A box (□) in the above table replaces S (Basic type) or N (Ethernet built-in type) or E (EMC filter built-in type) depending on the enclosure.

A triangle (△) in the above table replaces S (Basic type) or N (Ethernet built-in type) depending on the enclosure.

Note: The 10% ED type is not equipped with a function for outputting temperature detection signals, and therefore it is necessary to specify electronic thermal overload relay function (function code F50, F51, F52) settings for braking resistor protection.

Table 11.4-6 Braking resistors (10% ED type) (cont'd)

HHD mode (kW/HP rating motor)

Power supply voltage	Standard applicable motor (kW)		Inverter type	Selecting Options			Maximum braking torque			Continuous braking (100% braking torque)		Repetitive braking (each cycle is 100 s or less)	
				Braking resistor				50Hz	60Hz	Discharging capability	Braking time	Average allowable loss	Duty cycle
	(kW)	(HP)		Model	Q'ty	Resistance (Ω)		(N·m)	(N·m)	(kWs)	(s)	(kW)	(%ED)
Three-phase 200V	0.1	1/8	FRN0001E3△-2G	DB0.75-2C	1	100	150	1.01	0.83	50	1000	0.075	100
	0.2	1/4	FRN0002E3△-2G					2.01	1.66	50	500	0.075	75
	0.4	1/2	FRN0004E3△-2G					4.02	3.32	50	250	0.075	37
	0.75	1	FRN0006E3△-2G					7.57	6.25	50	133	0.075	20
	1.5	2	FRN0010E3△-2G	DB2.2-2C	1	40		15.0	12.4	55	73	0.110	14
	2.2	3	FRN0012E3△-2G					22.0	18.2	55	50	0.110	10
	3.7	5	FRN0020E3△-2G	DB3.7-2C	1	33		37.1	30.5	140	75	0.185	10
	5.5	7.5	FRN0030E3△-2G	DB5.5-2C	1	20		54.3	45.0	55	20	0.275	10
	7.5	10	FRN0040E3△-2G	DB7.5-2C	1	15		73.6	61.6	37	10	0.375	10
	11	15	FRN0056E3△-2G	DB11-2C	1	10		108	89.5	55	10	0.55	10
	15	20	FRN0069E3△-2G	DB15-2C	1	8.6		147	122	75	10	0.75	10
	18.5	25	FRN0088E3△-2G	DB22-2C	1	5.8		182	151	92	10	0.925	10
	22	30	FRN0115E3△-2G					216	179	110	10	1.1	10
Three-phase 400V	0.4	1/2	FRN0002E3□-4G	DB0.75-4C	1	200	150	4.02	3.32	50	250	0.075	37
	0.75	1	FRN0004E3□-4G					7.57	6.25	50	133	0.075	20
	1.5	2	FRN0006E3□-4G	DB2.2-4C	1	160		15.0	12.4	55	73	0.110	14
	2.2	3	FRN0007E3□-4G					22.0	18.2	55	50	0.110	10
	3.7	5	FRN0012E3□-4G	DB3.7-4C	1	130		37.1	30.5	140	75	0.185	10
	5.5	7.5	FRN0022E3□-4G	DB5.5-4C	1	80		54.3	45.0	55	20	0.275	10
	7.5	10	FRN0029E3□-4G	DB7.5-4C	1	60		73.6	61.6	37	10	0.375	10
	11	15	FRN0037E3□-4G	DB11-4C	1	40		108	89.5	55	10	0.55	10
	15	20	FRN0044E3□-4G	DB15-4C	1	34.4		147	122	75	10	0.75	10
	18.5	25	FRN0059E3□-4G	DB22-4C	1	22		182	151	92	10	0.925	10
	22	30	FRN0072E3□-4G					216	179	110	10	1.1	10
Single-phase 200V	0.1	1/8	FRN0001E3□-7G	DB0.75-2C	1	100	150	1.01	0.83	50	1000	0.075	100
	0.2	1/4	FRN0002E3□-7G					2.01	1.66	50	500	0.075	75
	0.4	1/2	FRN0003E3G-7G FRN0004E3△-7G					4.02	3.32	50	250	0.075	37
	0.75	1	FRN0005E3G-7G FRN0006E3△-7G					7.57	6.25	50	133	0.075	20
	1.5	2	FRN0008E3G-7G FRN0010E3△-7G	DB2.2-2C	1	40		15.0	12.4	55	73	0.110	14
	2.2	3	FRN0011E3G-7G FRN0012E3△-7G					22.0	18.2	55	50	0.110	10

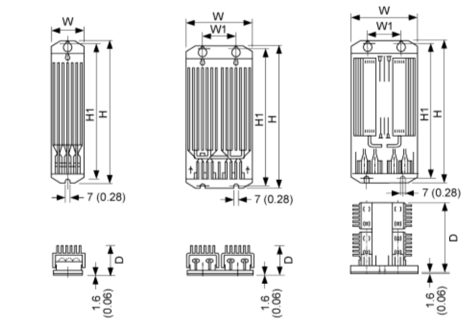
Note: A box (□) in the above table replaces S (Basic type) or N (Ethernet built-in type) or E (EMC filter built-in type) depending on the enclosure.

A triangle (△) in the above table replaces S (Basic type) or N (Ethernet built-in type) depending on the enclosure.

Note The 10% ED type is not equipped with a function for outputting temperature detection signals, and therefore it is necessary to specify electronic thermal overload relay function (function code F50, F51, F52) settings for braking resistor protection.

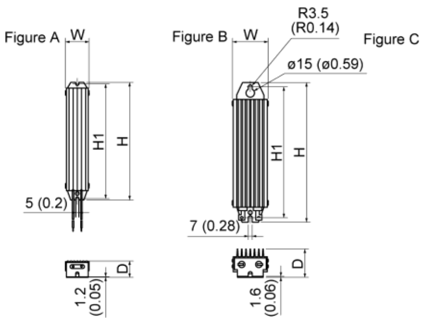
11.4.4 External dimensions

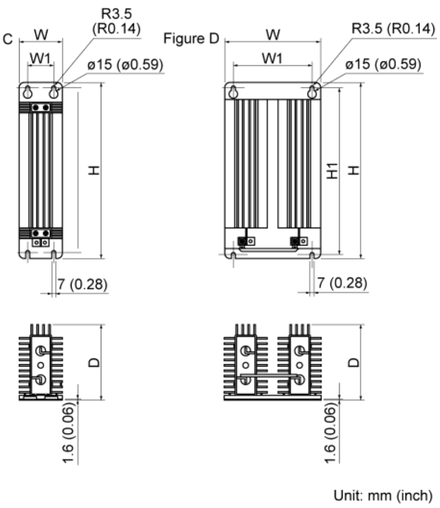
Braking resistors, standard type



Power supply voltage	Type	Figure	Dimensions mm(inch) W	W1	H	H1	D	Mass kg (lb)
200 V series	DB0.75-2	A	68 (2.7)		310 (12.2)	295 (11.6)	67 (2.6)	1.3 (2.9)
	DB2.2-2	A	80 (3.2)	-	345 (13.6)	332 (13.1)	94 (3.7)	2.0 (4.4)
	DB3.7-2	A	80 (3.2)		345 (13.6)	332 (13.1)	94 (3.7)	2.0 (4.4)
	DB5.5-2	B	146 (5.7)	90 (3.5)	450 (17.7)	430 (16.9)	67.5(2.7)	4.5 (9.9)
	DB7.5-2	B	160 (6.3)	90 (3.5)	390 (17.7)	370 (14.6)	90 (3.5)	5.0 (11)
	DB11-2	C	142 (5.6)	74 (2.9)	430 (16.9)	415 (16.3)	160 (6.3)	6.9 (15)
	DB15-2	C	142 (5.6)	74 (2.9)	430 (16.9)	415 (16.3)	160 (6.3)	6.9 (15)
	DB18.5-2	C	142 (5.6)	74 (2.9)	510 (20.1)	495 (19.5)	160 (6.3)	8.7 (19)
	DB22-2	C	142 (5.6)	74 (2.9)	510 (20.1)	495 (19.5)	160 (6.3)	8.7 (19)
400 V series	DB0.75-4		68 (2.7)		310 (12.2)	295 (11.6)	67 (2.6)	1.3 (2.9)
	DB2.2-4	A	68 (2.7)	-	470 (18.5)	455 (17.9)	67 (2.6)	2.0 (4.4)
	DB3.7-4		68 (2.7)		470 (18.5)	455 (17.9)	67 (2.6)	1.7 (3.7)
	DB5.5-4	B	146 (5.7)	74 (2.9)	470 (18.5)	455 (17.9)	67 (2.6)	4.5 (9.9)
	DB7.5-4		146 (5.7)	74 (2.9)	430 (16.9)	495 (19.5)	67 (2.6)	5.0 (11)
	DB11-4	C	142 (5.6)	74 (2.9)	430 (16.9)	415 (16.3)	160 (6.3)	6.9 (15)
	DB15-4	C	142 (5.6)	74 (2.9)	430 (16.9)	415 (16.3)	160 (6.3)	6.9 (15)
	DB18.5-4	C	142 (5.6)	74 (2.9)	430 (16.9)	495 (19.5)	160 (6.3)	8.7 (19)
	DB22-4	C	142 (5.6)	74 (2.9)	430 (16.9)	495 (19.5)	160 (6.3)	8.7 (19)

Braking resistors, 10% ED type





Type	Figure	Dimensions mm (inch) W	W1	H	H1	D	Mass kg (lb)
DB0.75-2C/4C	A	43 (1.7)	–	221 (8.7)	215 (8.5)	30.5 (1.2)	0.4 (0.9)
DB2.2-2C/4C	B	67 (2.6)	–	188 (7.4)	172 (6.8)	55 (2.2)	0.8 (1.8)
DB3.7-2C/4C	B	67 (2.6)	–	328 (12.9)	312 (12.3)	55 (2.2)	1.4 (3.1)
DB5.5-2C/4C	B	80 (3.2)	–	378 (14.9)	362 (14.3)	78 (3.1)	2.6 (5.7)
DB7.5-2C/4C	B	80 (3.2)	–	418 (16.5)	402 (15.8)	78 (3.1)	2.8 (6.2)
DB11-2C/4C	C	80 (3.2)	50 (2.0)	460 (18.1)	440 (17.3)	140 (5.5)	4.3 (9.5)
DB15-2C/4C	C	80 (3.2)	50 (2.0)	580 (22.8)	560 (22.1)	140 (5.5)	5.6 (12)
DB22-2C/4C	D	180 (7.1)	144 (5.7)	400 (15.8)	383 (15.1)	145 (5.7)	8.4 (19)

11.5 High Power Factor Power Supply Regeneration PWM Converters (RHC Series)

11.5.1 Overview

■ Compliance with harmonic suppression guidelines

Since the power supply side current is converted into a sine wave with PWM control combined with an inverter, thereby significantly reducing harmonic current, the conversion factor Ki in the "Guideline for Suppressing Harmonics by Customers Receiving High Voltage or Special High Voltage" issued by the Agency for Natural Resources and Energy in the Ministry of Economy, Trade and Industry can be treated as "0" (in other words, zero harmonics are produced).

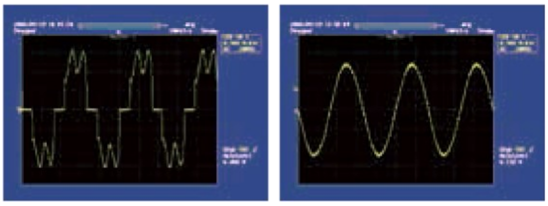
FRENIC-eRHC FRENIC-RHC

■ Reduction of power supply equipment capacity

Current is supplied with the same phase as the power supply phase voltage with power factor control, allowing operation to be performed with a power factor of approximately 1.
Consequently, the power supply transformer capacity and devices can be reduced in size compared to standard type inverters.

Input current waveform comparison

(Without PWM converter) (With PWM converter)

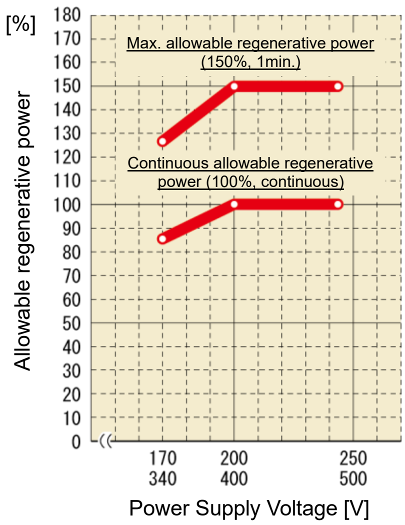


■ Significantly improved braking ability

Regenerative energy when performing high-frequency acceleration and deceleration operations, or when running equipment such as elevators, is all generated on the power supply side. This delivers energy-saving benefits when energy is regenerated.
Furthermore, the current waveform when energy is regenerated becomes a sine wave, eliminating any concerns of trouble with the power supply system.

Continuous regeneration rating	100%
1 minute regeneration rating	150% MD (CT) mode
	120% LD (VT) mode

Permissible characteristics



■ Extensive protection and maintenance functions

(1) Past alarms can be searched using the segment LED. This allows the cause of alarms to easily analyzed, and countermeasures to be easily employed.

(2) Gate turn-off is performed when a momentary power failure occurs, allowing operation to be resumed quickly once power is restored.

(3) Users can be warned of converter trips beforehand with early warning signals when overloads or fin overheating occurs, or when the high power factor power supply regeneration PWM converter service life is reached.

■ Extensive network support

The FRENIC-RHC series can be connected to MICREX-SX and CC-Link master devices. (Option)

■ FRENIC-RHC, FRENIC-eRHC two-series lineup

The FRENIC-RHC series lineup comprises large-capacity models compatible with large-scale systems, (capacity range 200 V: 30kW to 90kW , 400 V: 45kW to 630kW) and the FRENIC-eRHC series lineup comprises more compact models than the conventional models.
Fuji Electric also offers a lineup of small-capacity models. (Capacity range 200 V: 5.5kW to 22kW , 400 V: 5.5kW to 75kW)

Note

If an old inverter (FRENIC5000VG7S, FRENIC5000G11S) is replaced by FRENIC-Ace, it might be necessary to make changes to the wiring. For details, refer to Appendix G "Inverter Replacement Precautions (When Using PWM Converter (RHC series))."

11.5.2 Specifications

[1] Standard specifications

MD (CT) mode (for medium overloads)

Three-phase 200 V input series (unit type)

Item		Specification					
Type: RHC□-2EJ		30	37	45	55	75	90
Applicable inverter capacity [kW]		30	37	45	55	75	90
Output	Continuous capacity [kW]	36	44	53	65	88	103
	Overload rating	Continuous rating of 150%-1 min					
	Voltage	320 to 355 VDC (varies based on input voltage) (*2)					
Input power supply	Main power supply Number of phases, voltage, frequency	Three-phase three-wire system, 200 to 220 V/50 Hz, 200 to 230 V/60 Hz (*1)					
	Control power auxiliary input Number of phases, voltage, frequency	Single-phase 200 to 230 V, 50/60 Hz					
	Fan power auxiliary input Number of phases, voltage, frequency	-	Single-phase 200 to 220 V/50 Hz, 200 to 230 V/60 Hz (*1)				
	Permissible fluctuations	Voltage: -15 to +10%, frequency: +5 to -5%, voltage interphase unbalance ratio: within 2% (*3)					
	Required power supply capacity [kVA] (*6)	38	47	57	70	93	111
Carrier frequency [kHz]		7.5 to 15 (*4)				5 to 10 (*5)	
Approximate weight [kg]		24	29	39	39	55	95
Protective construction		IP00 open type					

(Note 1) The specifications are as shown above for function code F03 = 0 (MD (CT)).

(*1) Customer orders for 220 to 230 V/50 Hz models are accepted.

(*2) When the power supply voltage is 200 V, the output voltage is approximately 320 VDC, 343 VDC when 220 V, and 355 VDC when 230 V.

(*3) Interphase unbalance ratio (%) = $\frac{\text{Max. voltage [V] - Min. voltage [V]}}{\text{Three-phase average voltage}} \times 67$

(*4) When equipped with OPC-RHCE-TBSI-2 and not equipped with a transformer, the carrier frequency automatically becomes 7.5 kHz.

(*5) When equipped with OPC-RHCE-TBSI-2 and not equipped with a transformer, the carrier frequency automatically becomes 5 kHz.

(*6) Be sure to connect to a power supply with the above required power supply capacity or higher.
(If the power supply capacity is insufficient, the converter or inverter may suffer damage due to waveform distortion on the power supply side.)
If a power supply boosted with a low-capacity transformer is used for the main circuit power supply, etc., particularly for performing a control panel sequence check, there is a possibility that problems may occur.
In cases such as this, open the converter “RUN-CM,” and perform a sequence check of other parts without running the converter.

Three-phase 400 V input series (unit type)

Item		Specification														
Type: RHC☐-4EJ		45	55	75	90	110	132	160	200	220	280	315	355	400	500	630
Applicable inverter capacity [kW]		45	55	75	90	110	132	160	200	220	280	315	355	400	500	630
Output	Continuous capacity [kVA]	53	65	88	103	126	150	182	227	247	314	353	400	448	560	705
	Overload rating	Continuous rating of 150%-1 min														
	Voltage	640 to 710 VDC (varies based on input voltage) (*2)														
Input power supply	Main power supply Number of phases, voltage, frequency	Three-phase three-wire system, 380 to 440 V/50 Hz, 380 to 460 V/60 Hz (*1)														
	Control power auxiliary input Number of phases, voltage, frequency	Single-phase 380 to 480 V, 50/60 Hz														
	Fan power auxiliary input Number of phases, voltage, frequency	-		Single-phase 380 to 440 V/50 Hz 380 to 480 V/60 Hz												
	Permissible fluctuations	Voltage: -15 to +10% (interphase unbalance ratio: within 2% (*3)), frequency: +5 to -5%														
	Required power supply capacity [kVA] (*7)	57	70	93	111	136	161	196	244	267	341	383	433	488	610	762
Carrier frequency [kHz]		7.5 to 15 (*4)		5 to 10 (*5)												3 to 6 (*6)
Approximate weight [kg]		30	32	38	58	60	85	87	116	119	215	215	290	290	485	485
Protective construction		IP00 open type														

(Note 1) The specifications are as shown above for function code F03 = 0 (MD (CT)).

(*1) The tap inside the converter must be switched when the power supply voltage is 380 to 398 V/50 Hz or 380 to 430 V/60 Hz.
The capacity must be reduced when the power supply voltage is less than 400 V.

(*2) When the power supply voltage is 400 V, the output voltage is approximately 640 VDC, 686 VDC when 440 V, and 710 VDC when 460 V.

(*3) Interphase unbalance ratio (%) = $\frac{\text{Max. voltage [V] - Min. voltage [V]}}{\text{Three-phase average voltage}} \times 67$

(*4) When equipped with OPC-RHCE-TBSI-4 and not equipped with a transformer, the carrier frequency automatically becomes 7.5 kHz.

(*5) When equipped with OPC-RHCE-TBSI-4 and not equipped with a transformer, the carrier frequency automatically becomes 5 kHz.

(*6) When equipped with OPC-RHCE-TBSI-4 and not equipped with a transformer, the carrier frequency automatically becomes 2.5 kHz.

(*7) Be sure to connect to a power supply with the above required power supply capacity or higher.
(If the power supply capacity is insufficient, the converter or inverter may suffer damage due to waveform distortion on the power supply side.)
If a power supply boosted with a low-capacity transformer is used for the main circuit power supply, etc., particularly for performing a control panel sequence check, there is a possibility that problems may occur.
In cases such as this, open the converter "RUN-CM," and perform a sequence check of other parts without running the converter.

LD (VT) mode (for low overload)

Three-phase 200 V input series (unit type)

Item		Specification					
Type: RHC☐-2EJ		30	37	45	55	75	90
Applicable inverter capacity [kW]		37	45	55	75	90	110
Output	Continuous capacity [kW]	44	53	65	88	103	126
Output	Overload rating	Continuous rating of 120%-1 min					
Output	Voltage	320 to 355 VDC (varies based on input voltage) (*2)					
Input power supply	Main power supply Number of phases, voltage, frequency	Three-phase three-wire system, 200 to 220 V/50 Hz, 200 to 230 V/60 Hz (*1)					
Input power supply	Auxiliary power input for control Phase, voltage and frequency	Single-phase 200 to 230 V, 50/60 Hz					
Input power supply	Fan power auxiliary input Number of phases, voltage, frequency	-	Single-phase 200 to 220 V/50 Hz, 200 to 230 V/60 Hz (*1)				
Input power supply	Permissible fluctuations	Voltage: -15 to +10%, frequency: +5 to -5%, voltage interphase unbalance ratio: within 2% (*3)					
Input power supply	Required power supply capacity [kVA] (*4)	47	57	70	93	111	136
Carrier frequency [kHz]		7.5 to 10				5 to 6	
Approximate weight [kg]		24	29	39	39	55	95
Protective construction		IP00 open type					

(Note 1) The specifications are as shown above for function code F03 = 1 (LD (VT)).

(*1) Customer orders for 220 to 230 V/50 Hz models are accepted.

(*2) When the power supply voltage is 200 V, the output voltage is approximately 320 VDC, 343 VDC when 220 V, and 355 VDC when 230 V.

(*3) Interphase unbalance ratio (%) = $\frac{\text{Max. voltage [V] - Min. voltage [V]}}{\text{Three-phase average voltage}} \times 67$

(*4) Be sure to connect to a power supply with the above required power supply capacity or higher.
(If the power supply capacity is insufficient, the converter or inverter may suffer damage due to waveform distortion on the power supply side.)
If a power supply boosted with a low-capacity transformer is used for the main circuit power supply, etc., particularly for performing a control panel sequence check, there is a possibility that problems may occur. In cases such as this, open the converter “RUN-CM,” and perform a sequence check of other parts without running the converter.

Three-phase 400 V input series (unit type)

Item		Specification												
Type: RHC☐-4EJ		45	55	75	90	110	132	160	200	220	280	315	355	400
Applicable inverter capacity [kW]		55	75	90	110	132	160	200	220	280	315	355	400	500
Output	Continuous capacity [kVA]	65	88	103	126	150	182	227	247	314	353	400	448	560
	Overload rating	Continuous rating of 120%-1 min												
	Voltage	640 to 710 VDC (varies based on input voltage) (*2)												
Input power supply	Main power supply Number of phases, voltage, frequency	Three-phase three-wire system, 380 to 440 V/50 Hz, 380 to 460 V/60 Hz (*1)												
	Control power auxiliary input Number of phases, voltage, frequency	Single-phase 380 to 480 V, 50/60 Hz												
	Fan power auxiliary input Number of phases, voltage, frequency	-		Single-phase 380 to 440 V/50 Hz 380 to 480 V/60 Hz										
	Permissible fluctuations	Voltage: +10% to -15 (interphase unbalance ratio: within 2% (*3)), frequency: +5 to -5%												
	Required power supply capacity [kVA] (*4)	70	93	111	136	161	196	244	267	341	383	433	488	610
Carrier frequency [kHz]		7.5 to 10		5 to 6										
Approximate weight [kg]		30	32	38	58	60	85	87	116	119	215	215	290	290
Protective construction		IP00 open type												

(Note 1) The specifications are as shown above for function code F03 = 1 (LD (VT)).

(*1) The tap inside the converter must be switched when the power supply voltage is 380 to 398 V/50 Hz or 380 to 430 V/60 Hz.
The capacity must be reduced when the power supply voltage is less than 400 V.

(*2) When the power supply voltage is 400 V, the output voltage is approximately 640 VDC, 686 VDC when 440 V, and 710 VDC when 460 V.

(*3) Interphase unbalance ratio (%) = $\frac{\text{Max. voltage [V] - Min. voltage [V]}}{\text{Three-phase average voltage}} \times 67$

(*4) Be sure to connect to a power supply with the above required power supply capacity or higher.
(If the power supply capacity is insufficient, the converter or inverter may suffer damage due to waveform distortion on the power supply side.)
If a power supply boosted with a low-capacity transformer is used for the main circuit power supply, etc., particularly for performing a control panel sequence check, there is a possibility that problems may occur. In cases such as this, open the converter “RUN-CM,” and perform a sequence check of other parts without running the converter.

[2] Common specifications

Item			Specifications Unit type
Control	Control method		AVR constant control with DC ACR minor
Control	Operation method		By turning the power ON following connection, rectification is performed, boosting operation is performed with a run signal (RUN-CM short circuit, or run command through communication), and the unit is ready for operation.
Control	Running status signal		Running, powering, regenerating, ready for operation, batch alarm, etc.
Control	MD (CT)/LD (VT) switching		MD (CT): Overload rating of 150% for 1 min, LD (VT): overload rating of 120% for 1 min selection
Control	Carrier frequency		2.5 to 15 Hz (for details, refer to individual specifications.)
Control	Input power factor		0.99 or higher (excl. with 100% load, or when equipped with OPC-RHCE-TBSI-☐) (*1)
Control	Input harmonic current		A conversion coefficient of Ki = 0 can be used in accordance with the harmonic suppression countermeasure guidelines issued by the Ministry of Economy, Trade and Industry.
Control	Restart after momentary power failure		When a momentary power failure occurs, the gate is shut off at the insufficient voltage level, and the converter resumes operation automatically following recovery.
Control	Power limiting control		Control is possible at the previously set limit value or less.
Display	Keypad	Alarm display (protective functions)	AC fuse blown, AC overvoltage, AC undervoltage, AC overcurrent, AC input current error, input phase loss, synchronous power supply frequency error, DC fuse blown (*2), DC overvoltage, DC undervoltage, charging circuit error, fin overheating, external fault, converter overheating, overload, memory error, keypad communication error, CPU error, network equipment error, operating procedure mistake, A/D converter error, optical network error, DC fan lock, hardware error, simulation failure
Display	Keypad	Alarm history	The latest and past alarm codes (up to the last 10 times), and the latest and past detailed alarm information (up to the last 3 times) are saved and displayed, and the date and time at which alarms occurred are saved and displayed with the calendar/clock display function (accuracy: ±27 sec/month (Ta = 25°C). Storage period: 5 years or longer (ambient temperature: 25°C) * Battery: Built into models of all capacities as standard)
Display	Keypad	Monitor	Displays input power, input RMS current value, input RMS voltage value, intermediate DC current, and power supply frequency (alarm code).
Display	Keypad	Load factor	The load factor can be measured from the keypad.
Display	Keypad	Display language	Function codes can be set and referenced in Japanese, English, Chinese, and Korean (4 languages).
Display	Loader (*3)	Historical trace	Sampling data stored in the converter is read and displayed in a graph. Sampling time: 62.5 us to 1 s
Display	Loader (*3)	Real-time trace	Data is read from the converter in real time and displayed in a graph. Sampling time: 1 ms to 1 s
Display	Loader (*3)	Traceback	Sampling data stored in the converter is read when an alarm occurs and displayed in a graph. Sampling time: 62.5 us to 1 s (However, for data other than current, the traceback function can be used with sampling time of 400 us or longer.) Sampling data is retained in the memory using battery power. Retention time: 5 years or longer (ambient temperature: 25 °C)
Display	Loader (*3)	Operation monitor	I/O monitoring, system monitoring, and alarm history monitoring, etc., can be performed.
Display	Loader (*3)	Function code settings	The function code setting status can be checked. Function code settings can be edited, transferred, compared, and initialized.
Display	Charge lamp		Lights up while power is being supplied to the converter unit. Lights up when there is control power.
Maintainabi	Common		• Recording and display of control power supply cumulative capacitor life and cooling fan cumulative run time • Recording and display of converter run time • Recording and display of maximum input current value for past hour, maximum power, and maximum converter internal temperature

Item		Specifications
		Unit type
Communication	RS-485	Function codes can be set and referenced by connecting a computer or programmable controller through RS-485 communication.
	USB	This is a USB connector (Mini-B specification) for connecting to a computer. Function codes can be edited, transferred, and verified, and all converter states can be monitored using the converter support loader.

*1: When the power supply voltage is 420 V (210 V) or higher, and the operating load is 50% or higher, the power factor for the power supply drops to approx. 0.95 (only during regenerative operation).

*2: The optional AC blown fuse detection card (OPC RHCE ACF) is necessary.

*3: The FRENIC-RHC Loader software can be downloaded from Fe Library, Fuji Electric’s dedicated material resource site.

11.5.3 Function Specifications

■ **Terminal functions (unit type)**

Classification	Terminal symbol	Terminal name	Specification
Main circuit	L1/R, L2/S, L3/T	Main power supply input	Connect to a three-phase power supply via a dedicated reactor.
	P(+), N(-)	Converter output	Connect to inverter power supply input terminals P(+) and N(-).
	E (G)	Grounding terminal	Grounding terminal for converter chassis (case)
	R0, T0	Control power auxiliary input	Connect to the control power supply backup terminal, same power supply system as the main circuit power supply.
	R1, T1	Fan power supply	This is the connection terminal for the fan power supply. Connected with R1-Ri and T1-Ti shorted when shipped. If using the fan power supply independently, consult your Fuji Electric representative.
Voltage detection	Ri, Si, Ti (unit type)	Synchronous power supply input for voltage detection	This is a detection terminal used for the control inside the converter, and is connected to the dedicated reactor and dedicated filter power supply side.
	R, T, R2, T2 *1 (when equipped with option card)	Input for control monitoring	This is a connection terminal for detecting blown AC fuses.
Input signal	RUN	Run command	Converter runs when ON between RUN and CM, and stops when OFF.
	RST	Alarm reset command	By eliminating the cause of the alarm when an alarm stoppage occurs, and turning ON between RST and CM, the protective function that was activated is canceled, and operation resumes.
	X1 to X3 (unit type)	Digital input	0: External alarm [THR], 1: Current limiting cancel [LMT_CCL], 2: 73 answerback [73ANS], 3: Current limiting switch [I-LIM], 4-13: Custom Di1-10 [C-DI1 to C-DI10], 14: Universal DI [U-DI], 15: AC fuse blown [ACF], 16: RHF overheating alarm [RHF-OH], 17: Parallel system cancel [MT-CCL] 18: Generator/commercial power supply switching [SW-GEN]
	CM	Digital input common	This is a common terminal for digital input signals.
	PLC	PLC signal power supply	Connect the power supply for PLC output signals. (Rated voltage: 24 V (22 to 27) DC)
Output signal	30A, 30B, 30C	Batch output alarm	A signal is output when the converter protective function activates and an alarm stoppage occurs. (Contact: 1C, when error occurs, across 30A-30C: ON) (Contact capacity: 250 VAC, 50 mA max.)
	Y1, Y2, Y3, Y11 to Y18	General-purpose transistor output	0: Running [RUN], 1: Ready for operation [RDY], 2: Power supply current limiting [IL], 3: Lifetime alarm [LIFE], 4: Cooling fin overheating warning [PRE-OH], 5: Overload warning [PRE-OL], 6: Power running [DRV], 7: Regenerating [REG], 8: Current limiting warning [CUR], 9: Restart after momentary power failure [U-RES], 10: Source frequency synchronization [SY-HZ], 11: Alarm information 1 [AL1], 12: Alarm information 2 [AL2], 13: Alarm information 4 [AL4], 14: DC fan lock [DCFL], 15-24: Custom Do1-10 [C-DO1 to C-DO10], 25: Universal DO [U-DO], 26: Warning [L-ALM], 27: Cooling fan running [FAN], 28: Parallel system communication established [MTS], 29: Parallel system cancel response [MEC-AB], 30: Parallel system master selection [MSS], 31: Parallel system local station fault [AL-SF], 32: Alarm output (for any alarm) [ALM], 33: Y-terminal test output ON [Y-ON], 34: Y-terminal test output OFF [Y-OFF]. 35: Clock battery life [BATT], 36: Retry function running [TRY] * 8 point DO extension function (Di function cannot be used) with OPC-VG1-DIO option
	CMY	General-purpose transistor output common	
	Y5A, Y5C	Relay output	
	A01, A04, A05	General-purpose analog output	0: Input power [PWR], 1: Input RMS current value [I-AC], 2: Input RMS voltage value [V-AC], 3: Intermediate DC voltage [V-DC], 4: Power supply frequency [FREQ], 5: +10 V test [P10], 6: -10 V test [N10], 12-18: Custom-AO1-7 [C-AO1 to C-AO7], 19: Universal AO [U-AO] * 2-point AO extension function (Ai function cannot be used) with OPC-VG1-AIO
	M	Analog output common	This is a common terminal for analog output signals.
	73A, 73C	Charging resistance ON relay output	This is the control output for the external charging resistance ON relay (73).

*1: To use the AC blown fuse detection function, the OPC-RHCE-ACF card for AC blown fuse detection is required.
For details, refer to the RHC-E Unit Type Instruction Manual.

■ Communication specifications

Item			Specification
Communication specifications	General communication specifications		Operating information, running status, function code monitor function (polling), and RUN, RST, and X1 control (selecting) is possible. * Function code writing is not possible.
	【DX+】, 【DX-】	RS-485 (built in as standard)	Communication is possible with the PC or PLC (Fuji standard and RTU protocols are supported).
	T-Link (option)		T-Link communication with MICREX-F or an SX T-Link module is possible with the OPC-VG1-TL option.
	CC-Link (option)		Connection to CC-Link master devices is possible with the OPC-VG1-CCL option.
	SX bus (option)		MICREX-SX and SX bus connection is possible with the OPC-VG1-SX option.
	E-SX bus (option)		MICREX-SX and E-SX bus connection is possible with the OPC-VG1-ESX option.
	Optical communication (option)		Parallel multiplex system load sharing can be controlled with the OPC-RHCE-TBSI-☐ option.

■ **Function settings**

Function code	Name
F00	Data protection
F01	High-frequency filter selection
F02	Restart mode after momentary power failure (Operation selection)
F03	Current rating switching
F04	LED monitor display selection
F05	LCD monitor display selection
F06	LCD monitor language selection
F07	LCD monitor contrast adjustment
F08	Carrier frequency
F09	Display coefficient for integral power data
E01	X1 function selection
E02 to E13	Y1, Y2, Y3, Y5, Y11 to 18 function selection
E14	I/O function normally open/closed
E15	RHC overload early warning level
E16	Cooling fan ON-OFF control
E17	Current limiting output (hysteresis width)
E18 to E20	A01, A04, A05 function selection
E21 to E23	A01, A04, A05 gain setting
E24 to E26	AO1, AO4, AO5 bias setting
E27	AO1, AO4, AO5 filter setting
E28, E29	X2 to X3 function selection
H01	Station address
H02	Operation selection when error occurs (Common to communication option and RS-485)
H03	Timer operating time
H04	Baud rate
H05	Data length selection
H06	Parity selection
H07	Stop bit selection
H08	Communication disconnection time
H09	Response interval time
H10	Protocol selection
H11	TL transmission format (OPC-VG1-TL option)
H12	Paralleling system (OPC-RHCE-TBSI-☐ option)
H13	Number of paralleling system follower stations (OPC-RHCE-TBSI-☐ option)
H14	Alarm data deletion
H15, H16	Power supply current limiting (for driving 1 to 2)
H17, H18	Power supply current limiting (for braking 1 to2)
H19	Current limiting early warning (level)
H20	Current limiting early warning (timer)
H21	Multiplex system station number setting
H22	Cooling fan ON-OFF control continuation timer
H23	Cumulative cooling fan run time default setting
H24 to 26	Clock time setting (set time: year/month, day/hour, minute/second)
H27	Clock time setting (clock time writing)
H28 to H33	Applicable warning definition 1 to 6
H34	Simulated failure
H35	Retry (count)
H36	Retry (waiting time)
H37	All save function
H38	Data initialization
H39, H40	For manufacturer: 1 to 2
H41	AVR-P (gain)
H42	AVR-I (integration constant)
H43	ACR-P (gain)
H44	ACR-I (integration constant)
H45	ACR-ADJ (ACR adjustment)
o01 to o49	Bus setting parameters 0 to 48
U01	SX, E-SX bus communication format selection
U02	SX, E-SX bus station number monitor
U03	Protective function operation selection
U04	AVR control response
U05	DC voltage command value selection
U06 to U48	Reserved for manufacturers
U49	System voltage adjustment
U101 to U139	Reserved for manufacturers

■ **Protective functions**

Item	Display	Protection specification
AC blown fuse	ACF	This is activated when the external AC fuse blows due to shorting or damage to the internal circuit. If using this function, an AC fuse with option or microswitch is required.
AC overvoltage	AOU	This is activated if the AC power supply voltage exceeds the AC overvoltage detection level. AC overvoltage detection level (200V series: 276 Vrms, 400V series: 552 Vrms)
AC undervoltage	ALU	This is activated if the AC power supply voltage drops to the undervoltage detection level or below during operation. However, no alarm is output when "F02: Restart mode after momentary power failure (mode selection)" data is set to 1 (Enable). AC undervoltage detection level (200V series: 88 Vrms, 400V series: 176 Vrms)
AC overcurrent	AOC	This is activated if the AC current instantaneous value exceeds the overcurrent detection level, such as when a power supply circuit short circuit or ground fault occurs.
AC input current error	ACE	This alarm is issued when the difference between the converter current command value and input AC current detection value exceeds the input current error detection level. However, no alarm is output when "F02: Restart mode after momentary power failure (mode selection)" data is set to 1 (Enable).
Input phase loss	LPU	This is activated when the power is turned ON, and if there is a phase interruption at the three-phase power supply connected to the main circuit's main power supply input terminals L1/R, L2/S, and L3/T, or if the three-phase power supply voltage is unbalanced, an alarm stop will occur on the converter. It is necessary to turn the power OFF and ON again to reset the alarm.
Synchronous power supply frequency error	FrE	This is activated when the power supply frequency detection value lies outside the 46 to 54 Hz or 56 to 64 Hz range (only when power ON), or a frequency of ±15% or more of the reference frequency (50/60 Hz) is detected (when run command is input). However, no alarm is output when "F02: Restart mode after momentary power failure (mode selection)" data is set to 1 (Enable).
DC blown fuse	dCF	This is activated if the converter output is equipped with a DC fuse, and the DC fuse blows due to shorting or damage to the internal circuit. (200 V 75 kW or higher, 400 V 90 kW or higher)
DC overvoltage	dOU	This is activated at such times as when regenerative current from the inverter increases (regenerative energy exceeds braking capability), and the main circuit intermediate voltage exceeds the DC overvoltage detection level. DC overvoltage detection level (200V series: 405 VDC, 400V series: 820 VDC)
DC undervoltage	dLU	This is activated if the intermediate DC voltage drops to the insufficient voltage detection level or below due to such reasons as a drop in the power supply voltage during converter operation. However, no alarm is output when "F02: Restart mode after momentary power failure (mode selection)" data is set to 1 (Enable). DC undervoltage detection level (200V series: 186 VDC, 400V series: 371 VDC)
Charger circuit error	PbF	This is activated if 73 answerback [73ANS] is selected with the X-terminal function selection. This is activated if there is no X-terminal input (electromagnetic contactor for bypassing charging circuit is closed) within 0.5 sec after the converter charging circuit control output [73A] signal is issued. To reset the alarm, change the X-terminal function selection, or turn the power OFF and back ON again.
Fin overheating	OH1	This is activated when the temperature around the cooling fins used to cool the main circuit semiconductor rises due to such reasons as cooling fan stoppage.
External alarm	OH2	A converter alarm stoppage occurs when an external signal is input (THR).
Converter internal overheat	OH3	This is activated when the temperature around the control PCB rises due to reasons such as poor ventilation inside the converter.
Overload	OLU	This is activated if the AC power supply current exceeds the converter overload level for the anti-time limit characteristic. MD (CT): 150%/60 s, LD (VT): 120%/60 s
DC fan lock	dFA	This alarm is issued when the DC fan stops. (200 V 45 kW or higher, 400 V 75 kW or higher)
Memory error	Er1	This is activated if a memory error such as a data write error occurs.
Keypad communication error	Er2	This is activated if a keypad transfer error occurs. If this alarm is displayed on the keypad, the converter unit does not output a batch alarm.
CPU error	Er3	This function is activated if a CPU error occurs.
Network equipment error	Er4	This is activated when a transmission error occurs due to noise, etc., while the converter is running with RS-485 communication, CC-Link, T-Link, SX-bus, or E-SX bus. It is activated by a PLC device error, communication line disconnection, or option failure.
Operating procedure mistake	Er6	This is activated when multiple network options (T-Link, SX-bus, CC-Link) are installed.
A/D converter error	Er8	Operation stops when an error occurs in the A/D converter circuit.
Link communication error	Erb	This function is activated when a transmission error occurs during communication between RHC units using a high-speed serial communication terminal block (option).
Hardware error	ErH	Triggered when an error occurs at the LSI on the power supply PCB.
Simulated failure	Err	A simulated alarm state can be produced by keypad operation.

■ Construction and environment

Item		Construction, environment, standards
Construction specification	Construction	Type installed inside panel, external cooling type
	Protective construction	IP00
	Cooling system	Forced air cooling
	Mounting method	Vertical mounting
Environment	Usage location	The inverter must not be exposed to dust, direct sunlight, corrosive gases (Note 1), flammable gases, oil mist, vapor or water droplets. (Pollution degree 2 (IEC60664-1)) (Note 2) The atmosphere can contain a small amount of salt (0.01 mg/cm^2 or less per year). There should be no condensation due to sudden temperature changes.
	Ambient temperature	-10 to 50°C (14 to 122 °F)
	Humidity	5 to 95% RH, there should no condensation
	Altitude	3000 m or less (However, output is reduced at 1001 to 3000 m)
	Vibration	Max. amplitude: 55 kW or lower (200V series) 75 kW or lower (400V series) 3 mm less than 2 to 9 Hz 9.8 m/s^2 less than 9 to 20 Hz 2 m/s^2 less than 20 to 55 Hz 1 m/s^2 less than 55 to 200 Hz 75 kW or higher (200V series) 90 kW or higher (400V series) 3 mm less than 2 to 9 Hz 2 m/s^2 less than 9 to 55 Hz 1 m/s^2 less than 55 to 200 Hz
	Storage temperature	-25 to +70ºC (-13 to +158°F) (For long-term storage: -10 to +30ºC (14 to 95°F))
	Storage humidity	5 to 95% RH

(Note 1) Please contact Fuji Electric if sulfurized gas is produced in the location where the product is installed.

(Note 2) Do not install the inverter in an environment where it may be exposed to lint, cotton waste or moist dust or dirt which will clog the heat sink of the inverter.
If the inverter is to be used in such an environment, install it in a cabinet to prevent lint, etc. getting in.

11.5.4 Device configuration

■ Device configuration list

MD mode

Power supply voltage	Standard applicable motor [kW]	PWM converter type	Charging circuit contactor		Power supply contactor		Charging circuit box (*1, 2)		Charging resistor		AC fuse		Boosting reactor		Filter resistor		Filter reactor		Filter capacitor		Filter circuit contactor	
			(73)	Qty	(52)	Qty	(CU)	Qty	(R0)	Qty	(Fac)	Qty	(Lr)	Qty	(Rf)	Qty	(Lf)	Qty	(Cf)	Qty	(6F)	Qty
Three-phase 200 V	30	RHC30-2EJ	SC-N4	1	—	—	CU30-2C	1	(GRZG120 2 Ω)	(3)	(CR2L-200/UL) *4	(2)	LR2-37C	1	GRZG400 0.1 Ω	3	LFC2-37C	1	CF2-37C	1	—	—
	37	RHC37-2EJ	SC-N5	1			CU45-2C	1			(CR2L-260/UL) *4	(2)										
	45	RHC45-2EJ	SC-N7	1									LR2-55C	1			LFC2-55C	1	CF2-55C	1		
	55	RHC55-2EJ	SC-N8	1			CU55-2C	1			(CR2L-400/UL) *4	(2)										
	75	RHC75-2EJ	SC-N11	1			CU75-2C	1					LR2-75C	1			LFC2-75C	1	CF2-75C	1		
	90	RHC90-2EJ					CU90-2C	1	(GRZG400 1 Ω)	(3)	(A50P600-4) *5	(2)	LR2-110C	1	GRZG400 0.12 Ω [2 in parallel]	6	LFC2-110C	1	CF2-110C	1		
Three-phase 400 V	45	RHC45-4EJ	SC-N3	1	—	—	CU45-4C	1	(80 W 7.5 Ω) (HF5C5504)	(3)	(CR6L-150/UL) *4		LR4-55C	1	GRZG400 0.26 Ω	3	LFC4-55C	1	CF4-55C	1	—	—
	55	RHC55-4EJ	SC-N4	1			CU55-4C	1			(CR6L-200/UL) *4	(2)										
	75	RHC75-4EJ	SC-N5	1			CU75-4C	1					LR4-75C	1	GRZG400 0.38 Ω	3	LFC4-75C	1	CF4-75C	1		
	90	RHC90-4EJ	SC-N7	1			CU90-4C	1			(CR6L-300/UL) *4	(2)	LR4-110C	1	GRZG400 0.53 Ω [2 in parallel]	6	LFC4-110C	1	CF4-110C	1		
	110	RHC110-4EJ	SC-N8	1			CU110-4C	1	(GRZG120 2 Ω)	(3)												
	132	RHC132-4EJ					CU132-4C	1			(A50P400-4) *5	(2)	LR4-160C	1	RF4-160C	1	LFC4-160C	1	CF4-160C	1		
	160	RHC160-4EJ	SC-N11	1			CU160-4C	1			(A50P600-4) *5	(2)										
	200	RHC200-4EJ	SC-N12	1			CU200-4C	1	(GRZG400 1 Ω)	(3)			LR4-220C	1	RF4-220C	1	LFC4-220C	1	CF4-220C	1		
	220	RHC220-4EJ					CU220-4C	1			(A70QS800-4) *5	(2)										
	280	RHC280-4EJ	SC-N3	1	SC-N14	1	—	—	GRZG400 1 Ω [2 in parallel]	6	A70QS800-4 *5	2	LR4-280C	1	RF4-280C	1	LFC4-280C	1	CF4-280C	1	SC-N4	1
	315	RHC315-4EJ									A70P1600-4TA *5	2	LR4-315C	1	RF4-315C	1	LFC4-315C	1	CF4-315C	1		
	355	RHC355-4EJ											LR4-355C	1	RF4-355C	1	LFC4-355C	1	CF4-355C	1		
	400	RHC400-4EJ			SC-N16								LR4-400C	1	RF4-400C	1	LFC4-400C	1	CF4-400C	1		
	500	RHC500-4EJ			SC-N11	3							LR4-500C	1	RF4-500C	1	LFC4-500C	1	CF4-500C	1(※3)		
	630	RHC630-4EJ			SC-N12	3					A70P2000-4 *5	2	LR4-630C	1	RF4-630C	1	LFC4-630C	1	CF4-630C	1(※3)	SC-N7	1

(*1) There is a fuse (F) and charging resistor (R0) built into the charging circuit box.

(*2) Individual support will be required for charging circuit boxes with capacity of 280 kW or higher. Please contact Fuji Electric.

(*3) CF4-500C to CF4-800C are comprised of two capacitors. For an order quantity of “1” for CF4-500C to CF4-800C, two capacitors will be shipped.

(*4) If a blown fuse is detected, install the OPC-RHCE-ACF card for AC blown fuse detection.
If not using a charging circuit box, a fuse with microswitch for blown fuse detection can be prepared. In such a case, there is no need for the OPC-RHCE-ACF. Please contact Fuji Electric.

(*5) If a blown fuse is detected, install the OPC-RHCE-ACF card for AC blown fuse detection.

(*6) For details on MCCB/ELCB selection, refer to the PWM Converter Instruction Manual (INR-SI47-2269).

LD mode

Power supply	Standard applicable motor [kW]	PWM converter type	Charging circuit contactor		Power supply contactor		Charging circuit box (*1, 2)						Boosting reactor		Filter resistor		Filter reactor		Filter capacitor		Filter circuit contactor	
			(73)	Qty	(52)	Qty	(CU)	Qty	Charging resistor (R0)	Qty	AC fuse (Fac)	Qty	(Lr)	Qty	(Rf)	Qty	(Lf)	Qty	(Cf)	Qty	(6F)	Qty
Three-phase 200 V	37	RHC30-2EJ	SC-N5	1	—	—	CU30-2C	1	(GRZG120 2 Ω)	(3)	(CR2L-200/UL) *4	(2)	LR2-37C	1	GRZG400 0.12 Ω	3	LFC2-37C	1	CF2-37C	1	—	—
	45	RHC37-2EJ	SC-N7	1			CU45-2C	1			(CR2L-260/UL) *4	(2)	LR2-55C	1			LFC2-55C	1	CF2-55C	1		
	55	RHC45-2EJ	SC-N8	1																		
	75	RHC55-2EJ	SC-N11	1			CU55-2C	1			(CR2L-400/UL) *4	(2)	LR2-75C	1			LFC2-75C	1	CF2-75C	1		
	90	RHC75-2EJ					CU75-2C	1					LR2-110C	1	GRZG400 0.12 Ω [2 in parallel]	6	LFC2-110C	1	CF2-110C	1		
	110	RHC90-2EJ	SC-N12	1			CU90-2C	1	(GRZG400 1 Ω)	(3)	(A50P600-4) *5	(2)										
Three-phase 400 V	55	RHC45-4EJ	SC-N4	1	—	—	CU45-4C	1	(80W 7.5 Ω) (HF5C5504)	(3)	(CR6L-150/UL) *4	(2)	LR4-55C	1	GRZG400 0.26 Ω	3	LFC4-55C	1	CF4-55C	1	—	—
	75	RHC55-4EJ	SC-N5	1			CU55-4C	1			(CR6L-200/UL) *4	(2)	LR4-75C	1	GRZG400 0.38 Ω	3	LFC4-75C	1	CF4-75C	1		
	90	RHC75-4EJ	SC-N7	1			CU75-4C	1					LR4-110C	1	GRZG400 0.53 Ω [2 in parallel]	6	LFC4-110C	1	CF4-110C	1		
	110	RHC90-4EJ	SC-N8	1			CU90-4C	1			(CR6L-300/UL) *4	(2)										
	132	RHC110-4EJ					CU110-4C	1	(GRZG120 2 Ω)	(3)			LR4-160C	1	RF4-160C	1	LFC4-160C	1	CF4-160C	1		
	160	RHC132-4EJ	SC-N11	1			CU132-4C	1			(A50P400-4) *5	(2)										
	200	RHC160-4EJ	SC-N12	1			CU160-4C	1			(A50P600-4) *5	(2)	LR4-220C	1	RF4-220C	1	LFC4-220C	1	CF4-220C	1		
	220	RHC200-4EJ					CU200-4C	1	(GRZG400 1 Ω)	(3)												
	280	RHC220-4EJ	SC-N14	1			CU220-4C	1			(A70QS800-4) *5	(2)	LR4-280C	1	RF4-280C	1	LFC4-280C	1	CF4-280C	1		
	315	RHC280-4EJ	SC-N3	1	SC-N14	1	—	—	GRZG400 1 Ω [2 in parallel]	6	A70QS800-4 *5	2	LR4-315C	1	RF4-315C	1	LFC4-315C	1	CF4-315C	1	SC-N4	1
	355	RHC315-4EJ									A70P1600-4TA *5	2	LR4-355C	1	RF4-355C	1	LFC4-355C	1	CF4-355C	1		
	400	RHC355-4EJ			SC-N16	1							LR4-400C	1	RF4-400C	1	LFC4-400C	1	CF4-400C	1		
	500	RHC400-4EJ			SC-N11	3							LR4-500C	1	RF4-500C	1	LFC4-500C	1	CF4-500C	1(※3)		

(*1) There is a fuse (F) and charging resistor (R0) built into the charging circuit box.

(*2) Individual support will be required for charging circuit boxes with capacity of 280 kW or higher. Please contact Fuji Electric.

(*3) CF4-500C is comprised of two capacitors. For an order quantity of “1” for CF4-500C, two capacitors will be shipped.

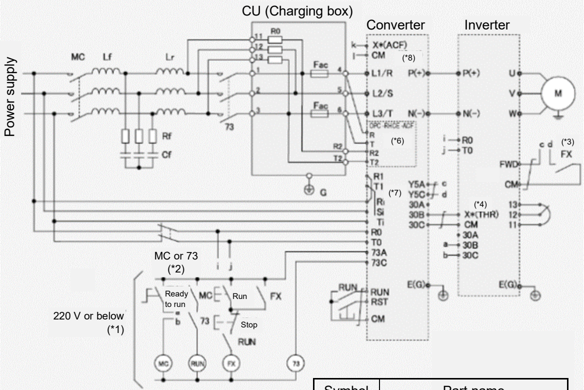
(*4) If a blown fuse is detected, install the OPC-RHCE-ACF card for AC blown fuse detection.
If not using a charging circuit box, a fuse with microswitch for blown fuse detection can be prepared. In such a case, there is no need for the OPC-RHCE-ACF. Please contact Fuji Electric.

(*5) If a blown fuse is detected, install the OPC-RHCE-ACF card for AC blown fuse detection.

(*6) For details on MCCB/ELCB selection, refer to the PWM Converter Instruction Manual.

■ Basic connection drawings

■RHC30-2EJ to RHC90-2EJ MD and LD Mode
■RHC45-4EJ to RHC220-4EJ MD and LD Mode



Symbol	Part name
Lr	Boosting reactor
Lf	Filtering reactor
Cf	Filtering capacitor
Rf	Filtering resistor
CU	Charging box
73	Magnetic contactor for charging circuit

Note 1) If using a 400V series inverter for the main power supply, connect a step-down transformer to ensure that the sequence circuit voltage is 220 V or less.

Note 2) Be sure to connect the PWM converter and inverter auxiliary power input terminals (R0, T0) to the main power via contact b of the charging circuit electromagnetic contactors (73 or MC). When using for a non-grounded power supply, it is necessary to add an insulated transformer.

Note 3) Design the sequence so that the RUN signal is not input to the inverter until the PWM converter is ready.

Note 4) Set any of the inverter unit X terminals for external alarm (THR).

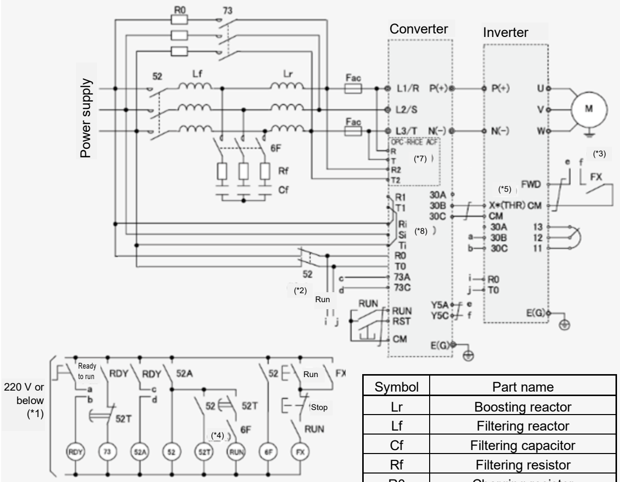
Note 5) Be sure to connect wires to the L1/R, L2/S, L3/T, Ri, Si, and Ti terminals to match the phase sequence.

Note 6) If a blown fuse is detected, install the OPCRHCE-ACF card for AC fuse blown detection, and connect as shown in the diagram.

Note 7) With converters with R1 and T1 terminals, power is supplied to the AC fan by the internal connections of the R1 and T1 terminals and the Ri and Ti terminals, and therefore the wiring must not be disconnected.

Note 8) If using a fuse with microswitch for detecting a blown fuse, set one of the PWM converter X terminals to AC blown fuse alarm (ACF), and connect all microswitches in series with the X terminal. Set contact b input with function code E14 for input with contact b.

■RHC280-4EJ to RHC630-4EJ MD Mode
■RHC280-4EJ to RHC400-4EJ LD Mode



Symbol	Part name
Lr	Boosting reactor
Lf	Filtering reactor
Cf	Filtering capacitor
Rf	Filtering resistor
R0	Charging resistor
F	Fuse
73	Magnetic contactor for charging circuit
52	Magnetic contactor for power supply
6F	Magnetic contactor for filter circuit

Note 1) Connect a step-down transformer to ensure that the sequence circuit voltage is 220 V or less.

Note 2) Be sure to connect the PWM converter and inverter auxiliary power input terminals (R0, T0) to the main power via contact b of the power supply circuit magnetic contactor (52).
When using for a non-grounded power supply, it is necessary to add an insulated transformer.

Note 3) Design the sequence so that the RUN signal is not input to the inverter until the PWM converter is ready.

Note 4) Set the 52T timer set time to 1 s.

Note 5) Set any of the inverter unit X terminals for external alarm (THR).

Note 6) Be sure to connect wires to the L1/R, L2/S, L3/T, Ri, Si, and Ti terminals to match the phase sequence.

Note 7) If a blown fuse is detected, install the OPCRHCE-ACF card for AC fuse blown detection, and connect as shown in the diagram.

Note 8) With converters with R1 and T1 terminals, power is supplied to the AC fan by the internal connections of the R1 and T1 terminals and the Ri and Ti terminals, and therefore the wiring must not be disconnected.

11.5.5 External dimensions

PWM converter unit

Figure A

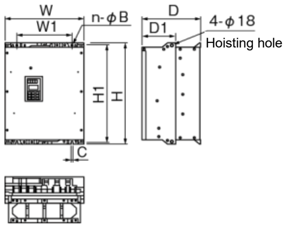


Figure B

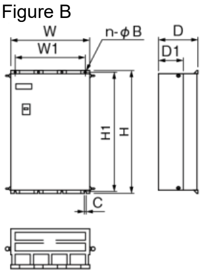
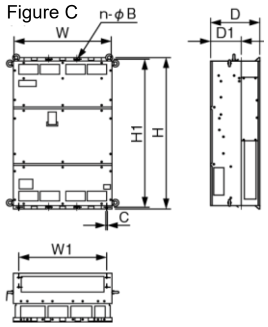


Figure C



PWM converter type		Figure	Dimensions (mm)									Capacity	Approx. weight (kg)
			W	W1	H	H1	D	D1	n	B	C		
200V series	RHC30-2EJ	A	320	240	550	530	255	115	2	10	10	30	24
	RHC37-2EJ	A	355	275	615	595	270	115	2	10	10	37	29
	RHC45-2EJ	A	355	275	740	720	270	115	2	10	10	45	39
	RHC55-2EJ	A	355	275	740	720	270	115	2	10	10	55	39
	RHC75-2EJ	B	530	430	750	720	285	145	2	15	15	75	55
	RHC90-2EJ	B	680	580	880	850	360	180	3	10	10	90	95
400V series	RHC45-4EJ	A	355	275	615	595	270	115	2	10	10	45	30
	RHC55-4EJ	A	355	275	675	655	270	115	2	10	10	55	32
	RHC75-4EJ	A	355	275	740	720	270	115	2	10	10	75	38
	RHC90-4EJ	B	530	430	740	710	315	135	2	15	15	90	58
	RHC110-4EJ											110	60
	RHC132-4EJ	B	530	430	1000	970	360	180	2	15	15	132	85
	RHC160-4EJ											160	87
	RHC200-4EJ	B	680	580	1000	970	360	180	3	15	15	200	116
	RHC220-4EJ											220	119
	RHC280-4EJ	B	680	580	1400	1370	440	260	3	15	15	280	215
	RHC315-4EJ											315	
	RHC355-4EJ	B	880	780	1400	1370	440	260	4	15	15	355	290
	RHC400-4EJ											400	
	RHC500-4EJ	C	1000	900	1550	1520	500	313.2	4	15	15	500	485
	RHC630-4EJ											630	

<Boosting reactor>

Figure A

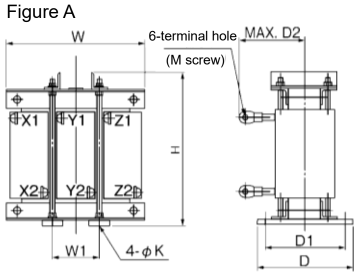
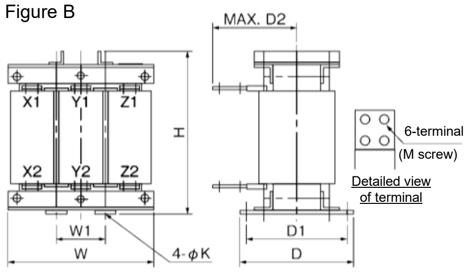


Figure B



Boosting reactor type		Figure	Dimensions (mm)								Approx. weight (kg)
			W	W1	H	D	D1	D2	K	M	
200V series	LR2-37C	A	265	95	385	234	205	150	12	M10	48±2
	LR2-55C	A	285	95	420	250	215	160	12	M12	58
	LR2-75C	A	330	110	440	255	220	165	12	M12	70
	LR2-110C	A	345	115	500	280	245	185	12	M12	100
400V series	LR4-55C	A	270	95	370	244	215	145	12	M10	47±2
	LR4-75C	A	330	110	410	250	220	150	12	M10	61±2
	LR4-110C	A	330	115	455	275	245	170	12	M12	90±3
	LR4-160C	A	380	125	515	300	260	180	15	M12	121±4
	LR4-220C	A	450	150	580	330	290	220	15	M12	192±5
	LR4-280C	A	480	160	730	325	290	220	15	M16	220±5
	LR4-315C	A	480	160	745	335	300	225	15	M16	242±5
	LR4-355C	A	480	160	800	350	315	230	15	M16	282±5
	LR4-400C	A	480	160	825	375	330	260	19	M16	309±5
	LR4-500C	A	525	175	960	410	360	290	19	M16	420
	LR4-630C	B	600	200	640	440	390	285	19	4×M12	450

<Filter reactor>

Figure A

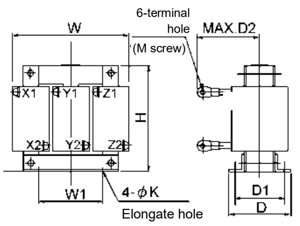


Figure B

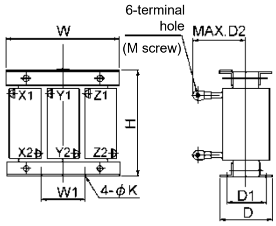


Figure C

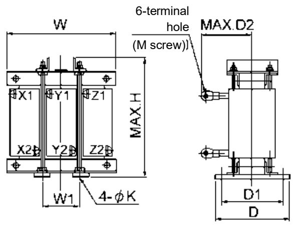
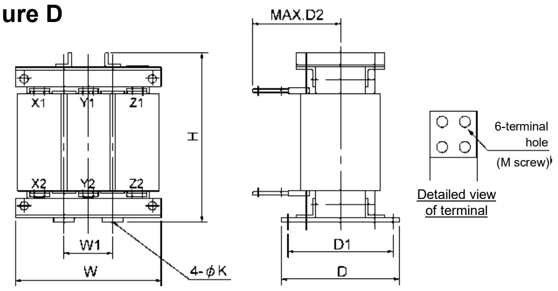


Figure D



Filter reactor type		Figure	Dimensions (mm)								Approximate weight [kg]
			W	W1	H	D	D1	D2	K	M	
200V series	LFC2-37C	A	130*	60	115	101	85	115	6	M10	4.2±0.2
	LFC2-55C	A	175	60	145	110	90	140	6	M12	8.0
	LFC2-75C	A	195	80	200	120	100	150	7	M12	13
	LFC2-110C	B	255	85	230	118	95	165	7	M12	20
400V series	LFC4-55C	A	160*	60	130	108	90	115	6	M10	6.6±0.3
	LFC4-75C	A	180*	80	170	111	93	130	7	M10	11.5±0.6
	LFC4-110C	B	215	85	190	111	90	135	7	M12	14.7±0.7
	LFC4-160C	B	240*	85	205	126	110	140	10	M12	21.2±0.7
	LFC4-220C	C	275	100	315	208	180	165	10	M12	37±2
	LFC4-280C	C	275	110	325	223	195	195	12	M16	45±2
	LFC4-315C	C	290	105	350	223	195	200	12	M16	48±2
	LFC4-355C	C	290	105	350	228	200	205	12	M16	51±2
	LFC4-400C	C	330	115	400	230	200	185	12	M16	54±2
	LFC4-500C	C	345	115	480	240	205	240	12	M16	72
	LFC4-630C	D	435	145	550	295	255	200	15	4×M12	175

* Central values are indicated (These are not maximum values).

<Filter capacitor>

Figure A

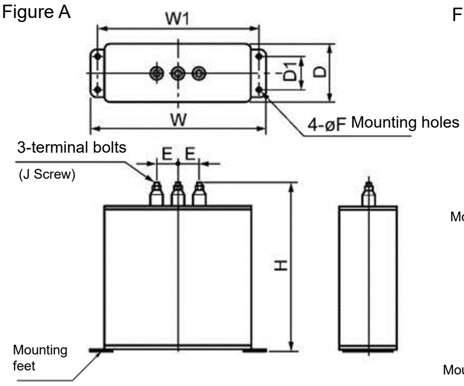
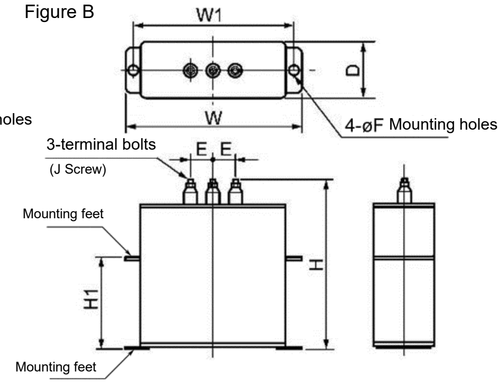


Figure B



Filter capacitor type		Figure	Dimensions (mm)									Approximate weight [kg]
			W	W1	H	H1	D	D1	E	F	J	
200V series	CF2-37C	A	280	265	235	-	90	55	80	7	M5	7.0
	CF2-55C	A	280	265	340	-	90	55	80	7	M8	8.5
	CF2-75C	A	280	265	235	-	90	55	80	7	M6	7.0
	CF2-110C	A	280	265	340	-	90	55	80	7	M8	8.5
400V series	CF4-55C	A	205	190	245	-	70	40	30	7	M5	3.5
	CF4-75C	A	205	190	205	-	70	40	30	7	M5	2.9
	CF4-110C	A	205	190	245	-	70	40	30	7	M5	3.5
	CF4-160C	A	280	265	260	-	90	55	80	7	M6	6.0
	CF4-220C	B	435	400	310	125	100	-	80	15 x 20 elongated hole	M12	13.0
	CF4-280C	B	435	400	350	165	100	-	80	15 x 20 elongated hole	M12	15.0
	CF4-315C	B	435	400	460	275	100	-	80	15 x 20 elongated hole	M12	20.0
	CF4-355C	B	435	400	520	335	100	-	80	15 x 20 elongated hole	M12	23.0
	CF4-400C	B	435	400	610	425	100	-	80	15 x 20 elongated hole	M12	27.0
	CF4-500C	B	435	400	310	125	100	-	80	15 x 20 elongated hole	M12	13.0
	CF4-630C	B	435	400	460	275	100	-	80	15 x 20 elongated hole	M12	20.0

Note

- Mount vertically. Do not lower onto its side and mount.
- All mounting feet must be secured to the cabinet floor, etc. Figure A: 2 mounting feet locations, Figure B: 4 mounting feet locations

Failure to observe this could result in damage due to vibration or impact.

<Filter resistor>

Figure A

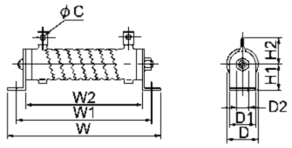


Figure B

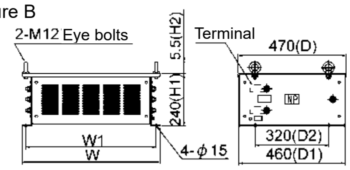
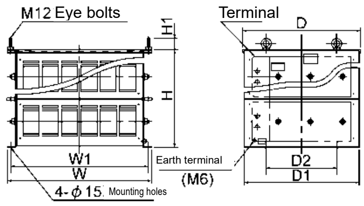


Figure C



Filter resistor type		Figure	Dimensions (mm)									Approximate weight [kg]
			W	W1	W2	H1	H2	D	D1	D2	C	
200V series	GRZG400 0.1 Ω	A	411	385	330	40	46	47	40	9.5	8.2	0.85
	GRZG400 0.12 Ω	A	411	385	330	40	46	47	40	9.5	8.2	0.85
400V series	GRZG400 0.38 Ω	A	411	385	330	40	46	47	40	9.5	8.2	0.85
	GRZG400 0.26 Ω	A	411	385	330	40	46	47	40	9.5	8.2	0.85
	GRZG400 0.53 Ω	A	411	385	330	40	46	47	40	9.5	8.2	0.85
	RF4-160C	B	400	370	-	240	55	470	460	320	-	22
	RF4-220C											25
	RF4-280C	C	655	625	-	240	55	470	460	320	-	31
	RF4-315C											35
	RF4-355C											36
	RF4-400C											38
	RF4-500C											41
	RF4-630C	C	655	625	-	440	55	530	520	320	-	70

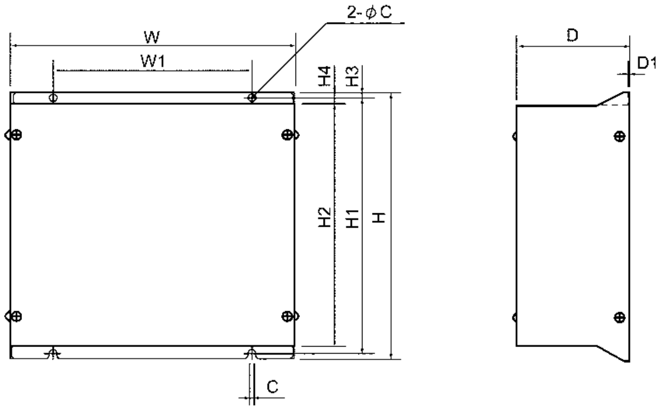
<Charging box>

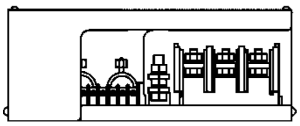
The charging box contains a combination of a charging resistor and a fuse, which is essential in the configuration of the RHC-E series of PWM converters. Using this charging box eases mounting and wiring jobs.

■ Capacity range

200V series: 30 to 90 kW, 5 types
400V series: 45 to 220 kW, 9 types, 14 types in total

As for 400V series with a capacity of 280 to 400 kW, the charging resistor and the fuse are separately provided.





Fuse type		Dimensions (mm)										Mounting bolt	Approximate weight [kg]
		W	W1	H	H1	H2	H3	4	D	D1	C		
200V series	CU30-2C	300	200	310	295	280	7.5	15	110	2.4	6	M5	7
	CU45-2C	330	230	310	295	280	7.5	15	130	2.4	6	M5	8
	CU55-2C												
	CU75-2C	430	330	560	536	510	12	25	150	3.2	10	M8	17
	CU90-2C												20
400V series	CU45-4C	300	200	310	295	280	7.5	15	110	2.4	6	M5	7
	CU55-4C												
	CU75-4C	330	230	310	295	280	7.5	15	130	2.4	6	M5	8
	CU90-4C												
	CU110-4C												
	CU132-4C	430	330	560	536	510	12	25	150	3.2	10	M8	18
	CU160-4C												
	CU200-4C												20
	CU220-4C												

<Charging resistors>

Figure A

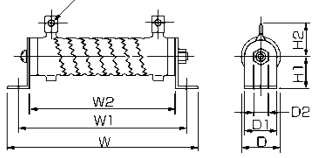
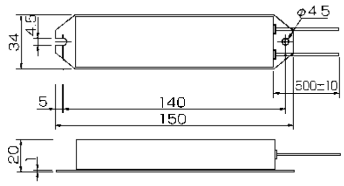


Figure B



Charging resistor type	Figure	Dimensions (mm)									Approximate weight [kg]
		W	W1	W2	H1	H2	D	D1	D2	C	
GRZG120 2 Ω	A	217	198	165	22	32	33	22	6	5.5	0.25
GRZG400 1 Ω	A	411	385	330	40	39	47	40	9.5	5.5	0.85
80 W 7.5 Ω (HF5C5504)	B	-	-	-	-	-	-	-	-	-	0.19

<Fuses>

Figure A

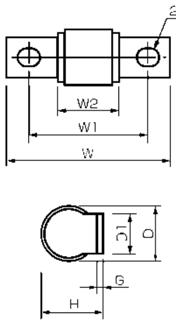


Figure B

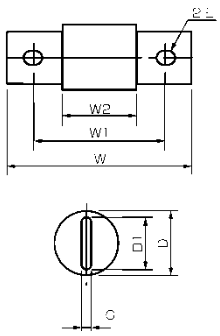
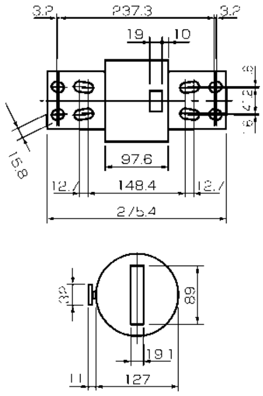
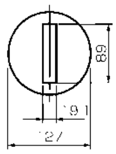


Figure C



Side view of A70P1600-4TA



Side view of A70P2000-4

Fuse type		Figure	Dimensions (mm)								Approximate weight [kg]
			W	W1	W2	H	D	D1	G	E	
200V series	CR2L-200/UL	A	85	60	30	33.5	30	25	3.2	11x13	0.13
	CR2L-260/UL										
	CR2L-400/UL	A	95	70	31	42	37	30	4	11x13	0.22
	A50P600-4	B	113.5	81.75	56.4	-	50.8	38.1	6.4	10.3x18.2	0.60
400V series	CR6L-150/UL	A	95	70	40	34	30	25	3.2	11x13	0.15
	CR6L-200/UL	A	107	82	43	42	37	30	4	11x13	0.25
	CR6L-300/UL										
	A50P400-4	B	110	78.6	53.1	-	38.1	25.4	6.4	10.3x18.4	0.30
	A50P600-4	B	113.5	81.75	56.4	-	50.8	38.1	6.4	10.3x18.2	0.60
	A70QS800-4	B	180.2	129.4	72.2	-	63.5	50.8	9.5	13.5x18.3	1.1
	A70P1600-4T	C	-	-	-	-	-	-	-	-	8.0
	A70P2000-4	C	-	-	-	-	-	-	-	-	8.0

Generated loss

In MD mode

Unit		Boosting reactor		Filter reactor		Filter resistor		
Type	Generated loss [W]	Type	Generated loss [W]	Type	Generated loss [W]	Type	Qty	Generated loss [W]
RHC30-2EJ	950	LR2-37C	330	LFC2-37C	32	GRZG400 0.1 Ω	3	107
RHC37-2EJ	1200							
RHC45-2EJ	1200	LR2-55C	450	LFC2-55C	43			240
RHC55-2EJ	1450							
RHC75-2EJ	1900	LR2-75C	520	LFC2-75C	74			137
RHC90-2EJ	2250	LR2-110C	720	LR2-110C	115	GRZG400 0.12 Ω (2 in parallel)	6	374
RHC45-4EJ	1250	LR4-55C	490	LFC4-55C	43	GRZG400 0.26 Ω	3	130
RHC55-4EJ	1550							
RHC75-4EJ	1800	LR4-75C	520	LFC4-75C	78	GRZG400 0.38 Ω	3	112
RHC90-4EJ	2200	LR4-110C	710	LFC4-110C	90	GRZG400 0.53 Ω (2 in parallel)	6	405
RHC110-4EJ	2550							
RHC132-4EJ	2800	LR4-160C	1000	LFC4-160C	160	RF4-160C	1	568
RHC160-4EJ	3350							
RHC200-4EJ	4100	LR4-220C	1240	LFC4-220C	200	RF4-220C	1	751
RHC220-4EJ	4600							
RHC280-4EJ	5700	LR4-280C	1430	LFC4-280C	220	RF4-280C	1	1027
RHC315-4EJ	6400	LR4-315C	1660	LFC4-315C	260	RF4-315C	1	1154
RHC355-4EJ	6950	LR4-355C	1910	LFC4-355C	300	RF4-355C	1	1286
RHC400-4EJ	7900	LR4-400C	2160	LFC4-400C	350	RF4-400C	1	1454
RHC500-4EJ	10400	LR4-500C	2470	LFC4-500C	450	RF4-500C	1	5463
RHC630-4EJ	10550	LR4-630C	2300	LFC4-630C	510	RF4-630C	1	4722

In LD mode

Unit		Boosting reactor		Filter reactor		Filter resistor		
Type	Generated loss [W]	Type	Generated loss [W]	Type	Generated loss [W]	Type	Qty	Generated loss [W]
RHC30-2EJ	1150	LR2-37C	330	LFC2-37C	32	GRZG400 0.1 Ω	3	107
RHC37-2EJ	1400	LR2-55C	450	LFC2-55C	43			240
RHC45-2EJ	1400							
RHC55-2EJ	1800	LR2-75C	520	LFC2-75C	74			137
RHC75-2EJ	2050	LR2-110C	720	LFC2-110C	115	GRZG400 0.12 Ω (2 in parallel)	6	374
RHC90-2EJ	2400							
RHC45-4EJ	1250	LR4-55C	490	LFC4-55C	43	GRZG400 0.26 Ω	3	130
RHC55-4EJ	1700	LR4-75C	520	LFC4-75C	78	GRZG400 0.38 Ω	3	112
RHC75-4EJ	1800	LR4-110C	710	LFC4-110C	90	GRZG400 0.53 Ω (2 in parallel)	6	405
RHC90-4EJ	2050							
RHC110-4EJ	2450	LR4-160C	1000	LFC4-160C	160	RF4-160C	1	568
RHC132-4EJ	2750							
RHC160-4EJ	3500	LR4-220C	1240	LFC4-220C	200	RF4-220C	1	751
RHC200-4EJ	3700							
RHC220-4EJ	4850	LR4-280C	1430	LFC4-280C	220	RF4-280C	1	1027
RHC280-4EJ	5700	LR4-315C	1660	LFC4-315C	260	RF4-315C	1	1154
RHC315-4EJ	6550	LR4-355C	1910	LFC4-355C	300	RF4-355C	1	1286
RHC355-4EJ	7150	LR4-400C	2160	LFC4-400C	350	RF4-400C	1	1454
RHC400-4EJ	8100	LR4-500C	2470	LFC4-500C	450	RF4-500C	1	1821

Note: Generated losses listed in the above tables are approximate values that are calculated according to the following conditions:

- The power supply is 200 V or 400 V, 50 Hz, with 0% interphase voltage unbalance ratio.
- The capacity of the power supply used is the larger of either: 500 kVA, or 10 times the rated capacity of the inverter.
- The motor is a 4-pole standard model at full load (100%).

11.6 Compact Power Regeneration PWM Converter

This is a more compact, lightweight product than the RHC series in section 11.5, and similarly, since the power supply side current is converted into a sine wave with PWM control combined with an inverter, thereby significantly reducing harmonic current, the conversion factor Ki in the "Guideline for Suppressing Harmonics by Customers Receiving High Voltage or Special High Voltage" issued by the Agency for Natural Resources and Energy in the Ministry of Economy, Trade and Industry can be treated as "0" (in other words, zero harmonics are produced.)

11.6.1 Specifications

[1] Standard specifications

■ 200V series

Item		Specifications					
Type: RHC☐C-2EJ		5.5	7.5	11	15	18.5	22
Applicable inverter capacity [kW]		5.5	7.5	11	15	18.5	22
Output	Continuous capacity [kW]	6.5	8.8	13	18	22	26
	Overload rating	150% of regenerative rated capacity for 1 min					
	DC voltage	320 to 355 VDC Varies based on power supply voltage.					
	Rated DC current (DC) [A]	21	28	41	55	68	81
Carrier frequency		10 kHz					
Input	Phase, voltage and frequency	Three-phase 200 to 240 VAC, 50/60 Hz					
	Permissible fluctuations	Voltage: +10 to -15% (Phase-to-phase imbalance ratio: within 2%) Frequency: +5 to -5%					
	Rated power supply current (AC) [A]	20	27	40	55	67	80
	Power factor	0.99 or higher (for 100% load)*1					
Approximate weight [kg]		3.5	3.5	4.6	4.6	8.9	8.9

■ 400V series

Item		Specifications										
Type: RHC☐C-4EJ		5.5	7.5	11	15	18.5	22	30	37	45	55	75
Applicable inverter capacity [kW]		5.5	7.5	11	15	18.5	22	30	37	45	55	75
Output	Continuous capacity [kW]	6.5	8.8	13	18	22	26	36	44	53	65	88
	Overload rating	150% of regenerative rated capacity for 1 min										
	DC voltage	640 to 710 VDC Varies based on power supply voltage.										
	Rated DC current (DC) [A]	11	14	21	28	34	41	55	68	83	101	138
Carrier frequency		10 kHz										
Input	Phase, voltage and frequency	Three-phase 380 to 480 VAC, 50/60 Hz										
	Permissible fluctuation	Voltage: +10 to -15% (interphase unbalance ratio: 2% or less) Frequency: +5 to -5%										
	Rated power supply current (AC) [A]	10	14	20	27	34	40	55	67	82	100	134
	Power factor	0.99 or higher (for 100% load)*1										
Approximate weight [kg]		3.5	3.5	4.6	4.6	8.9	8.9	23.8	23.8	28.3	28.3	35.6

*1 When the power supply voltage is 210 V or 420 V or higher, and the operating load is 50% or higher, the power factor for the power supply drops to approximately 0.95 (only during regenerative operation).

[2] Common specifications

Item		Details
Control	Control method	AVR constant control with DC ACR minor
	Digital input	Run, stop command, alarm reset command, digital inputs (X1, X2), power supply for PLC signal
	Digital output	Transistor output (Y1, Y2, Y3), relay output (Y5A/Y5C), and batch alarm output (30A/30B/30C)
	Analog output	FM1, FM2
	Input harmonic current	A conversion coefficient of ki = 0 can be used in accordance with the harmonic suppression countermeasure guidelines issued by the Ministry of Economy, Trade and Industry.
Protection		AC overcurrent, AC/DC low voltage, AC/DC overvoltage, input phase loss, synchronous power supply frequency errors, cooling fin overheating, external alarms, internal overheating, overloads, memory errors, keypad communication errors, CPU errors, network equipment errors, charging circuit errors, AC blown fuses, AC input current errors, DC fan locks
Environmental specifications	Ambient temperature	-10 to 50°C (14 to 122°F)
	Relative humidity	5 to 95% (there should be no condensation)
	Altitude	1,000 m or lower
	Atmospheric pressure	86 to 106 kPa
	Vibration	3 mm (max. amplitude), less than 2 to 9 Hz 9.8 m/s^2, less than 9 to 20 Hz 2 m/s^2, less than 20 to 55 Hz 1 m/s^2, less than 55 to 200 Hz
Peripheral equipment		Boosting reactors, filter reactors, filter capacitors, filter resistors, magnetic contactors, AC fuses, charging resistors

[3] Terminal functions

Terminal: Type	Terminal: Symbol	Terminal: Function	Specifications
Main circuit	R, S, T	Main power supply input	Connect to a three-phase power supply via a dedicated reactor.
	P, N	Converter output	Connect to inverter power supply input terminals P and N.
	R0, T0	Control power auxiliary input	These are backup terminals for the control power supply. (30 kW or higher)
	G	Grounding terminal	This is a terminal for grounding.
	Ri, Si, Ti	Synchronous power supply input for voltage detection	This is a voltage detection terminal used for control inside the converter, and it is connected to the dedicated filter power supply.
	73A, C	Charging circuit control output	This is the control output for the external charging circuit. Contact capacity: 250 VAC, 5 A
Control input terminals	RUN	RUN / STOP commands	Runs when ON between RUN and CM, and stops when OFF or boosting.
	RST	Alarm reset command	By eliminating the cause of the alarm when an alarm stoppage occurs, and turning ON between RST and CM, the protective function that was activated is canceled, and operation resumes.
	X1, X2	Digital input (SINK / SOURCE)	Signals selected from the following functions can be input. 0: External alarm [THR], 1: Current limiting cancel [LMT-CCL], 2: 73 answerback [73ANS], 3: Current limiting switch [I-LIM], 14: Universal DI [U-DI], 15: AC blown fuse [ACF]
	PLC	PLC signal power supply	Connects the power supply for PLC output signals. The terminal can also be used as the power supply for loads connected to transistor outputs. Rated voltage: +24 V (22 to 27 VDC), max. output current: 100 mA
	CM	Digital input common	This is a common terminal for digital input signals.
Control output signals	30A 30B 30C	Batch alarm output (non-voltage contact signal (1C) output)	A signal is output when the protective function activates and an alarm stoppage occurs. Contact capacity: 250 VAC, 0.3 A, cosφ = 0.3
	Y1, Y2, Y3	Transistor output	Signals selected from the following functions can be output. 0: Running [RUN], 1: Ready for operation [RDY], 2: Power supply current limiting [IL], 3: Lifetime early warning [LIFE], 4: Cooling fin overheating early warning [PRE-OH], 5: Overload early warning [PRE-OL], 6: Power running [DRV], 7: Regenerating [REG], 8: Current limiting warning [CUR], 9: Restart after momentary power failure [U-RES], 10: Source frequency synchronization [SY-HZ], 11: Alarm information [AL1], 12: Alarm information [AL2], 13: Alarm information [AL4], 14: DC fan lock [DCFL], 25: Universal DO [U-DO], 27: Cooling fan running [FAN], 32: Alarm output (for any alarm) [ALM], 33: Y-terminal test output ON [Y-ON], 34: Y-terminal test output OFF [Y-OFF]
	CMY	Transistor output common	This is a common terminal for transistor output signals.
	Y5A Y5C	Relay output	Signals can be selected in the same way as terminals Y1 to Y3. Contact capacity: 250 VAC, 0.3 A, cosφ = 0.3
	FM1, FM2	Analog output	The following monitor signals are output by selecting from analog DC voltage 0 to 10 V, DC current 4 to 20 mA, or in pulse 25 to 32000 p/s. (FM2 can output DC voltage only). 0: Power supply side power [PWR] 200%/+10 V, 1: Power supply side current RMS value [I-AC] 200%/+10 V, 2: Power supply side voltage RMS [V-AC] 250 (500) V/10 V, 3: Intermediate DC voltage [V-DC] 500 (1000) V/10 V, 4: Power supply frequency [FREQ] 100 Hz/10 V, 5: +10 V output test [P10]
	M	Analog output common	This is a common terminal for analog output signals.
Communication	RJ-45 connector	RJ-45 connector for keypad connection	This is used to connect the keypad. The keypad power is supplied from the converter via an extension cable for remote operation.
		RS-485 communication port	This is used to connect a computer or programmable controller, etc. by RS-485 communication.

■ Protection and early warning functions

Alarm name	Display	Operation details
AC overcurrent	AOC	This function is activated if the AC current instantaneous value exceeds the overcurrent detection level, such as when a power supply circuit short circuit or ground fault occurs.
AC undervoltage	ALU	This function is activated if the AC power supply voltage drops to the undervoltage detection level or below during converter operation. However, no alarm is output when "F02:Momentary power failure restart (mode selection)" data is set to 1 (Enable).
AC overvoltage	AOU	This function is activated if the AC power supply voltage exceeds the AC overvoltage detection level.
DC overvoltage	dOU	This function is activated when regenerative current from the inverter increases (regenerative energy exceeds braking capability), and the main circuit intermediate voltage exceeds the DC overvoltage detection level.
DC undervoltage	dLU	This function is activated if the intermediate DC voltage drops to the insufficient voltage detection level or below due to a drop in the power supply voltage during converter operation, etc. However, no alarm is output when "F02: Momentary power failure restart (mode selection)" data is set to 1 (Enable).
Input phase loss	LPU	This function is activated when the power is turned ON, and if there is a phase interruption at the three-phase power supply connected to the main circuit main power supply input terminals R, S, and T, or if the three-phase power supply voltage is unbalanced, an alarm stoppage will occur on the converter. It is necessary to turn the power OFF and ON again to reset the alarm.
Synchronous power supply frequency error	FrE	This function is activated when the power supply frequency detection value lies outside the range. However, no alarm is output when "F02: Momentary power failure restart (mode selection)" data is set to 1 (Enable).
Cooling fin overheat	OH1	This function is activated when the temperature around the cooling fins used to cool the main circuit semiconductor devices rises due to cooling fan stoppage, etc.
External alarm	OH2	A converter alarm stoppage occurs when an external signal is input (THR).
Converter internal overheat	OH3	This function is activated when the temperature around the PCBs rises due to poor ventilation inside the converter, etc.
Converter overload	OLU	This function is activated if the AC power supply current exceeds the converter overload level. Converter overload detection level (150%/60 s)
Memory error	Er1	This is activated if a memory error such as a data write error occurs.
Keypad communication error	Er2	This function is activated if a keypad transfer error occurs.
CPU error	Er3	This function is activated if a CPU error occurs.
Network error	Er4	This alarm is triggered when a transmission abnormality such as noise occurs while the converter is running with RS-485 communication. It is most likely caused by a PLC device error or communication line disconnection.
Charger circuit fault	PbF	This function is activated only when "73 answerback [73ANS]" is selected using X1/X2 function selection. There is no X1/X2 input (that is, the electromagnetic contactor for bypassing the charging circuit is closed) within 0.5 sec after the converter charging circuit control output (73A) signal is issued. To reset the alarm, change the X1/X2 function selection, or turn the power OFF and back ON again.
AC blown fuse	ACF	The converter's external AC fuse blows due to shorting or damage to the internal circuit.
AC input current error	ACE	This alarm is issued when the difference between the converter current command value and input AC current detection value exceeds the input current error detection level. However, no alarm is output when "F02: Momentary power failure restart (mode selection)" data is set to 1 (Enable).
DC fan lock	dFA	This alarm is issued when the DC fan stops. (75 kW models only) However, no alarm is output when "H28: Warning target definition" data is set to 1 (Disable).

11.6.2 Device configuration

[1] Device configuration table

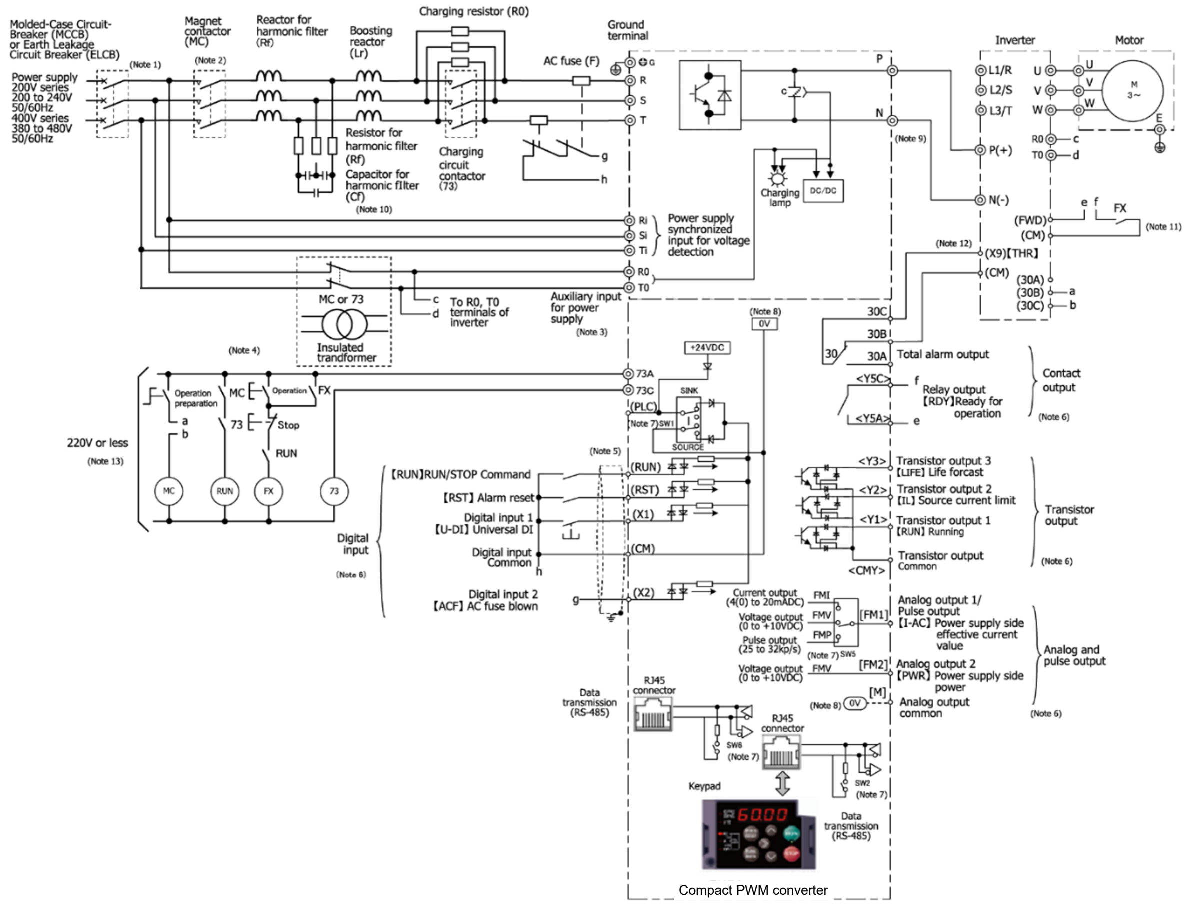
Voltage	Applicable motor [kW]	Type	Boosting reactor (Lr)	Qty	Filter resistor (Rf)	Qty	Filter reactor (Lf)	Qty	Filter capacitor (Cf)	Qty
200V series	5.5	RHC5.5C-2EJ	LR2C-7.5E	1	RF80-0.42OHM	3	LFC2C-7.5E	1	CF2C-7.5E	1
	7.5	RHC7.5C-2EJ								
	11	RHC11C-2EJ	LR2C-15E	1	RF150-0.2OHM	3	LFC2C-15E	1	CF2C-15E	1
	15	RHC15C-2EJ								
	18.5	RHC18.5C-2EJ	LR2C-22E	1	RF200-0.13OHM	3	LFC2C-22E	1	CF2C-22E	1
	22	RHC22C-2EJ								
400V series	5.5	RHC5.5C-4EJ	LR4C-7.5E	1	RF80-1.74OHM	3	LFC4C-7.5E	1	CF4C-7.5E	1
	7.5	RHC7.5C-4EJ								
	11	RHC11C-4EJ	LR4C-15E	1	RF150-0.79OHM	3	LFC4C-15E	1	CF4C-15E	1
	15	RHC15C-4EJ								
	18.5	RHC18.5C-4EJ	LR4C-22E	1	RF200-0.53OHM	3	LFC4C-22E	1	CF4C-22E	1
	22	RHC22C-4EJ								
	30	RHC30C-4EJ	LR4C-37E	1	RF400-0.38OHM	3	LFC4C-37E	1	CF4C-37E	1
	37	RHC37C-4EJ								
	45	RHC45C-4EJ	LR4C-55E	1	RF400-0.26OHM	3	LFC4C-55E	1	CF4C-55E	1
	55	RHC55C-4EJ								
	75	RHC75C-4EJ	LR4C-75E	1	RF400-0.38OHM	3	LFC4C-75E	1	CF4C-75E	1

Voltage	Applicable motor [kW]	Type	Charging circuit contactor (73)	Qty	Charging circuit: Charging resistor (R0)	Qty	Fuse (F)	Qty
200V series	5.5	RHC5.5C-2EJ	SC-5-1	1	CR80-7.5OHM	3	CR2LS-50S/UL	2
	7.5	RHC7.5C-2EJ						
	11	RHC11C-2EJ	SC-N1	1			CR2LS-75S/UL	2
	15	RHC15C-2EJ	SC-N2	1			CR2LS-100S/UL	2
	18.5	RHC18.5C-2EJ	SC-N3	1	CR120-2OHM	3		
	22	RHC22C-2EJ					CR2L-150S/UL	2
400V series	5.5	RHC5.5C-4EJ	SC-05	1	CR60-30OHM	3	CR6L-30S/UL	2
	7.5	RHC7.5C-4EJ						
	11	RHC11C-4EJ	SC-4-0	1			CR6L-50S/UL	2
	15	RHC15C-4EJ	SC-5-1	1				
	18.5	RHC18.5C-4EJ	SC-N1	1	CR80-7.5OHM	3		
	22	RHC22C-4EJ					CR6L-75S/UL	2
	30	RHC30C-4EJ	SC-N2	1			CR6L-100S/UL	2
	37	RHC37C-4EJ	SC-N2S	1			CR6L-150S/UL	2
	45	RHC45C-4EJ	SC-N3	1				
	55	RHC55C-4EJ	SC-N4	1			CR6L-200S/UL	2
	75	RHC75C-4EJ	SC-N5	1				

Note 1) Filter resistors (Rf) and charging resistors (RO) come in sets of three.
For an order quantity of “1,” three items will be shipped.

Note 2) Charging circuit contactors and fuses are products of Fuji Electric FA Components & Systems Co., Ltd.

[2] Basic connection diagrams



(Note 1) Install the recommended molded case circuit breaker (MCCB) or earth leakage circuit breaker (ELCB) (with overcurrent protection) to protect wiring on the PWM converter input (primary) side. Do not use a circuit breaker that exceeds the recommended rated current.

(Note 2) A magnetic contactor (MC) is used in addition to an MCCB or ELCB if isolating the PWM converter from the power supply, and therefore the recommended MC should be installed if required. Please note that if installing a coil such as an MC or solenoid near the PWM converter or inverter, connect a surge absorber in parallel.

(Note 3) If wishing to retain the integrated alarm signal issued if the protective function is triggered even when the PWM converter main power supply is shut off, or to constantly display the keypad, connect these terminals to the power supply. The PWM converter can be run even without inputting the power supply to these terminals (30 kW or higher only).

(Note 4) Isolate the circuit using an insulated transformer, or magnetic contactor (MC) auxiliary contact (contact b). When using for a non-grounded power supply, it is necessary to add an insulated transformer.

(Note 5) Use twisted wire or shielded wire for control signal lines. Shielded wires are generally grounded; however, if subject to significant induction noise from outside, it may be possible to suppress the effect of the noise by connecting wires to [CM]. Isolate control signal lines from the main circuit wiring as best as possible, and do not run inside the same duct (a distance of 10 cm or greater is recommended). If lines intersect, ensure that they do so almost perpendicularly to the main circuit wiring.

(Note 6) Each of the functions described for terminals [X1] to [X2] (digital input), terminals [Y1] to [Y3] (transistor output), and terminals [FM1] to [FM2] (monitor output) indicate the functions assigned by factory default.

(Note 7) These are the switches on control PCBs, and are used to set operations for each function.

(Note 8) 0V and 0V are isolated and insulated.

(Note 9) Ensure that inverter and PWM converter DC bus line wiring (between terminals P and P(+), N and N(-)) is within 5 m.

(Note 10) Ensure that the wire length between the filter capacitor and power line is within 5 m.

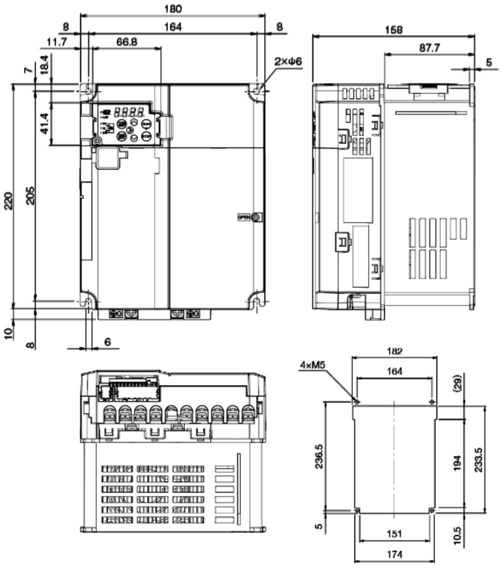
(Note 11) Design the sequence so that the RUN signal is not input to the inverter until the PWM converter is ready.

(Note 12) Set any of the inverter unit X terminals for external alarm (THR).

(Note 13) If using a 400V series inverter for the main power supply, connect a step-down transformer to ensure that the sequence circuit voltage is 220 V or less.

11.6.3 External Dimensions

■ Figure A

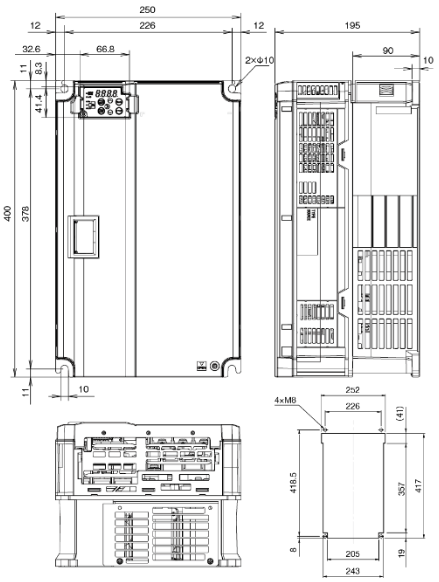


Panel cutting drawing

(Unit: mm)

Power supply voltage	Type
Three-phase 200 V	RHC5.5C-2EJ
	RHC7.5C-2EJ
Three-phase 400 V	RHC5.5C-4EJ
	RHC7.5C-4EJ

■ Figure B

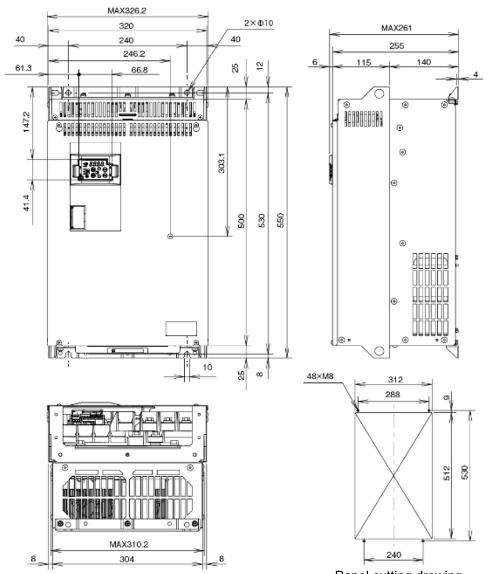


Panel cutting drawing

(Unit: mm)

Power supply voltage	Type
Three-phase 200 V	RHC18.5C-2EJ
	RHC22C-2EJ
Three-phase 400 V	RHC18.5C-4EJ
	RHC22C-4EJ

■ Figure C



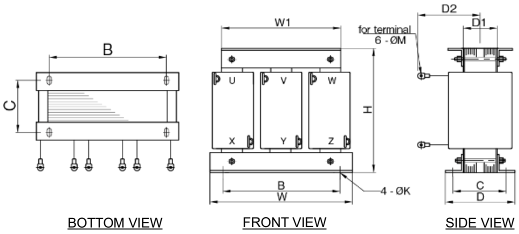
Panel cutting drawing

(Unit: mm)

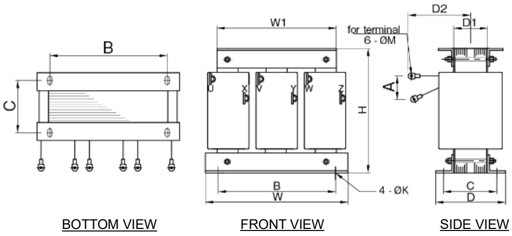
Power supply voltage	Type
Three-phase 400 V	RHC30C-4EJ
	RHC37C-4EJ

11.6.4 Peripheral equipment

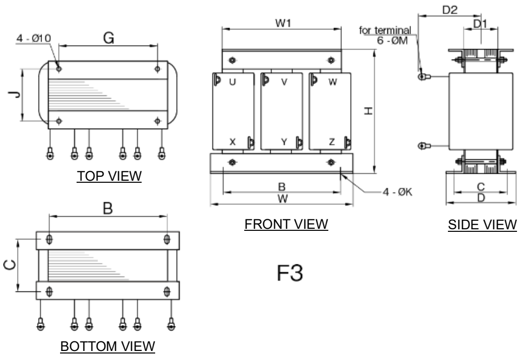
■ Boosting reactor



F1



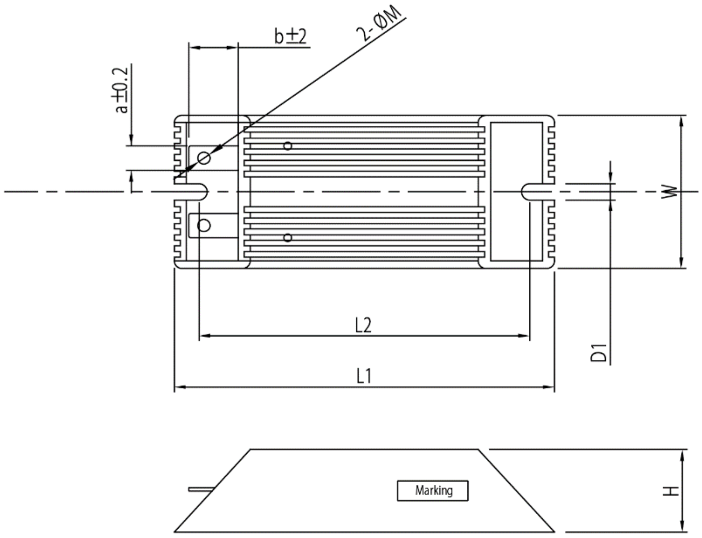
F2



F3

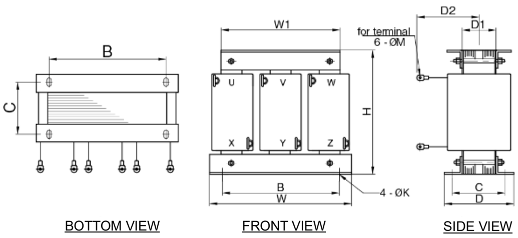
Converter type	Boosting reactor type	Dimensions (mm)											K	M	Figure	Approx. weight (kg)
		H (max)	W (±1)	B (±1)	C (±5)	D (±5)	W1 (±1)	D1 (±5)	D2 (±5)	A (±5)	G	J				
RHC5.5C-2EJ	LR2C-7.5E	150	180	128	127	149	160	57	100	10	-	-	7×10	5	F2	11
RHC7.5C-2EJ																
RHC11C-2EJ	LR2C-15E	180	210	140	133	155	175	63	115	-	-	-	7×10	8	F1	16
RHC15C-2EJ																
RHC18.5C-2EJ	LR2C-22E	195	240	160	153	175	200	63	115	-	170	99	7×10	8	F3	21
RHC22C-2EJ																
RHC5.5C-4EJ	LR4C-7.5E	152	180	128	117	139	160	47	90	-	-	-	7×10	5	F1	10
RHC7.5C-4EJ																
RHC11C-4EJ	LR4C-15E	178	215	145	123	145	180	53	100	-	-	-	7×10	5	F1	14
RHC15C-4EJ																
RHC18.5C-4EJ	LR4C-22E	175	210	150	143	165	185	73	115	-	-	-	7×10	6	F1	19
RHC22C-4EJ																
RHC30C-4EJ	LR4C-37E	257	250	175	163	185	215	73	125	-	185	109	7×10	8	F3	35
RHC37C-4EJ																
RHC45C-4EJ	LR4C-55E	269	305	205	180	202	255	86	135	-	225	122	12x14	10	F3	50
RHC55C-4EJ																
RHC75C-4EJ	LR4C-75E	277	310	210	190	212	260	96	140	-	230	132	12x14	10	F3	58

■ **Filter resistor**

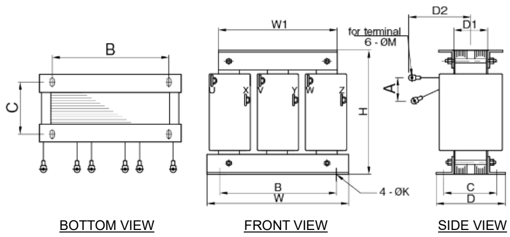


Converter type	Filter resistor type	Dimensions (mm)							M	Approx. weight (kg)
		L1 (±2)	L2 (±2)	W (±0.5)	H (±0.5)	D1 (±0.3)	a (±0.2)	b (±2)		
RHC5.5C-2EJ RHC7.5C-2EJ	RF80-0.42OHM	150	137	41	22	4.3	6.5	10	3.2	0.20
RHC11C-2EJ RHC15C-2EJ	RF150-0.2OHM	210	197	41	22	4.3	6.5	10	3.2	0.28
RHC18.5C-2EJ RHC22C-2EJ	RF200-0.13OHM	165	146	60	30	5.3	10	20.8	4.3	0.49
RHC5.5C-4EJ RHC7.5C-4EJ	RF80-1.74OHM	150	137	41	22	4.3	6.5	10	3.2	0.20
RHC11C-4EJ RHC15C-4EJ	RF150-0.79OHM	210	197	41	22	4.3	6.5	10	3.2	0.28
RHC18.5C-4EJ RHC22C-4EJ	RF200-0.53OHM	165	146	60	30	5.3	10	20.8	4.3	0.49
RHC30C-4EJ RHC37C-4EJ	RF400-0.38OHM	265	246	60	30	5.3	10	20.8	4.3	0.77
RHC45C-4EJ RHC55C-4EJ	RF400-0.26OHM	265	246	60	30	5.3	10	20.8	4.3	0.77
RHC75C-4EJ	RF400-0.38OHM	265	246	60	30	5.3	10	20.8	4.3	0.77

■ Filter reactor



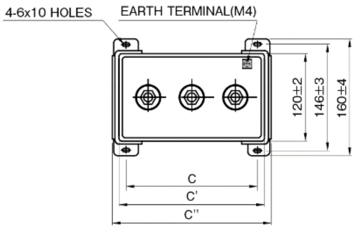
F1

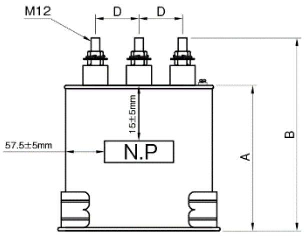


F2

Converter type	Filter reactor type	Dimensions (mm)									K	M	Figure	Approx. weight (kg)
		H (max)	W (±1)	B (±1)	C (±5)	D (±5)	W1 (±1)	D1 (±5)	D2 (±5)	A (±5)				
RHC5.5C-2EJ RHC7.5C-2EJ	LFC2C-7.5E	105	155	91	95	117	114	25	80	40	7x10	5	F2	3
RHC11C-2EJ RHC15C-2EJ	LFC2C-15E	105	155	91	98	120	114	28	85	-	7x10	8	F1	4
RHC18.5C-2EJ RHC22C-2EJ	LFC2C-22E	105	155	91	102	124	114	32	95	-	7x10	8	F1	4
RHC5.5C-4EJ RHC7.5C-4EJ	LFC4C-7.5E	107	155	91	95	117	114	25	70	18	7X10	5	F2	3
RHC11C-4EJ RHC15C-4EJ	LFC4C-15E	107	155	91	100	122	114	30	85	-	7x10	5	F1	4
RHC18.5C-4EJ RHC22C-4EJ	LFC4C-22E	109	155	91	110	132	114	40	85	-	7x10	6	F1	4
RHC30C-4EJ RHC37C-4EJ	LFC4C-37E	123	155	104	107	129	130	37	90	-	7x10	8	F1	6
RHC45C-4EJ RHC55C-4EJ	LFC4C-55E	120	155	104	120	142	130	50	105	-	7x10	10	F1	7
RHC75C-4EJ	LFC4C-75E	154	180	128	127	149	160	57	115	-	7x10	10	F1	13

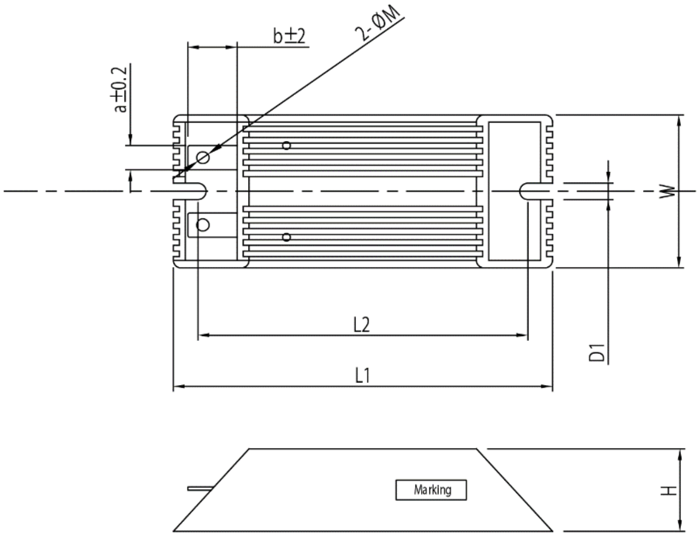
■ **Filter capacitor**





Converter type	Filter capacitor type	Dimensions (mm)						Approx. weight (kg)
		A (±3)	B (±7)	C (±2)	C' (±3)	C" (±4)	D (±5)	
RHC5.5C-2EJ	CF2C-7.5E	120	176	170	200	210	60	4.3
RHC7.5C-2EJ								
RHC11C-2EJ	CF2C-15E	160	216	170	200	210	60	5.2
RHC15C-2EJ								
RHC18.5C-2EJ	CF2C-22E	170	226	170	200	210	60	5.4
RHC22C-2EJ								
RHC5.5C-4EJ	CF4C-7.5E	140	196	170	200	210	60	4.7
RHC7.5C-4EJ								
RHC11C-4EJ	CF4C-15E	160	216	170	200	210	60	5.2
RHC15C-4EJ								
RHC18.5C-4EJ	CF4C-22E	180	236	170	200	210	60	5.7
RHC22C-4EJ								
RHC30C-4EJ	CF4C-37E	180	236	170	200	210	60	5.7
RHC37C-4EJ								
RHC45C-4EJ	CF4C-55E	250	306	170	200	210	60	7.2
RHC55C-4EJ								
RHC75C-4EJ	CF4C-75E	180	236	170	200	210	60	5.7

■ **Charging resistor**



Converter type	Charging resistor type	Dimensions (mm)							M	Approx. weight (kg)
		L1 (±2)	L2 (±2)	W (±0.5)	H (±0.5)	D1 (±0.3)	a (±0.2)	b (±2)		
RHC5.5C-2EJ RHC7.5C-2EJ RHC11C-2EJ RHC15C-2EJ	CR80-7.5OHM	150	137	41	22	4.3	6.5	10	3.2	0.20
RHC18.5C-2EJ RHC22C-2EJ	CR120-2OHM	182	169	41	22	4.3	6.5	10	3.2	0.24
RHC5.5C-4EJ RHC7.5C-4EJ RHC11C-4EJ RHC15C-4EJ	CR60-30OHM	100	87	41	22	4.3	6.5	13	3.2	0.11
RHC18.5C-4EJ RHC22C-4EJ RHC30C-4EJ RHC37C-4EJ RHC45C-4EJ RHC55C-4EJ RHC75C-4EJ	CR80-7.5OHM	150	137	41	22	4.3	6.5	10	3.2	0.20

11.7 DC Reactors (DCRs)

A DCR is mainly used for power supply matching and for input power factor correction (for reducing harmonic components). Please select a DC reactor according to the capacity of the applicable motor.

For power supply matching

- Use a DCR when the capacity of a power supply transformer exceeds 500 kVA and is 10 times or more the rated inverter capacity. In this case, the percent reactance of the power supply decreases, and harmonic components and their peak value increase. These factors may break rectifiers or capacitors in the converter section of the inverter, or decrease the capacitance of the capacitor (which can shorten the inverter's service life).
- Also use a DCR when there are thyristor-driven loads or when phase-advancing capacitors are being turned ON/OFF.
- Use a DCR when the interphase voltage unbalance ratio of the inverter power supply exceeds 2%.

$$\text{Interphase voltage unbalance (\%)} = \frac{\text{Max. voltage (V)} - \text{Min. voltage (V)}}{\text{Three-phase average voltage (V)}} \times 67$$

For input power factor correction (for suppressing harmonics)

Generally, a capacitor is used to improve the power factor of the load; however, it cannot be used in a system that includes an inverter. Using a DCR increases the reactance of the inverter's power supply so as to decrease harmonic components on the power supply lines and improve the power factor of the inverter. Using a DCR improves the input power factor to approximately 86% to 95% (for a three-phase power source).

Note
- At the time of shipping, a jumper bar is connected across terminals P1 and P (+) on the terminal block. Remove the jumper bar when connecting a DCR.
- If a DCR is not going to be used, do not remove the jumper bar.

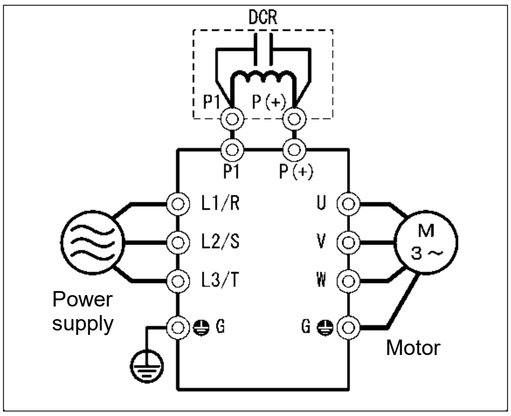


Figure 11.7-1 External view of a DC reactor (DCR) and connection example

Table 11.7-1 DC reactors (DCRs)

Power supply voltage	Standard applicable motor (kW)	Standard applicable motor (HP)	DC reactor type	Rated current (A)	Inductance (mH)	Generated loss (W)
Three-phase 200 V	0.1	1/8	DCR2-0.2D	1.5	20	2.4
	0.2	1/4				
	0.4	1/2	DCR2-0.4D	3.0	12	6.7
	0.75	1	DCR2-0.75D	5.0	7.0	9.2
	1.1	1.5	DCR2-1.5D	8.0	4.0	10
	1.5	2				
	2.2	3	DCR2-2.2D	11	3.0	13
	3.0	4	DCR2-3.7D	18	1.7	16
	3.7	5				
	5.5	7.5	DCR2-5.5D	25	1.2	17
	7.5	10	DCR2-7.5 D	34	0.8	19
	11	15	DCR2-11 D	50	0.6	25
	15	20	DCR2-15 D	67	0.4	23
	18.5	25	DCR2-18.5 D	81	0.35	27
	22	30	DCR2-22D	98	0.3	34
	30	40	DCR2-30D	136	0.23	39
Three-phase 400 V	0.4	1/2	DCR4-0.4D	1.5	50	4.1
	0.75	1	DCR4-0.75D	2.5	30	8.8
	1.1	1.5	DCR4-1.5D	4.0	16	11
	1.5	2				
	2.2	3	DCR4-2.2D	5.5	12	12
	3.0	4	DCR4-3.7D	9.0	7.0	17
	3.7	5				
	5.5	7.5	DCR4-5.5D	13	4.0	17
	7.5	10	DCR4-7.5D	18	3.5	22
	11	15	DCR4-11D	25	2.2	24
	15	20	DCR4-15D	34	1.8	35
	18.5	25	DCR4-18.5D	41	1.4	32
	22	30	DCR4-22D	49	1.2	40
	30	40	DCR4-30D	71	0.86	40
	37	50	DCR4-37D	88	0.70	41
Single-phase 200 V	0.1	1/8	DCR2-0.2D	1.5	20	2.4
	0.2	1/4	DCR2-0.4D	3.0	12	6.7
	0.4	1/2	DCR2-0.75D	5.0	7.0	9.2
	0.55	3/4				
	0.75	1	DCR2-1.5D	8.0	4.0	10
	1.1	1.5	DCR2-2.2D	11	3.0	13
	1.5	2	DCR2-3.7D	18	1.7	16
	2.2	3				
	3.0	4	DCR2-5.5D	25	1.2	17

Note: Generated losses listed in the above tables are approximate values that are calculated according to the following conditions:

- The power supply is three-phase 200 V/400 V, 50 Hz, with 0% interphase voltage unbalance ratio.
- The capacity of the power supply used is the larger of either: 500 kVA, or 10 times the rated capacity of the inverter.
- The motor is a 4-pole standard model at full load (100%).
- An AC reactor (ACR) is not connected.

Figure A

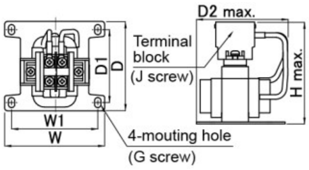


Figure B

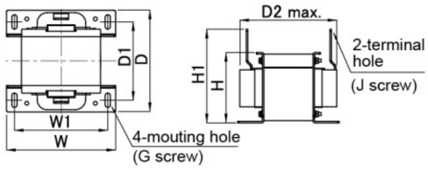


Figure C

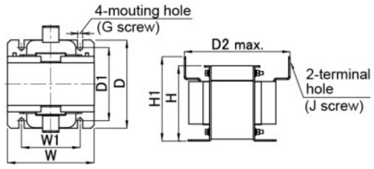
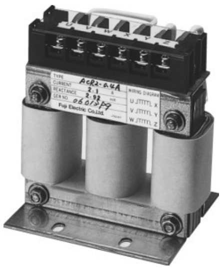


Table 11.7-2 DC reactors (DCRs) external dimensions

Power supply voltage	DC reactor type	Figure	Dimensions mm (inch)									Mass kg (lb)
			W	W1	D	D1	D2	H	H1	Mounting hole (G)	Terminal hole (J)	
Three-phase 200 V, Single-phase 200 V	DCR2-0.2D	A	66 (2.6)	56 (2.2)	86 (3.4)	72 (2.8)	89 (3.5)	88 (3.5)	—	M4 (5.2×8 (0.2×0.31))	M4	0.6 (1.3)
	DCR2-0.4D	A	66 (2.6)	56 (2.2)	86 (3.4)	72 (2.8)	89 (3.5)	88 (3.5)	—	M4 (5.2×8 (0.2×0.31))	M4	0.6 (1.3)
	DCR2-0.75D	A	66 (2.6)	56 (2.2)	86 (3.4)	72 (2.8)	89 (3.5)	88 (3.5)	—	M4 (5.2×8 (0.2×0.31))	M4	0.6 (1.3)
	DCR2-1.5D	A	66 (2.6)	56 (2.2)	86 (3.4)	72 (2.8)	89 (3.5)	88 (3.5)	—	M4 (5.2×8 (0.2×0.31))	M4	0.7 (1.5)
	DCR2-2.2D	A	83 (3.3)	71 (2.8)	95 (3.7)	80 (3.1)	96 (3.8)	93 (3.7)	—	M5 (6×9 (0.24×0.35))	M4	0.8 (1.8)
	DCR2-3.7D	A	83 (3.3)	71 (2.8)	95 (3.7)	80 (3.1)	96 (3.8)	93 (3.7)	—	M5 (6×9 (0.24×0.35))	M4	1.1 (2.4)
	DCR2-5.5D	A	110 (4.3)	95 (3.7)	98 (3.9)	80 (3.1)	103 (4.1)	120 (4.7)	—	M6 (7×11 (0.28×0.43))	M5	1.5 (3.3)
	DCR2-7.5D	A	110 (4.3)	95 (3.7)	98 (3.9)	80 (3.1)	120 (4.7)	120 (4.7)	—	M6 (7×11 (0.28×0.43))	M5	1.9 (4.2)
	DCR2-11D	A	110 (4.3)	95 (3.7)	98 (3.9)	80 (3.1)	125 (4.9)	130 (5.1)	—	M6 (7×11 (0.28×0.43))	M6	2.6 (5.7)
	DCR2-15D	B	145 (5.7)	124 (4.9)	119 (4.7)	88 (3.5)	136 (5.4)	93.4 (3.7)	124.4 (4.9)	M6 (7×19 (0.28×0.75))	M8	4.2 (9.3)
	DCR2-18.5D	B	145 (5.7)	124 (4.9)	132.5 (5.2)	101.5 (4.0)	146 (5.7)	93.4 (3.7)	124.4 (4.9)	M6 (7×19 (0.28×0.75))	M8	5.2 (11.5)
	DCR2-22D	B	145 (5.7)	124 (4.9)	135 (5.3)	104 (4.1)	146 (5.7)	93.4 (3.7)	124.4 (4.9)	M6 (7×19 (0.28×0.75))	M8	5.3 (11.7)
	DCR2-30D	C	132.9 (5.2)	90 (3.5)	135 (5.3)	112 (4.4)	190 (7.4)	115 (4.5)	129.1 (5.1)	M6 (8 (0.31))	M10	8.4 (18.5)
Three-phase 400 V	DCR4-0.4D	A	66 (2.6)	56 (2.2)	86 (3.4)	72 (2.8)	89 (3.5)	99 (3.9)	—	M4 (5.2×8 (0.2×0.31))	M4	0.7 (1.5)
	DCR4-0.75D	A	66 (2.6)	56 (2.2)	86 (3.4)	72 (2.8)	89 (3.5)	99 (3.9)	—	M4 (5.2×8 (0.2×0.31))	M4	0.7 (1.5)
	DCR4-1.5D	A	66 (2.6)	56 (2.2)	86 (3.4)	72 (2.8)	89 (3.5)	99 (3.9)	—	M4 (5.2×8 (0.2×0.31))	M4	0.7 (1.5)
	DCR4-2.2D	A	83 (3.3)	71 (2.8)	95 (3.7)	80 (3.1)	96 (3.8)	99 (3.9)	—	M5 (6×9 (0.24×0.35))	M4	1.0 (2.2)
	DCR4-3.7D	A	83 (3.3)	71 (2.8)	95 (3.7)	80 (3.1)	105 (4.1)	99 (3.9)	—	M5 (6×9 (0.24×0.35))	M4	1.2 (2.6)
	DCR4-5.5D	A	83 (3.3)	71 (2.8)	95 (3.7)	80 (3.1)	101 (4.0)	105 (4.1)	—	M5 (6×9 (0.24×0.35))	M4	1.3 (2.9)
	DCR4-7.5D	A	110 (4.3)	95 (3.7)	98 (3.9)	80 (3.1)	120 (4.7)	115 (4.5)	—	M6 (7×11 (0.28×0.43))	M5	2.0 (4.4)
	DCR4-11D	A	110 (4.3)	95 (3.7)	98 (3.9)	80 (3.1)	125 (4.9)	120 (4.7)	—	M6 (7×11 (0.28×0.43))	M5	2.3 (5.1)
	DCR4-15D	A	138 (5.4)	124 (4.9)	114 (4.5)	96 (3.8)	131 (5.2)	130 (5.1)	—	M6 (7×11 (0.28×0.43))	M5	3.1 (6.8)
	DCR4-18.5D	A	138 (5.4)	124 (4.9)	114 (4.5)	96 (3.8)	142 (5.6)	138 (5.4)	—	M6 (7×11 (0.28×0.43))	M6	3.9 (8.6)
	DCR4-22D	A	138 (5.4)	124 (4.9)	114 (4.5)	96 (3.8)	142 (5.6)	138 (5.4)	—	M6 (7×11 (0.28×0.43))	M6	4.2 (9.3)
	DCR4-30D	C	132.9 (5.2)	90 (3.5)	138 (5.4)	115 (4.5)	175 (6.9)	115 (4.5)	129.1 (5.1)	M6 (8 (0.31))	M8	8.9 (19.6)
	DCR4-37D	C	152.1 (6.0)	110 (4.3)	129 (5.1)	110 (4.3)	175 (6.9)	131.9 (5.2)	146.8 (5.8)	M6 (8 (0.31))	M8	11 (24.3)

11.8 AC Reactors (ACRs)

Use an ACR when the converter part of the inverter should supply very stable DC power, for example, in DC link bus operation (shared PN operation). Generally, ACRs are used for correction of voltage waveform and power factor, or for power supply matching, but not for suppressing harmonic components in the power lines. For suppressing harmonic components, use a DCR. Please select an AC reactor according to the capacity of the applicable motor.



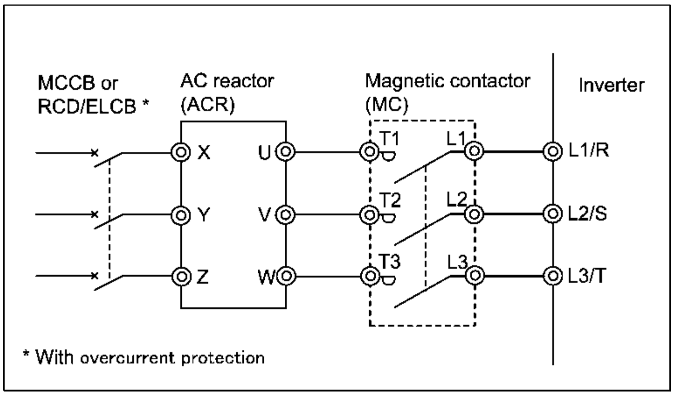


Figure 11.8-1 External view of AC reactor (ACR) and connection example

Table 11.8-1 AC reactor (ACR)

Power supply voltage	Standard applicable motor (kW)	Standard applicable motor (HP)	AC reactor type	Rated current (A)	Reactance (mΩ/phase)		Coil resistance (mΩ)	Generated loss (W)
					50Hz	60Hz		
Three-phase 200 V	0.1	1/8	ACR2-0.4A	3	917	1100	-	2.5
	0.2	1/4						5
	0.4	1/2						10
	0.75	1	ACR2-0.75A	5	493	592	-	12
	1.1	1.5	ACR2-1.5A	8	295	354	-	14
	1.5	2						
	2.2	3	ACR2-2.2A	11	213	256	-	16
	3.0	4	ACR2-3.7A	17	128	153	-	23
	3.7	5						
	5.5	7.5	ACR2-5.5A	25	87.7	105	-	27
	7.5	10	ACR2-7.5A	33	65	78	-	30
	11	15	ACR2-11A	46	45.5	54.7	-	37
	15	20	ACR2-15A	59	34.8	41.8	-	43
	18.5	25	ACR2-18.5A	74	28.6	34.3	-	51
	22	30	ACR2-22A	87	24	28.8	-	57
	30	40	ACR2-37	200	10.8	13	0.5	28.6
Three-phase 400 V	0.4	1/2	ACR4-0.75A	2.5	1920	2300	-	5
	0.75	1					-	10
	1.1	1.5	ACR4-1.5A	3.7	1160	1390	-	11
	1.5	2						
	2.2	3	ACR4-2.2A	5.5	851	1020	-	14
	3.0	4	ACR4-3.7A	9	512	615	-	17
	3.7	5						
	5.5	7.5	ACR4-5.5A	13	349	418	-	22
	7.5	10	ACR4-7.5A	18	256	307	-	27
	11	15	ACR4-11A	24	183	219	-	40
	15	20	ACR4-15A	30	139	167	-	46
	18.5	25	ACR4-18.5A	39	114	137	-	57
	22	30	ACR4-22A	45	95.8	115	-	62
	30	40	ACR4-37	100	41.7	50	2.73	38.9
	37	50	ACR4-37	100	41.7	50	2.73	55.7
Single-phase 200 V	0.1	1/8	ACR2-0.4A	3	917	1100	-	5
	0.2	1/4						10
	0.4	1/2	ACR2-0.75A	5	493	592	-	12
	0.55	3/4	ACR2-1.5A	8	295	354	-	14
	0.75	1						
	1.1	1.5	ACR2-2.2A	11	213	256	-	16
	1.5	2						
	2.2	3	ACR2-3.7A	17	128	153	-	23
	3.0	4	ACR2-5.5A	25	87.7	105	-	27

Note: Generated losses listed in the above table are approximate values that are calculated according to the following conditions:

- The power supply is three-phase 200 V/400 V, 50 Hz, with 0% interphase voltage unbalance ratio.
- The capacity of the power supply used is the larger of either: 500 kVA, or 10 times the rated capacity of the inverter.
- The motor is a 4-pole standard model at full load (100%).

Figure A

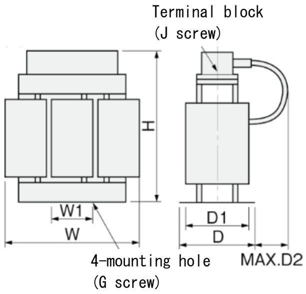


Figure B

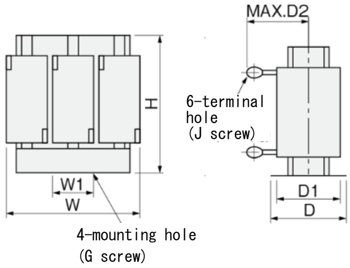


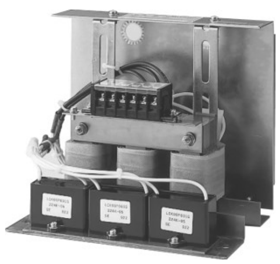
Table 11.8-2 AC reactors (ACRs) external dimensions

Power supply voltage	DC reactor type	Figure	Dimensions mm (inch)								Mass kg (lb)
			W	W1	D	D1	D2	G	H	Terminal hole (J)	
Single phase/ three-phase 200 V	ACR2-0.4A	A	120 (4.7)	40 (1.6)	90 (3.5)	65 (2.6)	20 (0.8)	M5 (6×10 (0.24×0.39))	115 (4.5)	M4	1.4 (3.1)
	ACR2-0.75A		120 (4.7)	40 (1.6)	100 (3.9)	75 (3.0)	20 (0.8)	M5 (6×10 (0.24×0.39))	115 (4.5)	M4	1.9 (4.2)
	ACR2-1.5A		120 (4.7)	40 (1.6)	100 (3.9)	75 (3.0)	20 (0.8)	M5 (6×10 (0.24×0.39))	115 (4.5)	M4	2.0 (4.4)
	ACR2-2.2A		120 (4.7)	40 (1.6)	100 (3.9)	75 (3.0)	20 (0.8)	M5 (6×10 (0.24×0.39))	115 (4.5)	M4	2.0 (4.4)
	ACR2-3.7A		125 (4.9)	40 (1.6)	100 (3.9)	75 (3.0)	25 (1.0)	M5 (6×10 (0.24×0.39))	125 (4.9)	M4	2.4 (5.3)
	ACR2-5.5A		125 (4.9)	40 (1.6)	115 (4.5)	90 (3.5)	25 (1.0)	M5 (6×10 (0.24×0.39))	125 (4.9)	M4	3.1 (6.8)
	ACR2-7.5A		125 (4.9)	40 (1.6)	115 (4.5)	90 (3.5)	106 (4.2)	M5 (6×10 (0.24×0.39))	95 (3.7)	M5	3.1 (6.8)
	ACR2-11A		125 (4.9)	40 (1.6)	125 (4.9)	100 (3.9)	106 (4.2)	M5 (6×10 (0.24×0.39))	95 (3.7)	M6	3.7 (8.2)
	ACR2-15A	B	180 (7.1)	60 (2.4)	110 (4.3)	85 (3.3)	106 (4.2)	M6 (7×11 (0.28×0.43))	115 (4.5)	M6	4.8 (10.6)
	ACR2-18.5A		180 (7.1)	60 (2.4)	110 (4.3)	85 (3.3)	109 (4.3)	M6 (7×11 (0.28×0.43))	115 (4.5)	M6	5.1 (11.2)
	ACR2-22A		180 (7.1)	60 (2.4)	110 (4.3)	85 (3.3)	109 (4.3)	M6 (7×11 (0.28×0.43))	115 (4.5)	M6	5.1 (11.2)
	ACR2-37		190 (7.5)	60 (2.4)	120 (4.7)	90 (3.5)	172 (6.8)	M6 (7×11 (0.28×0.43))	190 (7.5)	M8	11.0 (24.3)
Three-phase 400 V	ACR4-0.75A	B	120 (4.7)	40 (1.6)	90 (3.5)	65 (2.6)	106 (4.2)	M5 (6×10 (0.24×0.39))	85 (3.3)	M4	1.1 (2.4)
	ACR4-1.5A		125 (4.9)	40 (1.6)	100 (3.9)	75 (3.0)	106 (4.2)	M5 (6×10 (0.24×0.39))	85 (3.3)	M4	1.9 (4.2)
	ACR4-2.2A		125 (4.9)	40 (1.6)	100 (3.9)	75 (3.0)	106 (4.2)	M5 (6×10 (0.24×0.39))	95 (3.7)	M4	2.2 (4.9)
	ACR4-3.7A		125 (4.9)	40 (1.6)	100 (3.9)	75 (3.0)	106 (4.2)	M5 (6×10 (0.24×0.39))	95 (3.7)	M4	2.4 (5.3)
	ACR4-5.5A		125 (4.9)	40 (1.6)	115 (4.5)	90 (3.5)	106 (4.2)	M5 (6×10 (0.24×0.39))	95 (3.7)	M5	3.1 (6.8)
	ACR4-7.5A		125 (4.9)	40 (1.6)	115 (4.5)	90 (3.5)	106 (4.2)	M5 (6×10 (0.24×0.39))	95 (3.7)	M5	3.7 (8.2)
	ACR4-11A		180 (7.1)	60 (2.4)	110 (4.3)	85 (3.3)	106 (4.2)	M6 (7×11 (0.28×0.43))	115 (4.5)	M6	4.3 (9.5)
	ACR4-15A		180 (7.1)	60 (2.4)	110 (4.3)	85 (3.3)	106 (4.2)	M6 (7×11 (0.28×0.43))	137 (5.4)	M6	5.4 (11.9)
	ACR4-18.5A		180 (7.1)	60 (2.4)	110 (4.3)	85 (3.3)	106 (4.2)	M6 (7×11 (0.28×0.43))	137 (5.4)	M6	5.7 (12.6)
	ACR4-22A		180 (7.1)	60 (2.4)	110 (4.3)	85 (3.3)	106 (4.2)	M6 (7×11 (0.28×0.43))	137 (5.4)	M6	5.9 (13.0)
	ACR4-37		190 (7.5)	60 (2.4)	120 (4.7)	90 (3.5)	172 (6.8)	M6 (7×11 (0.28×0.43))	190 (7.5)	M8	12.0 (26.5)

11.9 Output Circuit Filters

Insert an output circuit filter (OFL) in the inverter power output circuit to:

- Suppress the surge voltage at motor terminals
  This protects the motor from insulation damage caused by the application of high voltage surge currents from the 400 V class series of inverters.
- Suppress leakage current from the output lines
  This reduces the leakage current from long power feed lines. (The maximum wiring length must be 400 m.)
- Minimize radiation and induction noise from the output lines
  An OFL effectively suppresses noise from long lines such as wiring at plants.



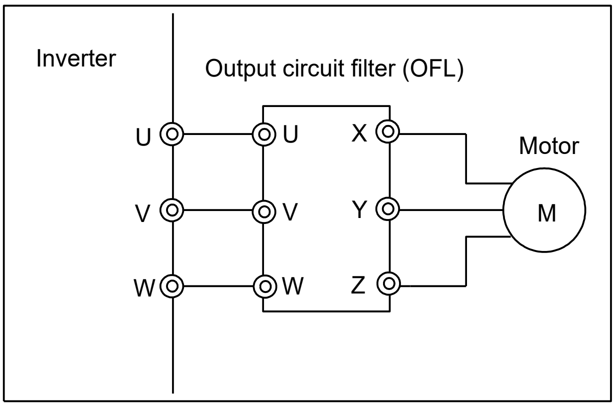


Figure 11.9-1 External view of output circuit filter (OFL) and connection example

Table 11.9-1 Output circuit filter (OFL)
OFL-□□□-4A

Power supply voltage	Standard applicable motor (kW)	Filter type	Rated current (A)	Overload capability	Inverter input power supply voltage	Permissible carrier frequency range (kHz)	Max. output frequency (Hz)	Generated loss (W)
Three-phase 400V	0.4	OFL-0.4-4A	1.5	"150%-1 min" "200%-0.5 s"	Three-phase 380 to 480 (V) 50/60 (Hz)	0.75 to 16	400	80
	0.75	OFL-1.5-4A	3.7					105
	1.5							
	2.2	OFL-3.7-4A	9					210
	3.0							
	3.7							
	5.5	OFL-7.5-4A	18					190
	7.5							
	11	OFL-15-4A	30					320
	15							
	18.5	OFL-22-4A	45					350
	22							
	30	OFL-30-4A	60	"150%-1 min" "180%-0.5 s"			120	570
	37	OFL-37-4A	75					610

OFL-□□□--4A

■ Filter (for 22 kW or below)

Figure A

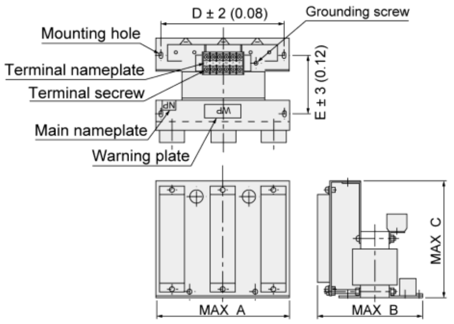
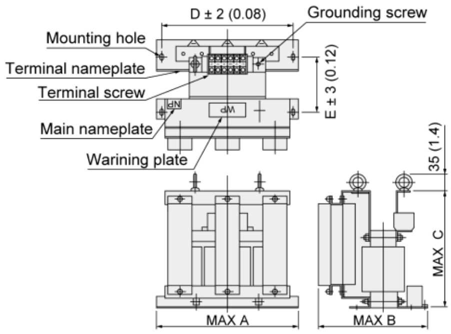
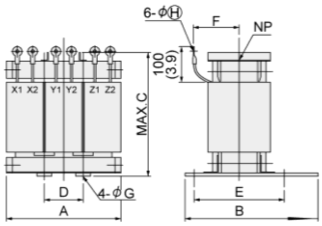


Figure B



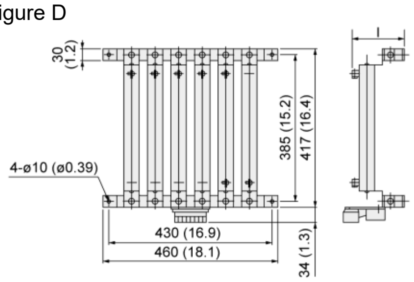
■ Reactor (for 30 kW or above)

Figure C



■ Resistor and capacitor (for 30 kW or above)

Figure D



For filters OFL-30-4A and greater, a reactor, resistor, and capacitor should be installed separately.
(Those parts are not included in the mass of a filter. If ordered with the filter type, the filter is shipped in combination with a reactor, resistor, and capacitor.)

	Filter type	Figure	A	B	C	D	E	F	Mounting screw G	Terminal screw H	I	Grounding screw
		Dimensions [mm] (inch)										
400 V class series	OFL-0.4-4A	A	220 (8.7)	175 (6.9)	195 (7.7)	200 (7.9)	95 (3.7)	—	M5	M4	—	M4
	OFL-1.5-4A											
	OFL-3.7-4A			225 (8.9)	220 (8.7)		115 (4.5)					
	OFL-7.5-4A		290 (11.4)	290 (11.4)	230 (9.1)	260 (10.2)	160 (6.3)		M6	M5		M5
	OFL-15-4A	B	330 (13.0)	275 (10.8)	310 (12.2)	300 (11.8)	145 (5.7)		M8	M6		M6
	OFL-22-4A			300 (11.8)	330 (13.0)		170 (6.7)					
	OFL-30-4A	C/D	210 (8.3)	175 (6.9)	210 (8.3)	70 (2.8)	140 (5.5)	90 (3.5)	8 (0.31)	6.4 (0.25)	160 (6.3)	—
	OFL-37-4A		220 (8.7)	190 (7.5)	220 (8.7)	75 (3)	150 (5.9)	95 (3.7)				

Note: The OFL-□□□-4A models have no restrictions on carrier frequency.

11.10 Zero-phase Reactors for Reducing Radio Noise (ACLs)

An ACL is used to reduce radio frequency noise emitted from the inverter output wiring, and therefore inverter output wiring should be passed through the ACL. Pass all four wires including the three inverter output wires and grounding wire through the ACL in the same direction. If using shielded wires, the shields should also be passed through the ACL. Be sure to use wires with heat resistance of 75°C (167°F) or higher. It is recommended that wiring should be passed though in a single turn.

The ACL absorbs high-frequency noise components and emits them as heat into the air so that the amount of heat generation can be large. If it happens, lower the carrier frequency, upgrade the heat-resistance rank of wires, increase the number of the ACLs to decrease the number of turns per ACL, replace the ACLs with higher type ones, or take any other measures.

The wire size is determined depending upon the ACL size (I.D.) and installation requirements. Refer to Table 11.10-1.

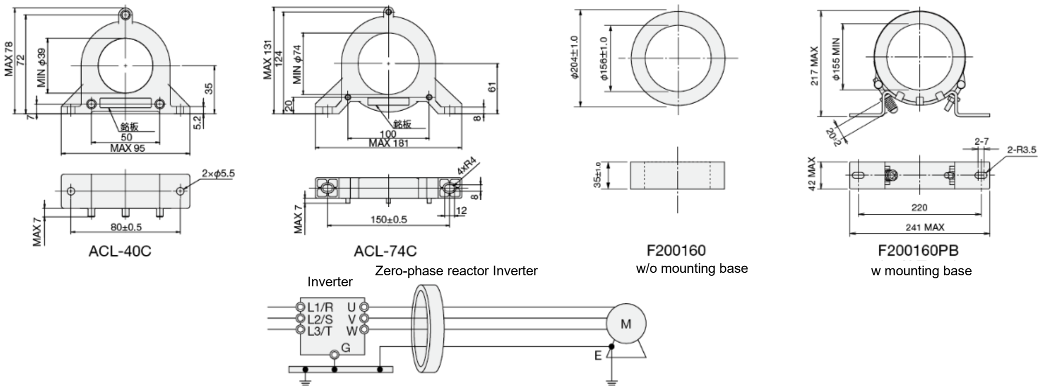


Figure 11.10-1 Dimensions of zero-phase reactor for reducing radio noise (ACL) and connection example

Table 11.10-1 Zero-phase reactors for reducing radio noise (ACL)

No. of turns	Inverter output wire size		Applicable zero-phase reactor
	75 °C, 90 °C wire *1	75 °C wire (AWG) *2	
1	38 mm^2 or less 5.5 mm^2 × 2P to 22 mm^2 × 2P	1AWG or less AWG 10 × 2P to AWG 4 × 2P	ACL-40C
	250 mm^2 or less 38 mm^2 × 2P to 100 mm^2 × 2P	500 kcmil or less AWG 2 × 2P to AWG 4/0 × 2P	ACL-74C
	150 mm^2×2P to 325 mm^2×2P 150 mm^2×3P to 325 mm^2×3P 250 mm^2×4P to 325 mm^2×4P	250 kcmil×2P to 600 kcmil×2P 250 kcmil×3P to 600 kcmil×3P 400 kcmil×4P to 600 kcmil×4P	F200160, F200160PB
2	14 mm^2 or less	AWG 6 or less	ACL-40C
	60 mm^2 or less 5.5 mm^2 × 2P to 22 mm^2 × 2P	AWG 1/ or less AWG 10 × 2P to AWG 4 × 2P	ACL-74C
4	5.5 mm^2 or less	AWG 10 or less	ACL-40C
	14 mm^2 or less	AWG 6 or less	ACL-74C

*1 HIV (heat-resistant polyvinyl chloride insulated wire) and crosslinked polyethylene are anticipated.

*2 THW (heat-resistant IV cable) is anticipated.

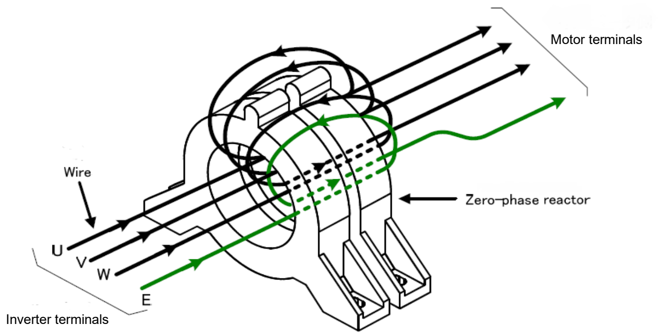


Fig. 11.10-2 Connection example for 2 reactors x 2 turns = 4 turns

11.11 External Cooling Attachments

The use of an external cooling attachment for FRN0030E3S/N-2G to FRN0115E3S/N-2G and FRN0022E3S/N-4G to FRN0072E3S/N-4G allows cooling fins to project outside the paneling. This enhances cooling efficiency and allows the panel size to be reduced. It can emit approximately 70% of the inverter's generated loss outside the paneling.

Fig. A

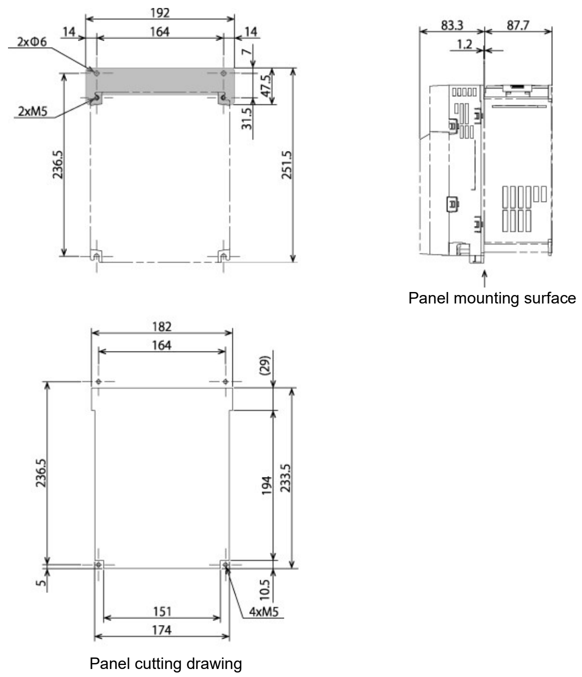
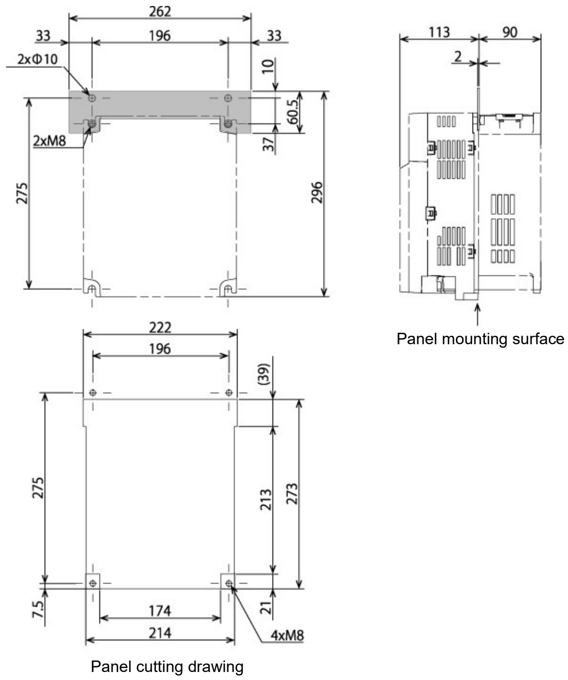
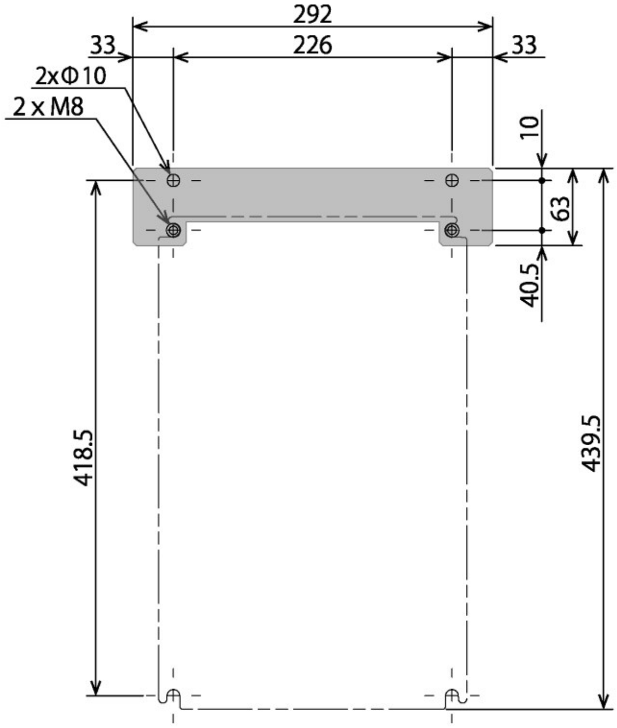


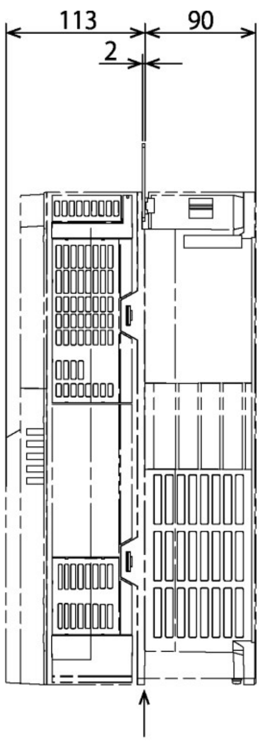
Fig.B



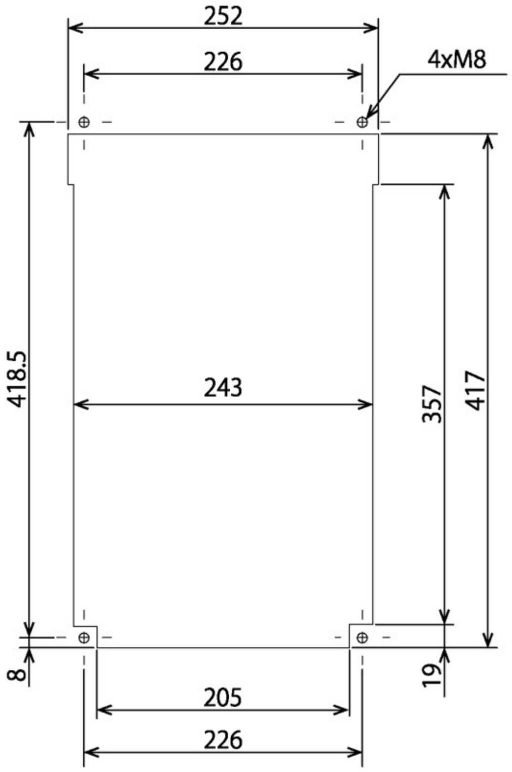
Option type	Figure	Applicable inverter type
PB-E1-7.5	A	FRN0030E3S-2G / FRN0040E3S-2G FRN0030E3N-2G / FRN0040E3N-2G FRN0022E3S-4G / FRN0029E3S-4G FRN0022E3N-4G / FRN0029E3N-4G
PB-F1-15	B	FRN0056E3S-2G / FRN0069E3S-2G FRN0056E3N-2G / FRN0069E3N-2G FRN0037E3S-4G / FRN0044E3S-4G FRN0037E3N-4G / FRN0044E3N-4G

∗ PB-E1-7.5 and PB-F1-15 cannot be used with EMC filter built-in type inverters.





Panel mounting surface



Panel cutting drawing

Option type	Applicable inverter type
PB-F1-30	FRN0088E3S-2G / FRN0115E3S-2G FRN0088E3N-2G / FRN0115E3N-2G FRN0059E3S-4G / FRN0072E3S-4G FRN0059E3N-4G / FRN0072E3N-4G

11.12 Adapter-equipped Type Option Cards Overview

The FRENIC-Ace (E3) is equipped with a dedicated adapter for installing adapter-equipped type option cards.

Note Communication option cards cannot be installed on the Ethernet built-in type (E3N).

11.12.1 Adapter for option card installation

This adapter is required to install a communication option card to the FRENIC-Ace (E3).

Table 11.12-1

Type	Name	Applicable inverter type
OPC-CP-ADP	Adapter for option installation	FRN0001E3S-2G to FRN0115E3S-2G FRN0002E3S-4G to FRN0072E3S-4G FRN0001E3S-7G to FRN0012E3S-7G FRN0002E3E-4G to FRN0012E3E-4G FRN0001E3E-7G to FRN0011E3E-7G

The following communication option cards should always be used in combination with the adapter for option installation (OPC-CP-ADP).

Table 11.12-2

Type	Name	Function overview	Ref.
OPC-PDP3	PROFIBUS-DP communication card	This card connects to the host controller with the FRENIC-Ace (E3) as the PROFIBUS-DP communication follower.	Section 11.12.2
OPC-COP2	CANopen communication card	This card connects to the host controller with the FRENIC-Ace (E3) as the CANopen communication follower.	Section 11.12.3
OPC-DEV	DeviceNet communication card	This card connects to the host controller with the FRENIC-Ace (E3) as the DeviceNet communication follower.	Section 11.12.4
OPC-CCL	CC-Link communication card	This card connects to the host controller with the FRENIC-Ace (E3) as the CC-Link communication follower.	Section 11.12.5
OPC-CP-ETM	Multiprotocol Ethernet communication card	This card connects to the host controller with the FRENIC-Ace (E3) as the Ethernet communication follower.	Section 11.12.6
OPC-DIO	Digital I/O interface card	Digital input: Binary (8 or 12 bits), the frequency can be set with BCD codes. Can be extended to a general-purpose input terminal. (I1 to I13) Digital output: Can be used for monitoring with binary code (8 bits). Can be extended to a general-purpose output terminal. (01 to 08)	Section 11.12.7
OPC-AIO	Analog interface card	The following analog I/O are available. One analog voltage input (0 to ±10 V) One analog current input (4 to 20 mA or 0 to 20 mA) One analog voltage output (0 to ±10 V) One analog current output (4 to 20 mA)	Section 11.12.8
OPC-CP-RY	Relay output interface card	Can be extended to three relay outputs.	Section 11.12.9

11.12.2 PROFIBUS-DP communication card (OPC-PDP3)

By installing the PROFIBUS-DP communication card in FRENIC-Ace and connecting to the PROFIBUS-DP master device, run commands, frequency commands, and the operating status can be monitored, and all FRENIC-Ace function codes can be changed or referenced.

The features of this communication card are shown below.

- PROFIBUS version : DP-V0 compatible
- Baud rate : 9,600 bps to 12 Mbps
- Compatible profile : PROFIDrive V2
- Reading/writing to all FRENIC-Ace function codes possible

The adapter for option installation (OPC-CP-ADP) is required to install this card. For details on installation, refer to the Option Instruction Manual.

PROFIBUS-DP specifications

Table 11.12-3

Item		Specifications	Remarks
Transmission	Line	RS-485 (insulated)	
	Connection length	Refer to table below.	
	Baud rate	9.6, 19.2, 45.45, 93.75, 187.5, 500 kbit/s 1.5, 3, 6, 12 Mbit/s (automatic detection)	Selected on master side
	Transmission protocol	PROFIBUS-DP (DP-V0)	IEC 61158, 61784
Connector		6-pole terminal block	PHOENIX CONTACT
Control	Controller	SPC3 (Siemens)	
	Transmission buffer	1472 bytes (SPC3 built-in memory)	
Address		Setting with rotary switch (0 to 99) or setting with inverter function code o31 (0 to 125)	o31 is valid when the rotary switch is set to 0.
Diagnostic function		Disconnection detection	Based on OFFL LED
		Configuration error detection	Based on ERR LED

The maximum transmission distance per segment when using a PROFIBUS-DP cable is as follows.

Table 11.12-4

Communication speed (bit/s)	Max. length per segment (m)
9.6 k	1200
19.2 k	1200
45.45 k	1200
93.75 k	1000
187.5 k	1000
500 k	400
1.5 M	200
3 M	100
6 M	100
12 M	100

Function code settings

To specify run commands and frequency commands from PROFIBUS, it is necessary to set inverter function codes. A list is shown in Table 11.12-5.

Table 11.12-5 Function code settings required to enable run and frequency commands from PROFIBUS

<table>
<tr><th>Function code</th><th>Description</th><th>Factory default</th><th>Setting change value</th><th>Remarks</th></tr>
<tr><td>y96</td><td>Communication compatibility mode</td><td>0</td><td>0/6/7</td><td>0: Disable
6: Enable (E1 compatibility)
7: Enable (E2 compatibility)</td></tr>
<tr><td>y98</td><td>Run, frequency commands from PROFIBUS</td><td>0</td><td>3</td><td>Select from the following.
<table>
<tr><th>y98</th><th>Frequency command source</th><th>Run command source</th></tr>
<tr><td>0</td><td>Inverter</td><td>Inverter</td></tr>
<tr><td>1</td><td>PROFIBUS</td><td>Inverter</td></tr>
<tr><td>2</td><td>Inverter</td><td>PROFIBUS</td></tr>
<tr><td>3</td><td>PROFIBUS</td><td>PROFIBUS</td></tr>
</table></td></tr>
<tr><td>y99</td><td>Run, frequency commands from Loader</td><td>0</td><td>0</td><td>Unnecessary to change from factory default</td></tr>
<tr><td>From E01</td><td>Terminal [X□] function selection (□: terminal number)</td><td>-</td><td>Set to other than 24 or 1024 (other than “LE” selection).
(Applies to all terminal X function codes.)</td><td>Even when “LE” is selected, the y98 setting will be valid if the terminal is turned ON.
When “LE” is set to OFF, the y98 setting will be invalid, and both run and frequency commands will be specified from the inverter.</td></tr>
</table>

Other related function codes are shown in the following table.

Table 11.12-6 Related inverter function codes

Function code	Description	Factory default	Setting range	Remarks
o27	Operation selection when PROFIBUS communication error detected	0	0 to 15	
o28	Operation timer when PROFIBUS communication error detected	0.0 s	0.0 s to 60.0 s	
o30	PPO TYPE	0	0 to 255	Refer to the communication card instruction manual.
o31	PROFIBUS station number selection	0	0 to 125	Station numbers that are valid when the rotary switch on the PCB is set to “00”
o40 to o47	Write function code assignment 1 to 8	0000	0x0000 to 0xFFFF	Sets function code for data mapped I/O writing. Same as PNU915
o48 to o55	Read function code assignment 1 to 8	0000	0x0000 to 0xFFFF	Sets function code for data mapped I/O reading. Same as PNU916

Node address

(1) Setting with rotary switches (SW1, SW2)

The node address must be set before turning ON the PROFIBUS-DP communication card power. The node address is set using the rotary switches (SW1, SW2) on the communication card, and can be set from 1 to 99 in decimal notation. SW1 is used to set the 10 digit, and SW2 is used to set the 1 digit.

Address = (SW1 setting value x 10) + (SW2 setting value x 1)

[Note] It is necessary to turn the power OFF and ON again after changing the node address.
[Note] If wishing to set an address greater than 99, the "(2) Setting with o31" procedure is required.

(2) Setting with o31

By setting the rotary switch on the communication card to "00" and turning the power OFF and ON again, the code set with o31 will be valid. If the rotary switch is set to other than "00," the rotary switch value will be valid.

The setting range is 0 to 125. If a value of 126 or higher is set, the ERR LED on the communication card will blink, notifying the user that there is a problem with the setting.

PPO type selection

This communication card supports PPO types 1 to 5 (for details on PPO, refer to the FRENIC-Ace PROFIBUS-DP Communication Card Instruction Manual).

Set the same PPO type on the keypad and in the master settings. If the settings are not the same, data exchange between the communication card and master will not start. If the settings do not match, the ERR LED on the communication card will blink, notifying the user that there is a problem with the setting.

■ Setting from the keypad

Inverter function code o codes are used to specify PROFIBUS-DP interface settings. o codes can be accessed from the inverter keypad after installing this communication card.

PPO type selection uses o30. After changing this parameter, it is necessary to turn the inverter power OFF and ON again to enable the change.

Table 11.12-7

o30	PPO type selection
0, 1, 6 to 255	PPO 1
2	PPO 2
3	PPO 3
4	PPO 4
5	PPO 5

■ Setting from master

The module definition is sent with the PROFIBUS-DP master setting frame. This definition can be found in the GSD file. For details on the PROFIBUS-DP setting method, refer to the "Master Manual."

11.12.3 CANopen communication card (OPC-COP2)

By installing the CANopen communication card in FRENIC-Ace and connecting to CANopen, run commands and frequency commands can be set, and all FRENIC-Ace function codes can be accessed from the CANopen master (PC, PLC, etc.). FRENIC-Ace can be controlled as a follower.

The adapter for option installation (OPC-CP-ADP) is required to install this card. For details on installation, refer to the Option Instruction Manual.

CANopen specifications

Table 11.12-8

Item	Specifications	Remarks
Physical layer	CAN（ISO11898）	
Baud rate	20 k, 50 k, 125 k, 250 k, 500 k, 800 k, 1 Mbit/s	Set with o32
Maximum cable length	2500 m (when 20 kbits/s) to 25 m (when 1 Mbit/s)	
Node ID	1 to 127	Set with o31
Profile	Conforms to the following profiles. - CiA DS-301 Ver.4.02 - CiA DS-402 Ver.2.0 Velocity mode	

Function code settings

Function codes necessary for CANopen communication

The function codes which must be set to communicate between this communication card and the CANopen master are shown in the following table.

Table 11.12-9

Function code	Function code name	Factory default	Data setting range	Description
o31 *1	Node ID setting	0	0 to 255 (Valid range: 0 to 127)	By setting 0 or 128 or higher, data is recognized as 127.
o32 *1	Baud rate setting	0	0 to 255 (Valid range: 0 to 7)	0: 125 kbits/s　5: 500 kbits/s 1: 20 kbits/s　6: 800 kbits/s 2: 50 kbits/s　7: 1 Mbit/s 3: 125 kbits/s　8 to 255: 1 Mbit/s 4: 250 kbits/s

*1 To reflect settings after setting o31 and o32, either turn the inverter unit power OFF and ON again, or send a ResetNode command from the CANopen master.

Other related function codes

Other related function codes that can be set with CANopen communication are shown in the following table.

Table 11.12-10

<table>
<tr><th>Function code</th><th>Function code name</th><th>Factory default</th><th>Data setting range</th><th>Description</th></tr>
<tr><td>o27</td><td>Operation when CANopen communication error detected</td><td>0</td><td>0 to 15</td><td></td></tr>
<tr><td>o28</td><td>Timer when CANopen communication error detected</td><td>0</td><td>0 to 60.0 s</td><td></td></tr>
<tr><td>o40 to o43 *2</td><td>Applicable function code setting written via RPDO No.3</td><td>0x0000</td><td>0x0000 to 0xFFFF</td><td>Set the function code as follows:
0xXX■■
XX: Group (refer to table below)
■■: Number
Example) F07 → 0x0407</td></tr>
<tr><td>o48 to o51 *2</td><td>Applicable function code setting monitored via TPDO No.3</td><td>0x0000</td><td>0x0000 to 0xFFFF</td><td>Same as above</td></tr>
<tr><td>y96</td><td>Communication compatibility mode</td><td>0</td><td>0/6/7</td><td>0: Disable
6: Enable (E1 compatibility)
7: Enable (E2 compatibility)</td></tr>
<tr><td>y98</td><td>Run, frequency command source selection</td><td>0</td><td>0 to 3</td><td>Select from the following.<table><tr><th>y98</th><th>Frequency command source</th><th>Run command source</th></tr><tr><td>0</td><td>Inverter</td><td>Inverter</td></tr><tr><td>1</td><td>CANopen</td><td>Inverter</td></tr><tr><td>2</td><td>Inverter</td><td>CANopen</td></tr><tr><td>3</td><td>CANopen</td><td>CANopen</td></tr></table></td></tr>
</table>

*2 To reflect settings after setting o40 to o43 and o48 to o51, either turn the inverter unit power OFF and ON again, or send a ResetNode command from the CANopen master.

Table 11.12-11 Function code types (function codes o40 o43 and o48 o51)

Type	Type code		Name	Type	Type code		Name	Type	Type code		Name
S	2	02_H	Command/Function Data	W	16	10_H	Monitor Data 2	T	30	$1E_H$	Scheduled Operation
M	3	03_H	Monitor Data	X	17	11_H	Alarm Data	E1	31	$1F_H$	Terminal Functions
F	4	04_H	Basic Functions	Z	18	12_H	Alarm Data 2	H1	32	20_H	High-performance Functions
E	5	05_H	Terminal Functions	b	19	13_H	Motor 3/Speed Control 3 Parameters	o1	33	21_H	Optional Functions
C	6	06_H	Control Functions	d	20	14_H	Application Functions 2	U1	34	22_H	Customized Logic Functions
P	7	07_H	Motor 1 Parameters		-			M1	35	23_H	Monitor Data
H	8	08_H	High-performance Functions		-			J1	36	24_H	Application Functions
A	9	09_H	Motor 2/Speed Control 2 Parameters	W1	23	17_H	Monitor Data 2	J2	37	25_H	Application Functions
o	10	$0A_H$	Optional Functions	W2	24	18_H	Monitor Data 2	J3	38	26_H	Application Functions
L	11	$0B_H$	Special Functions	W3	25	19_H	Monitor Data 2	J4	39	27_H	Application Functions
r	12	$0C_H$	Motor 4/Speed Control 4 Parameters	X1	26	$1A_H$	Alarm Data	J5	40	28_H	Application Functions
U	13	$0D_H$	Customized Logic Functions	X2	27	$1B_H$	Alarm Data	J6	41	29_H	Application Functions
J	14	$0E_H$	Application Functions	Z1	28	$1C_H$	Alarm Data 2	d1	42	$2A_H$	Application Functions 2
y	15	$0F_H$	Link Functions	K	29	$1D_H$	Keypad-related Functions	d2	55	37_H	Application Functions 2

Communication

This communication card is a CANopen follower, and supports the services shown in the following table.

Table 11.12-12

Item	Service	Remarks
PDO	RPDO x 3, TPDO x 3 TPDO supports Sync, Cyclic, and Async.	PDO variable mapping can be changed.
SDO	Expedited and Segmented protocol is supported. Only Default SDO is supported.	Block protocol is not supported.
Emergency (EMCY) Object	EMCY Producer	EMCY Consumer is not supported.
Network Management (NMT)	NMT Follower (DS-301 state machine) Guarding Heartbeat Producer Heartbeat Consumer Boot-up Protocol	NMT master is not supported.

11.12.4 DeviceNet communication card (OPC-DEV)

By installing the DeviceNet communication card in the FRENIC-Ace and connecting to DeviceNet, run commands and frequency commands can be set and monitored, and function code settings necessary for operation can be changed or checked from the DeviceNet master.

The adapter for option installation (OPC-CP-ADP) is required to install this card. For details on installation, refer to the Option Instruction Manual.

DeviceNet specifications

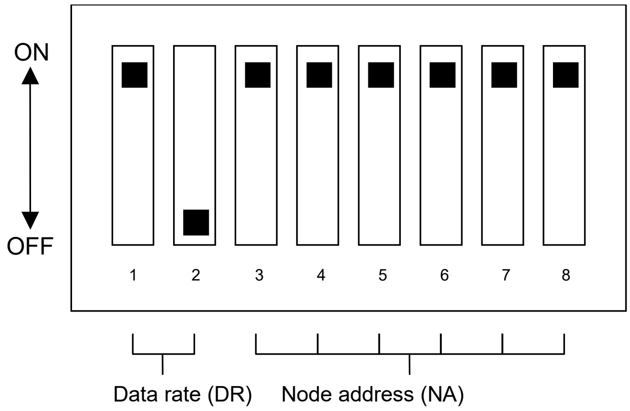
Table 11.12-13

<table>
<tr><th>Item</th><th colspan="4">Specifications</th></tr>
<tr><td>Number of nodes connectable</td><td colspan="4">Max. 64 (including the master)</td></tr>
<tr><td>MAC ID</td><td colspan="4">0 to 63</td></tr>
<tr><td>Insulation</td><td colspan="4">500 VDC (photocoupler insulation)</td></tr>
<tr><td>Transmission speed</td><td colspan="4">500, 250, 125 kbit/s</td></tr>
<tr><td rowspan="4">Max. cable length (when using thick cables)</td><td>Baud rate</td><td>500 kbit/s</td><td>250 kbit/s</td><td>125 kbit/s</td></tr>
<tr><td>Trunk line length</td><td>100 m</td><td>250 m</td><td>500 m</td></tr>
<tr><td>Branch line length</td><td>6 m</td><td>6 m</td><td>6 m</td></tr>
<tr><td>Total branch line length</td><td>39 m</td><td>78 m</td><td>156 m</td></tr>
<tr><td>Messages supported</td><td colspan="4">1. I/O messages (Poll, Change of State)
2. Explicit messages</td></tr>
<tr><td>Vendor ID</td><td colspan="4">319 (Registered name: Fuji Electric Group)</td></tr>
<tr><td>Device type</td><td colspan="4">AC drive (Code: 2)</td></tr>
<tr><td>Product code</td><td colspan="4">9221</td></tr>
<tr><td>Applicable device profile</td><td colspan="4">AC Drive</td></tr>
<tr><td>Number of input/output bytes</td><td colspan="4">Max. 8 bytes for each of input and output.
* Based on selected format
Refer to “Communication formats” (Table 11.12-16).</td></tr>
<tr><td>Applicable DeviceNet specifications</td><td colspan="4">CIP specifications
Volume1 2.2 edition Japanese version and Volume3 1.1 edition Japanese version</td></tr>
<tr><td>Node type</td><td colspan="4">Group 2 only server (noncompliant with UCMM)</td></tr>
<tr><td>Network power consumption</td><td colspan="4">80 mA DC24 V
[Note] The network power is supplied by an external power source.</td></tr>
</table>

For items not contained in the above table, the DeviceNet specifications apply.

DIP switch settings

The node address and data rate are set with DIP switches. (Refer to figure below.) The node address setting range is 0 to 63, and the data rate setting range is 125/250/500 kbit/s. Select the appropriate ranges with the DIP switches before turning ON the communication card power. Even if switches are set while the power is ON, please be aware that they will not be reflected until the power has been turned OFF and ON again.



DR (bit/s)	DIP 1-2
125 K	00
250 K	01
500 K	10
Prohibited	11

NA	DIP 3-8
0	000000
1	000001
2	000010
3	000011
…	…
62	111110
63	111111

Fig. 11.12-1 DIP switch details (in the diagram, the node address is 63, and the data rate is 500 kbit/s)

Function code settings

Table 11.12-14

<table>
<tr><th>Function code</th><th>Description</th><th>Factory default</th><th>Setting</th><th>Remarks</th></tr>
<tr><td>y96</td><td>Communication compatibility mode</td><td>0</td><td>0: Disable
6: Enable (E1 compatibility)
7: Enable (E2 compatibility)</td><td></td></tr>
<tr><td>y98</td><td>Run, frequency command source selection</td><td>0</td><td>Select from the following.<table><tr><th>y98</th><th>Frequency command source</th><th>Run command source</th></tr><tr><td>0</td><td>Inverter</td><td>Inverter</td></tr><tr><td>1</td><td>DeviceNet</td><td>Inverter</td></tr><tr><td>2</td><td>Inverter</td><td>DeviceNet</td></tr><tr><td>3</td><td>DeviceNet</td><td>DeviceNet</td></tr></table></td><td></td></tr>
<tr><td>o27</td><td>Operation selection when DeviceNet communication error detected</td><td>0</td><td>Refer to the communication card instruction manual.</td><td></td></tr>
<tr><td>o28</td><td>Operation timer when DeviceNet communication error detected</td><td>0.0 s</td><td>0.0 s to 60.0 s</td><td></td></tr>
<tr><td>o31</td><td>Output instance selection</td><td>0</td><td>Refer to Table 11.12-16</td><td rowspan="4">After setting, it is necessary to turn the power OFF and ON again to apply the operations to the inverter.</td></tr>
<tr><td>o32</td><td>Input instance selection</td><td>0</td><td>Refer to Table 11.12-16</td></tr>
<tr><td>o40 to 43</td><td>Write function code assignment 1 to 4</td><td>0000</td><td>Refer to supplementary information below.</td></tr>
<tr><td>o48 to 51</td><td>Read function code assignment 1 to 4</td><td>0000</td><td>Refer to supplementary information below.</td></tr>
</table>

[Supplementary information] Inverter function code o40 to o43 and o48 to o51 setting method
Specify the function code type (Table 11.12-15) and number with a 4-digit hexadecimal number as shown below.

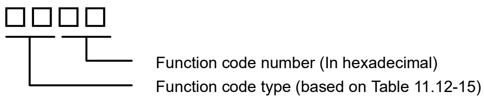


Fig. 11.12-2

Table 11.12-15 Function code types

Type	Type code		Name	Type	Type code		Name	Type	Type code		Name
S	2	02_H	Command/Function Data	W	16	10_H	Monitor Data 2	T	30	$1E_H$	Scheduled Operation
M	3	03_H	Monitor Data	X	17	11_H	Alarm Data	E1	31	$1F_H$	Terminal Functions
F	4	04_H	Basic Functions	Z	18	12_H	Alarm Data 2	H1	32	20_H	High-performance Functions
E	5	05_H	Terminal Functions	b	19	13_H	Motor 3/Speed Control 3 Parameters	o1	33	21_H	Optional Functions
C	6	06_H	Control Functions	d	20	14_H	Application Functions 2	U1	34	22_H	Customized Logic Functions
P	7	07_H	Motor 1 Parameters		-			M1	35	23_H	Monitor Data
H	8	08_H	High-performance Functions		-			J1	36	24_H	Application Functions
A	9	09_H	Motor 2/Speed Control 2 Parameters	W1	23	17_H	Monitor Data 2	J2	37	25_H	Application Functions
o	10	$0A_H$	Optional Functions	W2	24	18_H	Monitor Data 2	J3	38	26_H	Application Functions
L	11	$0B_H$	Special Functions	W3	25	19_H	Monitor Data 2	J4	39	27_H	Application Functions
r	12	$0C_H$	Motor 4/Speed Control 4 Parameters	X1	26	$1A_H$	Alarm Data	J5	40	28_H	Application Functions
U	13	$0D_H$	Customized Logic Functions	X2	27	$1B_H$	Alarm Data	J6	41	29_H	Application Functions
J	14	$0E_H$	Application Functions	Z1	28	$1C_H$	Alarm Data 2	d1	42	$2A_H$	Application Functions 2
y	15	$0F_H$	Link Functions	K	29	$1D_H$	Keypad-related Functions	d2	55	37_H	Application Functions 2

Example: For F26 $\left.\begin{array}{l} \text{F} \Rightarrow \text{Type code 04} \\ \text{26} \Rightarrow \text{1A (hexadecimal notation)} \end{array}\right\}$ "041A"

Communication formats

Supported communication formats are shown in the following table. Select o31 for output, and o32 for input. Please be aware that changes to the o31 and o32 settings are not reflected until the inverter power is turned OFF and ON again.

Table 11.12-16 Format list

o31, o32	Type	Instance ID	Description	Occupied words
o31 = 20	Output (master → inverter)	20	Basic I/O instance output	2
o31 = 21 or 0 (initial value)		21	Extension I/O instance output	2
o31 = 100		100	Fuji Electric original output	2
o31 = 102		102	Data mapped I/O (write)	4
o31 = 104 *		104	Function code access request	4
o32 = 70	Input (inverter → master)	70	Basic I/O instance input	2
o32 = 71 or 0 (initial value)		71	Extension I/O instance input	2
o32 = 101		101	Fuji Electric original input	2
o32 = 103		103	Data mapped I/O (monitor)	4
o32 = 105 *		105	Function code access response	4

* When selecting function code access request (o31 = 104) for the output format, select the function code access response (o32 = 105) for the input format. For details, refer to the DeviceNet communication card Option Instruction Manual.

11.12.5 CC-Link communication card (OPC-CCL)

CC-Link (Control & Communication Link) is an FA open field network system.

Installing the CC-Link communication in the FRENIC-Ace and connecting to the CC-Link master unit with a dedicated cable supports a transmission speed of 156 kbps to 10 Mbps and total length of 100 to 1,200 m, allowing it to be used in a wide range of systems requiring high-speed or long-distance transmission, enabling a flexible system configuration.

The adapter for option installation (OPC-CP-ADP) is required to install this card. For details on installation, refer to the Option Instruction Manual.

<u>CC-Link specifications</u>

Table 11.12-17

Item	Specifications				
Applicable controller	Mitsubishi Electric PLC, etc. (CC-Link master)				
Transmission system	CC-Link version 1.10 and 2.0 (Broadcast polling system)				
Number of connected inverters	Max. 42 units (one station occupied/unit)				
Number of stations occupied	CC-Link Ver1.10 1 station occupied CC-Link Ver2.0 1 station occupied (Selectable from among 2x, 4x and 8x settings)				
Baud rate	10 Mbps/5 Mbps/2.5 Mbps/625 Kbps/156 Kbps				
Total max. cable length (when using dedicated CC-Link cable)	10 Mbps	5M bps	2.5M bps	625 kbps	156 kbps
	100 m	150 m	200 m	600 m	1200 m
Insulation	500 VDC (photocoupler insulation)				
Station type	Remote device station				
Remote device type	Inverter (0x20)				

For items not contained in the above table, the CC-Link specifications apply.

Dedicated CC-Link function codes

Table 11.12-18

<table>
<tr><th>No.</th><th>Function code name</th><th>Setting range *1</th><th>Setting</th></tr>
<tr><td>y96</td><td>Communication compatibility mode</td><td>0/6/7</td><td>0: Disable (factory default)
6: Enable (E1 compatibility)
7: Enable (E2 compatibility)</td></tr>
<tr><td>y98</td><td>Run, frequency command source selection</td><td>0 to 3</td><td>Select from the following.<table><tr><th></th><th>Frequency command source</th><th>Run command source</th></tr><tr><td>0</td><td>Inverter</td><td>Inverter</td></tr><tr><td>1</td><td>CC-Link</td><td>Inverter</td></tr><tr><td>2</td><td>Inverter</td><td>CC-Link</td></tr><tr><td>3</td><td>CC-Link</td><td>CC-Link</td></tr></table></td></tr>
<tr><td rowspan="7">o27</td><td rowspan="7">Operation selection when CC-Link communication error detected</td><td>0, 4 to 9</td><td>Immediate coast to stop & Er5 trip</td></tr>
<tr><td>1</td><td>Coast to stop and Er5 after time set at o28 elapses</td></tr>
<tr><td>2</td><td>Error ignored if communication link restored within time set at o28
Coast to stop and Er5 if timeout occurs</td></tr>
<tr><td>3, 13 to 15</td><td>Maintains present operation, ignoring the communication error.
(No Er5 trip)</td></tr>
<tr><td>10</td><td>Immediate forced deceleration to a stop.
Er5 trip after stopping.</td></tr>
<tr><td>11</td><td>After the time specified by o28, forced deceleration to a stop. Er5 trip after stopping.</td></tr>
<tr><td>12</td><td>Error ignored if communication link restored within time set at o28
Er5 after forced deceleration if timeout occurs</td></tr>
<tr><td>o28</td><td>Timer time setting when communication error detected</td><td>0.0 to 60.0 s</td><td>Timer operating time when 1, 2, 11, or 12 set for o27</td></tr>
<tr><td rowspan="5">o30</td><td rowspan="5">CC-Link extension setting (multiple setting)</td><td>5 to 255</td><td>Disable</td></tr>
<tr><td>0, 1</td><td>1 station occupied (CC-Link version 1.10)</td></tr>
<tr><td>2</td><td>1 station occupied, 2x setting (CC-Link Ver.2.00)</td></tr>
<tr><td>3</td><td>1 station occupied, 4x setting (CC-Link Ver.2.00)</td></tr>
<tr><td>4</td><td>1 station occupied, 8x setting (CC-Link Ver.2.00)</td></tr>
<tr><td>o31</td><td>Station number setting *2</td><td>0, 1 to 64</td><td>Station number setting (follower: 1 to 64)
L.ERR lights up if other value set.</td></tr>
<tr><td>o32</td><td>Baud rate setting *2</td><td>0 to 4</td><td>0: 156 kbps, 1: 625 kbps, 2: 2.5 Mbps,
3: 5 Mbps, 4: 10 Mbps
L.ERR lights up if other value set.</td></tr>
</table>

*1 Underlined values are factory default setting values.

*2 By changing the station number or Baud rate settings while the inverter power is ON, L.ERR blinks, and communication is stopped. Setting values are reflected by resetting “RST” from the terminal block, or the next time the power is turned ON.

11.12.6 Multiprotocol Ethernet® Communication Card (OPC-CP-ETM)

By installing the Multiprotocol Ethernet communication card on FRENIC-Ace (E3), and setting/monitoring run commands and frequency from a master device connected by Ethernet, function code settings required for operation can be changed and checked. Furthermore, data can be exchanged with peripheral equipment.

The adapter for option installation (OPC-CP-ADP) is required to install this card. For details on installation, refer to the Option Instruction Manual.

Specifications

Table 11.12-19

Item	Specifications	Remarks
Supported protocols	• EtherNet® / IP server • PROFINET-RT device • Modbus TCP server	
Connector type	With RJ-45 shield, CAT5e or higher UTP or STP cable	
Physical layer type	IEEE 802.3	
Number of ports	2 ports (built-in switch function)	
Transmission speed	10 Mbps / 100 Mbps (automatically detected)	
Duplex mode	Half duplex/full duplex (automatically detected)	
Auto MDI-X	Enabled (auto straight/crossover cable recognition)	
Auto Polarity	Enabled (auto polarity detection)	
Cable length	Max. 100 m (328 ft) per segment	

Function code settings

Table 11.12-20

<table>
<tr><th>Function code</th><th>Description</th><th>Factory default</th><th>Setting</th></tr>
<tr><td>y95</td><td>Run operation command clear selection when communication error occurs</td><td>0</td><td>0: Do not clear data when a communication error alarm occurs.
1: Clear data for function codes S01/S05/S19 when a communications error occurs.
2: Clear the run command assigned bit of function code S06 when a communications error occurs.
3: Clear operations in 1 and 2 above are performed.
4: Clear data for 3 above and for function codes S02/S03/S13/S15/S20/S21.
* The applicable alarms are Er8, ErP, Er4, Er5.</td></tr>
<tr><td>y97</td><td>Communication data storage method selection</td><td>0</td><td>Set to “1” if frequently rewriting inverter function codes other than run command-related S codes (Sxx).
If the same value is written, the value is not rewritten, and the number of times is not counted.

0: Store in nonvolatile memory (Rewritable times are limited)
1: Write in temporary memory (Rewritable times are unlimited)
2: Save all data from temporary memory to nonvolatile memory (After all save, return to Data 1)</td></tr>
<tr><td>y98</td><td>Run, frequency command source selection</td><td>0</td><td>Select from the following.
<table>
<tr><th>y98</th><th>Frequency command source</th><th>Run command source</th></tr>
<tr><td>0</td><td>Inverter</td><td>Inverter</td></tr>
<tr><td>1</td><td>Ethernet</td><td>Inverter</td></tr>
<tr><td>2</td><td>Inverter</td><td>Ethernet</td></tr>
<tr><td>3</td><td>Ethernet</td><td>Ethernet</td></tr>
</table></td></tr>
</table>

Table 11.12-20 (cont'd)

Function code	Description	Factory default	Setting
o27	Transmission error (Operation selection)	0	0: Immediate Er5 trip when communication error occurs. 1: Immediate Er5 trip after running for time specified with timer after communication error occurs. 2: Immediate Er5 trip if communication error occurs, and communication does not recover after retry while running for time specified with timer. 3: Motor continues to run without Er5 trip even if communication error occurs. Motor runs in accordance with communication command after communication recovers. 4 to 9: Same as o27 = 0 10: Er5 trip following deceleration stop due to communication error. 11: Er5 trip following deceleration stop after running for time specified with timer after communication error occurs. 12: Deceleration stop if communication error occurs, and communication does not recover after retry while running for time specified with timer. Motor continues to run in accordance with communication command if communication recovers. 13 to 15: Same as o27 = 3
o28	Transmission error (Timer time)	0.0	0.0 to 60.0 s
o201	IP address setting 1	0	Example: To set to "192.168.11.1," set as follows. o201 = 192 o202 = 168 o203 = 11 o204 = 1 (if o213 = 1, the rotary switch setting is referenced)
o202	IP address setting 2	0	
o203	IP address setting 3	0	
o204	IP address setting 4	0	
o205	Subnet mask setting 1	255	Example: To set to "255.255.255.0," set as follows. o205 = 255 o206 = 255 o207 = 255 o208 = 0
o206	Subnet mask setting 2	255	
o207	Subnet mask setting 3	255	
o208	Subnet mask setting 4	0	
o209	Default gateway setting 1	0	Example: To set to "192.168.11.1," set as follows. o205 = 192 o206 = 168 o207 = 11 o208 = 1
o210	Default gateway setting 2	0	
o211	Default gateway setting 3	0	
o212	Default gateway setting 4	0	
o213	IP address setting mode	0	0: Fixed 1: Hard switching 2: DHCP (Other than PROFINET) 3: DCP (PROFINET) If 0, set o201 to o212 If 1, set IP address as o201.o202.o203.n (where n is the value at which hard switching is activated).
o214	Protocol settings	0	0: None (invalid) 1: PROFINET-RT 2: EtherNet/IP 3: Modbus TCP
o215	KEEP-ALIVE startup time	60	10 to 720 s
o216	Monitoring time	0	0.0 to 60.0s
o221 to o252	Write function code assignment 1 to 32 (max. 32 words)	0000_H	Set function code for writing output from master to inverter. (Group number) × 100_H + 2 lower order digits of function code (refer to Inverter function code settings)
o253 to o284	Read function code assignment 1 to 32 (max. 32 words)	0000_H	Set function code for reading input from inverter to master. (Group number) × 100_H + 2 lower order digits of function code (refer to Inverter function code settings)

Function code	Description	Factory default	Setting
o299	Apply Ethernet settings	0	0: Initial value 1: The o201 to o284 (*2) setting values are applied to the network. (The value automatically returns to “0.”)

Inverter function code settings (PROFINET-RT, EtherNet/IP)

If accessing inverter function codes, specify the function code type (Table 11.12-21) and number with a 4-digit hexadecimal number as follows.
However, these are ignored if the inverter has no function codes.

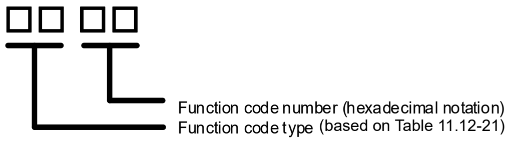


Table 11.12-21 Function code type

Type	Type code		Function code name	Type	Type code		Function code name
S	2	02_H	Command/Function Data	W3	25	19_H	Monitor Data 2
M	3	03_H	Monitor Data	X1	26	$1A_H$	Alarm Data
F	4	04_H	Basic Functions	X2	27	$1B_H$	Reserved
E	5	05_H	Terminal Functions	Z1	28	$1C_H$	Reserved
C	6	06_H	Control Functions	K	29	$1D_H$	Keypad-related Functions
P	7	07_H	Motor 1 Parameters	T	30	$1E_H$	Scheduled Operation
H	8	08_H	High-performance Functions	E1	31	$1F_H$	Reserved
A	9	09_H	Motor 2/Speed Control 2 Parameters	H1	32	20_H	High-performance Functions
o	10	$0A_H$	Optional Functions	o1	33	21_H	Optional Functions
L	11	$0B_H$	Specific Purpose Functions	U1	34	22_H	Customized Logic Functions
r	12	$0C_H$	Motor 4/Speed Control 4 Parameters	M1	35	23_H	Monitor Data
U	13	$0D_H$	Customized Logic Functions	J1	36	24_H	Application Functions
J	14	$0E_H$	Application Functions	J2	37	25_H	Application Functions
y	15	$0F_H$	Link Functions	J3	38	26_H	Application Functions
W	16	10_H	Monitor Data 2	J4	39	27_H	Application Functions
X	17	11_H	Alarm Data	J5	40	28_H	Application Functions
Z	18	12_H	Alarm Data 2	J6	41	29_H	Application Functions
b	19	13_H	Motor 3/Speed Control 3 Parameters	d1	42	$2A_H$	Application Functions 2
d	20	14_H	Application Functions 2	d2	55	37_H	Application Functions 2
W1	23	17_H	Monitor Data 2	o2	62	$3E_H$	Optional Functions
W2	24	18_H	Monitor Data 2				

Example: In the case of F26

$$\left.\begin{array}{l}\text{F} \Rightarrow \text{Type code 04} \\ \text{26} \Rightarrow \text{1A (hexadecimal notation)}\end{array}\right\} \text{"041A"}$$

Inverter function code settings (Modbus TCP)

If accessing inverter function codes, specify the function code type (Table 11.12-22) and number with a 4-digit hexadecimal number as follows.
However, these are ignored if the inverter has no function codes.

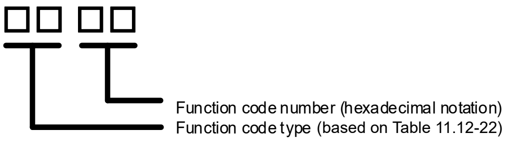


Table 11.12-22 Function code type

Type	Type code		Function code name	Type	Type code		Function code name
S	7	07_H	Command Data	W3	24	18_H	Monitor Data 2
M	8	08_H	Monitor Data	X1	25	19_H	Alarm Data
F	0	00_H	Basic Functions	X2	26	$1A_H$	Reserved
E	1	01_H	Terminal Functions	Z1	27	$1B_H$	Reserved
C	2	02_H	Control Functions	K	28	$1C_H$	Keypad-related Functions
P	3	03_H	Motor 1 Parameters	T	29	$1D_H$	Scheduled Operation
H	4	04_H	High-performance Functions	E1	30	$1E_H$	Reserved
A	5	05_H	Motor 2 Parameters	H1	31	$1F_H$	High-performance Functions
o	6	06_H	Optional Functions	o1	37	25_H	Optional Functions
L	9	09_H	Specific Purpose Functions	U1	39	27_H	Customized Logic Functions
r	10	$0A_H$	Motor 4 Parameters	M1	41	29_H	Monitor Data
U	11	$0B_H$	Customized Logic Functions	J1	48	30_H	Application Functions
J	13	$0D_H$	Application Functions	J2	49	31_H	Application Functions
y	14	$0E_H$	Link Functions	J3	50	32_H	Application Functions
W	15	$0F_H$	Monitor Data 2	J4	51	33_H	Application Functions
X	16	10_H	Alarm Data	J5	52	34_H	Application Functions
Z	17	11_H	Alarm Data 2	J6	53	35_H	Application Functions
b	18	12_H	Motor 3 Parameters	d1	54	36_H	Application Functions 2
d	19	13_H	Application Functions 2	d2	55	37_H	Application Functions 2
W1	22	16_H	Monitor Data 2	o2	38	26_H	Optional Functions
W2	23	17_H	Monitor Data 2				

Example: In the case of F26 F $\Rightarrow$ Type code 00
26 $\Rightarrow$ 1A (hexadecimal notation) } "001A"

11.12.7 Digital input/output interface card (OPC-DIO)

Installing the digital input interface card to the FRENIC-Ace provides the following features.

- Can set frequency with binary code (8- or 12-bit) or BCD code.
- Can perform monitoring with binary code (8-bit).
- Can be extended to a general-purpose input terminal. (I1 to I13)
- Can be extended to a general-purpose output terminal. (01 to 08)

The adapter for option installation (OPC-CP-ADP) is required to install this card. For details on installation, refer to the Option Instruction Manual.

Table 11.12-23 Terminal functions

Terminal symbol	Terminal name	Function
[I1] to [I13]	Input terminals	Terminals for setting input General-purpose terminals
[M1]	External power supply for input terminals	Connection terminal for the external power supply for input terminals
[CM]	Common for input terminals Insulated from the terminal M2.	Common terminal for input terminals
[01] to [08]	Output terminals	Terminals for output monitor General-purpose output terminals
[M2]	Common for output terminals Insulated from the terminal CM.	Common terminal for output terminals

M1	I13	I11	I9	I7	I5	I3	I1
CM	I12	I10	I8	I6	I4	I2	CM

	O8	O6	O4	O2
M2	O7	O5	O3	O1

Fig. 11.12-3 Terminal block layout

Table 11.12-24 Electrical specifications

Terminal symbol	Item		Specifications min.	Specifications max.
[I1] to [I13]	Operating voltage (SINK)	ON level	0 V	2 V
		OFF level	22 V	27 V
	Operating voltage (SOURCE)	ON level	22 V	27 V
		OFF level	0 V	2 V
	Operating current when ON		2.5 mA	4.5 mA
	Allowable leak current at OFF		-	0.5 mA
[01] to [08]	Operating voltage	ON level	-	2 V
		OFF level	-	27 V
	Max load current at ON		-	-50 mA
	Leak current at OFF		-	0.1 mA

Table 11.12-25 Input terminal connection methods

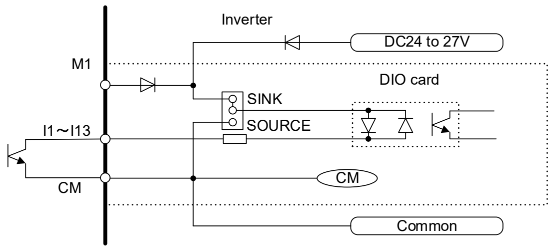
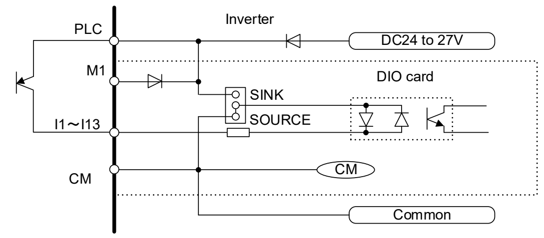
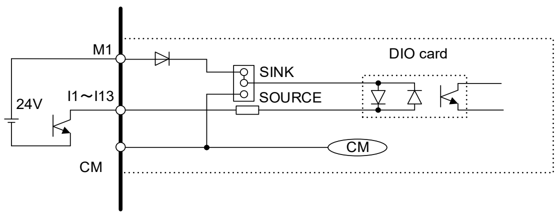
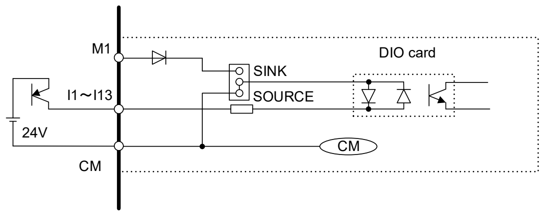
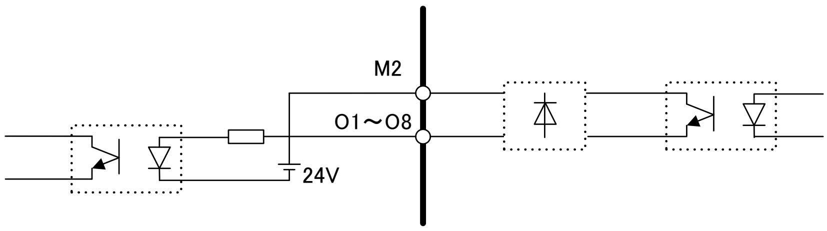
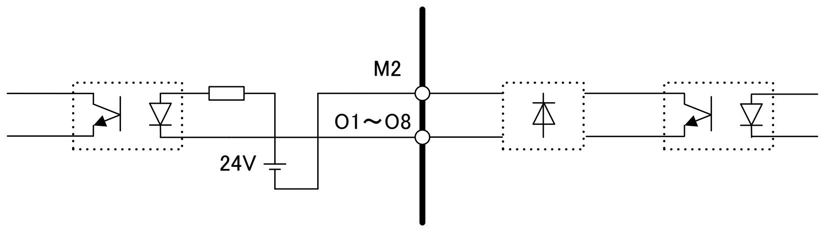
<table>
<tr><th rowspan="2">Power supply</th><th colspan="2">Connection method</th></tr>
<tr><th>SINK method</th><th>SOURCE method</th></tr>
<tr><td>Internal</td><td></td><td></td></tr>
<tr><td>External</td><td></td><td></td></tr>
</table>

Table 11.12-26 Output terminal connection methods

<table>
<tr><td>SINK method</td><td></td></tr>
<tr><td>SOURCE method</td><td></td></tr>
</table>

Chap 11 SELECTING PERIPHERAL EQUIPMENT

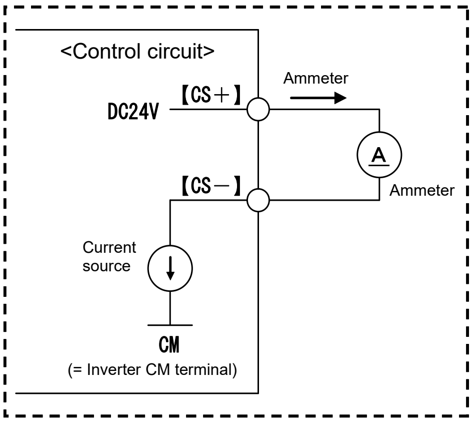
11.12.8 Analog interface card (OPC-AIO)

This is an optional card for adding analog inputs and outputs to FRENIC-Ace; it has the following features.

- One analog voltage input (0 to ±10 V)
- One analog current input (4 to 20 mA or 0 to 20 mA)
- One analog voltage output (0 to ±10 V)
- One analog current output (4 to 20 mA)

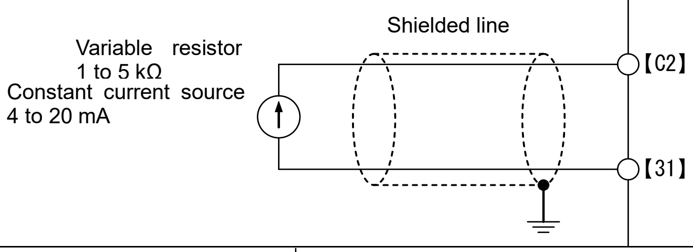
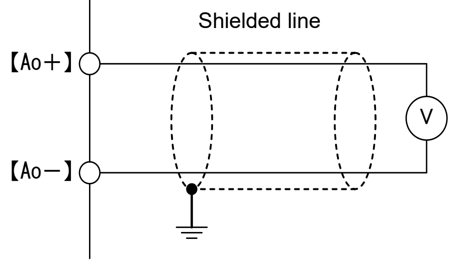
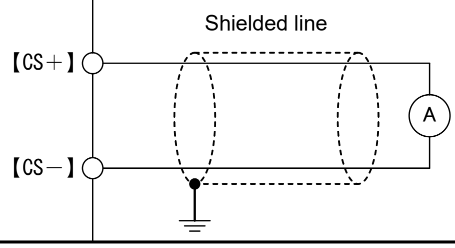
The adapter for option installation (OPC-CP-ADP) is required to install this card. For details on installation, refer to the Option Instruction Manual.

Table 11.12-27 Terminal functions

<table>
<tr><th></th><th>Terminal symbol</th><th>Terminal name</th><th>Specifications</th><th>Remarks</th></tr>
<tr><td rowspan="4">Analog input</td><td>[P10]</td><td>Power supply for potentiometer</td><td>Power supply for frequency command potentiometer (Variable resistor: 1 to 5 kΩ)
(DC 10 V, DC 10 mA max)</td><td></td></tr>
<tr><td>[32]</td><td>Analog voltage input</td><td>• Used as frequency setting voltage input.
0 to ±10 VDC/0 to ±100% (0 to ±5 VDC/0 to ±100%)
• Signal content can be selected from signals that can be input to inverter standard terminal [12].
• Resolution: 1/3000</td><td>Input impedance: 22 (kΩ)
Maximum input: ±15 VDC</td></tr>
<tr><td>[C2]</td><td>Analog current input</td><td>• Used as frequency setting current input.
4 to 20 mA DC/0 to 100% or 0 to 20 mA DC/0 to 100%
• Signal content can be selected from signals that can be input to inverter standard terminal [12].
• Resolution: 1/3000</td><td>Input impedance: 250 (Ω)
Maximum input: 30 mA DC</td></tr>
<tr><td>[31]</td><td>Analog common</td><td>• Reference terminal for frequency setting signals ([P10], [32], [C2])</td><td>Equipotent with the inverter’s terminal [11]</td></tr>
<tr><td rowspan="4">Analog output</td><td>[Ao+]</td><td>Analog voltage output +</td><td>• Outputs analog DC voltage analog 0 to ±10 VDC monitor signal.
• Signals that can be output from inverter standard terminals [FM1] and [FM2] can be selected. In addition, PID deviation can be output in both polarities.
• Resolution: 1/3000</td><td>Capable of driving up to two analog voltmeters with 10 kΩ impedance.</td></tr>
<tr><td>[Ao-]</td><td>Analog voltage output -</td><td>• Reference terminal for analog voltage output + [Ao+]</td><td>Equipotent with the inverter’s terminal [11]</td></tr>
<tr><td>[Cs+]</td><td>Analog current output +</td><td rowspan="2">• Outputs the analog DC current 4 to 20 mA DC monitor signal.
• Signals that can be output from inverter standard terminals [FM] and [FM2] can be selected.
• Resolution: 1/3000

</td><td rowspan="2">Isolated from terminals [31], [Ao-], and [11]

Can be connected to a measuring instrument with maximum resistance of 500 Ω.</td></tr>
<tr><td>[CS-]</td><td>Analog current output -</td></tr>
</table>

Table 11.12-28 Connection methods

Terminal name	Connection method
[32]	
[C2]	
[Ao]	
[CS]	

11.12.9 Relay output interface card (OPC-CP-RY)

Three relay outputs (contact 1C) can be added by installing the relay output interface card (OPC-CP-RY) to the FRENIC-Ace (E3).

Terminal functions

Table 11.12-29

Terminal symbol	Terminal name	Functional description
[Y6A/Y6B/Y6C]	Relay output 1	These relay contact outputs output the signals (running signals, frequency arrival signals, overload warning signals, etc.) selected with the function codes o01 to o03. Short circuit between [Y*A and Y*C] when the output signal is active (when active ON). "*" is replaced with a number between 6 and 8.
[Y7A/Y7B/Y7C]	Relay output 2	
[Y8A/Y8B/Y8C]	Relay output 3	

Electrical specifications

Table 11.12-30

Item	Specifications
Contact capacity	250 VAC, 0.3 A COSΦ = 0.3 or, 48 VDC, 0.5 A (with resistive load)
Contact life expectancy	250 VAC, 0.3 A: 200,000 times (if turned ON, OFF in 1 second intervals) 48 VDC, 0.5 A: 200,000 times (if turned ON, OFF in 1 second intervals) Note) Where frequent ON/OFF switching is anticipated (for example, when selecting signals during inverter output limiting to perform aggressive current limiting), use terminal [Y1] to [Y2] (transistor output).

Internal circuit configuration

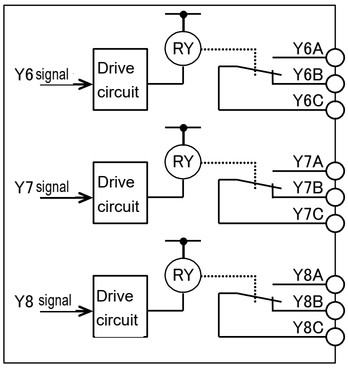


Fig.11.12-4 Internal circuit configuration

Table 11.12-31 Relay output functions can be selected with the following function codes.

Function code	Terminal name	Permissible setting range
o01	Relay output 1 (function selection)	For the same content as function code E20, refer to "Chapter 5 FUNCTION CODES."
o02	Relay output 2 (function selection)	
o03	Relay output 3 (function selection)	

Relay output 6 to relay output 8 signals are programmable general-purpose output signals and functions can be assigned using o01 to o03. These function codes can also switch the logic system between normal and negative to define how the inverter logic interprets the ON or OFF state of each terminal.

By using the logic inversion setting, each signal is active (e.g., on the side at which an alarm is occurring) for the period during which the inverter power is OFF. If necessary, take external measures by applying interlocks such as power ON signals.
Furthermore, signals are not output normally for approximately 2 seconds even after turning ON the power, and therefore measures such as external masking should be used.

11.13 Terminal Block Type Options

An option card can be built into the inverter main body by removing the control terminal block board from the inverter main body and installing the option card.

Note These options cannot be installed on the Ethernet built-in type (E3N).

Table 11.13-1

Type	Name	Function overview	Ref.
OPC-CP-RS	RS-485 communication card	Converts the RS-485 communication port from the terminal block type into two RJ-45 connectors.	Section 11.13.1
OPC-CP-PG3	PG interface card (12 V/15 V)	Allows input of open collector and complementary output pulse string signals (A, B, Z phase), at 12 V or 15 V specifications, to both the command and feedback sides.	Section 11.13.2
OPC-CP-PG	PG interface card (5 V)	Allows input of open collector and complementary output pulse string signals (A, B, Z phase), at 5 V specifications, to both the command and feedback sides.	Section 11.13.3
OPC-E2-TB1	Screw terminal block board	Converts the control terminal block from the spring (standard) type to the screw (E2 model) type.	Section 11.13.4

11.13.1 RS-485 communication card (OPC-CP-RS)

The RS-485 communication card (OPC-CP-RS) is used in replacement of the standard screw terminal block board option of the FRENIC-Ace (E3). It provides two RJ-45 connectors for RS-485 communication with the FRENIC-Ace unit and allows easy multi-drop connection.

Note The keypad cannot be connected to the RJ-45 connector of this option card.

Table 11.13-2 Terminal specifications

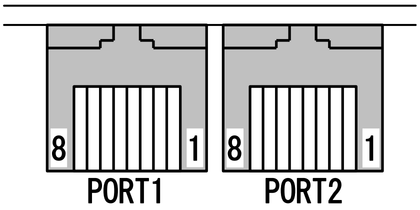
[Terminal configuration]

Terminal number	Terminal name	
	SW10 = 1 (factory default)	SW10 = 2 *2
1,6,7,8	N.C.	
2	SD	
3	N.C.	DX-
4	DX-	DX+
5	DX+	N.C.

*2: FVR-E11 compatible terminal configuration

[Terminal names and functions]

Terminal name	Functional description
DX+	RS-485 communication data (+) terminal
DX-	RS-485 communication data (-) terminal
SD	Shield terminal
N.C.	Vacant terminal (not connected)



(Seen from the inlet)

Fig. 11.13-1 Pin assignment

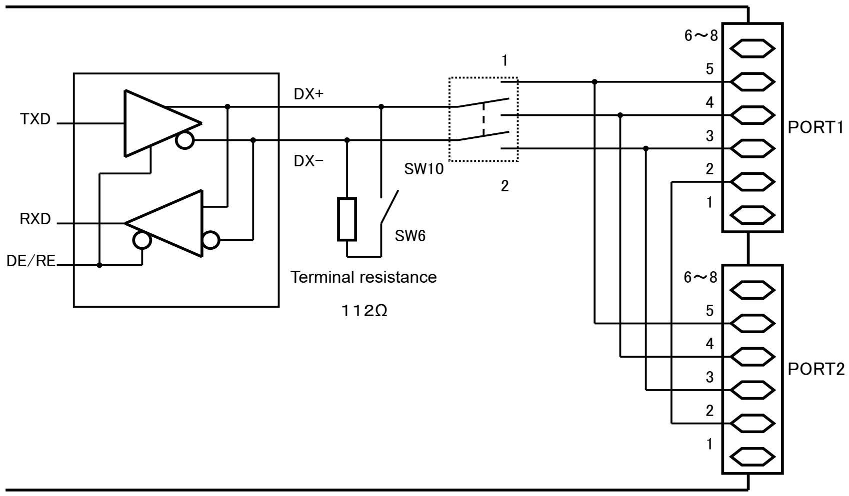


Fig. 11.13-2 Internal circuit

11.13.2 PG interface card (OPC-CP-PG3)

This option card has two pulse (ABZ phase) input circuits corresponding to 12 V and 15 V, and a power supply output circuit for PG (pulse generator). By exchanging this option card with the control circuit terminal that is installed in FRENIC-Ace main body as a standard, the following expansion functions can be used.

(1) Speed control (vector control with speed sensor, V/f control with speed sensor) is possible by PG feedback signal.

(2) Simplified position control is possible by PG feedback signal.

(3) Master-follower synchronous drive is possible by PG feedback signal or by pulse string input.

(4) Pulse string input is possible as the frequency command.

Note 1) If this card is used, the pulse string input function of the inverter main body terminal X5 cannot be used.

Table 11.13-3 Feedback side (PG interface) specifications

Item	Specifications	
PG method	Incremental A-phase, B-phase, Z-phase	
Pulse input type	Open collector	Complementary
Allowable frequency	30 kHz (duty: 50±10%)	100 kHz (duty: 50±10%)
Allowable wire length *1	20 m or less	30 m or less (100 kHz) 100 m or less (30 kHz)
Input pulse specifications	Max. SOURCE current: -3 mA (complementary only) Max. SINK current: 8 mA	
Pulse input voltage	H level voltage ≥6 V, L level voltage ≤2 V	
Input pulse count	20 to 3600 P/R	20 to 3600 P/R
Current output	With +12 V: 80 mA max., +12 V ±10% With +15 V: 60 mA max., +15 V ±10% *It is necessary to supply power from an external device when an encoder exceeding the specified current is connected (encoder power supply +150 mA max.). *The above current is the total value including the pulse string input interface.	

*1: These values are approximate. They might be shorter depending on the wire type or noise environment.

Table 11.13-4 Command side (pulse string input interface) specifications

Item	Specifications	
PG method	Incremental A-phase, B-phase, Z-phase	
Pulse input type	Open collector	Complementary
Allowable frequency	30 kHz (duty: 50±10%)	100 kHz (duty: 50±10%)
Allowable wire length *1	30 m or less	30 m or less (100 kHz) 100 m or less (30 kHz)
Input pulse specifications	Max. SOURCE current: -3 mA (complementary only) Max. SINK current: 8 mA	
Pulse input voltage	H level voltage ≥6 V, L level voltage ≤2 V	
Power supply output	With +12 V: 80 mA max., +12 V ±10% With +15 V: 60 mA max., +15 V ±10% *It is necessary to supply power from an external device when an encoder exceeding the specified current is connected (encoder power supply +150 mA max.). *The above current is the total value including the PG interface.	

*1: These values are approximate. They might be shorter depending on the wire type or noise environment.

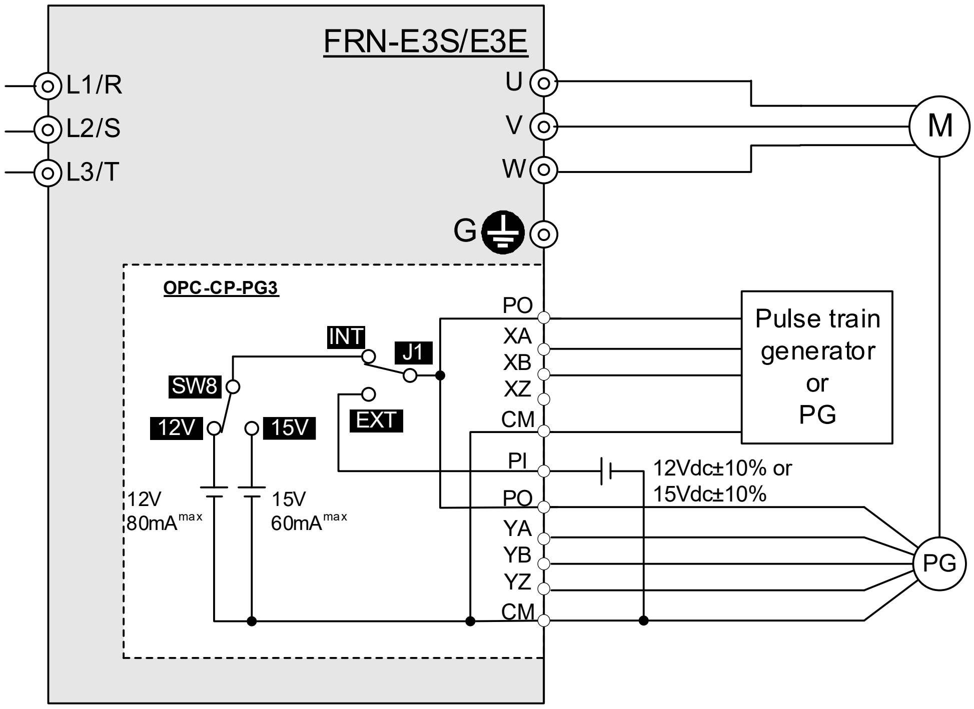


Fig. 11.13-3 Command side (pulse string input interface) specifications

Table 11.13-5 Output voltage switch, internal/external power supply selection jumper

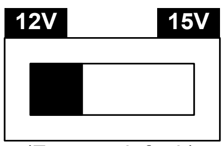
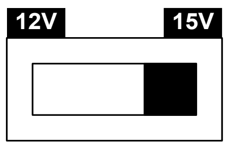
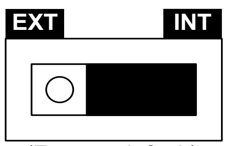
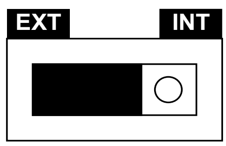
Symbol	Name	Specifications
SW8	Output voltage switch	Selection between +12 Vdc ±10% 80 mA^{max} and +15 Vdc ±10% 60 mA^{max} 【12V】  (Factory default) 【15V】 
J1	Internal/external power supply selection	It is possible to connect a device exceeding the internal current capacity to the PO terminal by connecting an external power supply to the PI terminal. In this case, switch J1 to **EXT**. (External power supply capacity = power supply of the connected device + 150 mA) 【INT】  (Factory default) 【EXT】 

Table 11.13-6 Terminal functions

Function	Terminal block	Symbol	Name	Specifications
Feedback side (PG interface)	TERM4	PO	Power supply output	Power supply output for external devices Can output 12 V/15 V power.
		YA	A phase input	Feedback pulse A-phase connection terminal
		YB	B phase input	Feedback pulse B-phase connection terminal
		YZ	Z-phase input	Feedback pulse Z-phase connection terminal (for position control)
		CM	Common	Power supply common terminal for PG/pulse string/digital input Insulated from terminal 11.
		PI	External power supply input	Terminal for inputting external power supply for PG. Can input +12 Vdc ±10% and +15 Vdc ±10%
Command side (pulse string input interface)	TERM5	PO	Power supply output	Power supply output for external devices Can output 12 V/15 V power.
		XA	A phase input	Terminal for inputting command pulse string A-phase
		XB	B phase input	Terminal for inputting command pulse string B-phase
		XZ	-	Not used
		CM	Common	Power supply common terminal for PG/pulse string/digital input Insulated from terminal 11.

11.13.3 PG interface card (OPC-CP-PG)

This option card has two pulse (ABZ phase) input circuits corresponding to 12 V and 15 V, and a power supply output circuit for PG (pulse generator). By exchanging this option card with the control circuit terminal that is installed in FRENIC-Ace main body as a standard, the following expansion functions can be used.

(1) Speed control (vector control with speed sensor, V/f control with speed sensor) is possible by PG feedback signal.

(2) Simplified position control is possible by PG feedback signal.

(3) Master-follower synchronous drive is possible by PG feedback signal or by pulse string input.

(4) Pulse string input is possible as the frequency command.

Note 1) If this card is used, the pulse string input function of the inverter main body terminal X5 cannot be used.

Table 11.13-7 Feedback side (PG interface) specifications

Item	Specifications	
PG method	Incremental A-phase, B-phase, Z-phase	
Pulse input type	Open collector	Complementary
Allowable frequency	30 kHz (duty: 50±10%)	
Allowable wire length *1	20 m or less	
Input pulse specifications	Max. SOURCE current: -3 mA (complementary only) Max. SINK current: 8 mA	
Pulse input voltage	H level voltage ≥3.5 V, L level voltage ≤1.5 V	
Input pulse count	20 to 3600 P/R	
Power supply output	With +5 V: 200 mA max., +5 V ±10% *It is necessary to supply power from an external device when an encoder exceeding the specified current is connected (encoder power supply +150 mA max.). *The above current is the total value including the pulse string input interface.	

*1: These values are approximate. They might be shorter depending on the wire type or noise environment.

Table 11.13-8 Command side (pulse string input interface) specifications

Item	Specifications	
PG method	Incremental A-phase, B-phase, Z-phase	
Pulse input type	Open collector	Complementary
Allowable frequency	30 kHz (duty: 50±10%)	
Allowable wire length *1	20 m or less	
Input pulse specifications	Max. SOURCE current: -3 mA (complementary only) Max. SINK current: 8 mA	
Pulse input voltage	H level voltage ≥3.5 V, L level voltage ≤1.5 V	
Power supply output	With +5 V: 200 mA max., +5 V ±10% *It is necessary to supply power from an external device when an encoder exceeding the specified current is connected (encoder power supply +150 mA max.). *The above current is the total value including the PG interface.	

*1: These values are approximate. They might be shorter depending on the wire type or noise environment.

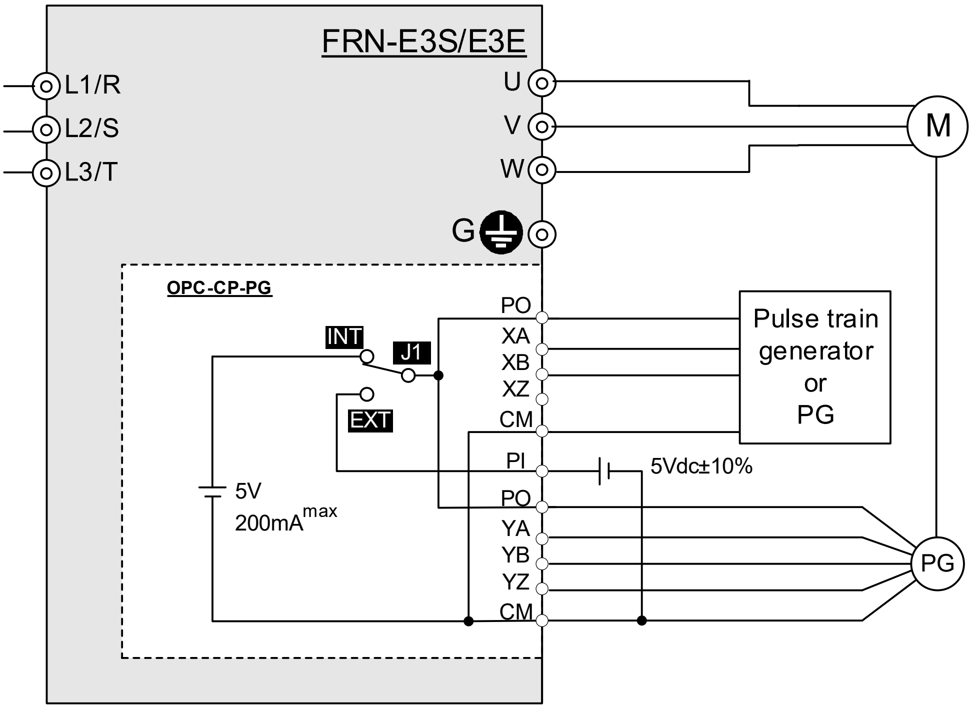


Fig. 11.13-4 Command side (pulse string input interface) specifications

Table 11.13-9 Output voltage switch, internal/external power supply selection jumper

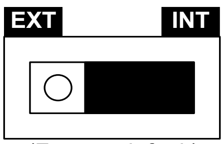
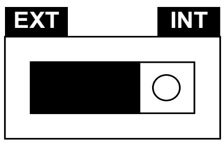
Symbol	Name	Specifications
J1	Internal/external power supply selection	It is possible to connect a device exceeding the internal current capacity to the PO terminal by connecting an external power supply to the PI terminal. In this case, switchJ1 to **EXT**. (External power supply capacity = power supply of the connected device + 150 mA) 【INT】  (Factory default) 【EXT】 

Table 11.13-10 Terminal functions

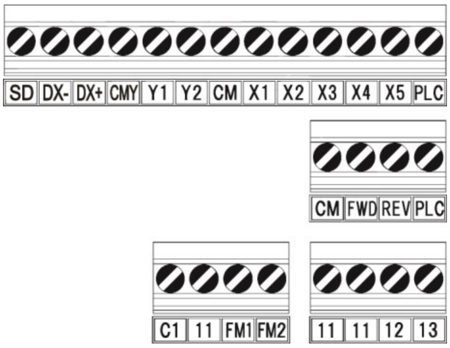
Function	Terminal block	Symbol	Name	Specifications
Feedback side (PG interface)	TERM4	PO	Power supply output	Power supply output for external devices Can output 5 V power.
		YA	A phase input	Feedback pulse A-phase connection terminal
		YB	B phase input	Feedback pulse B-phase connection terminal
		YZ	Z-phase input	Feedback pulse Z-phase connection terminal (for position control)
		CM	Common	Power supply common terminal for PG/pulse string/digital input Insulated from terminal 11.
		PI	External power supply input	Terminal for inputting external power supply for PG. Can input 5 Vdc ±10%
Command side (pulse string input interface)	TERM5	PO	Power supply output	Power supply output for external devices Can output 5 V power.
		XA	A phase input	Terminal for inputting command pulse string A-phase
		XB	B phase input	Terminal for inputting command pulse string B-phase
		XZ	-	Not used
		CM	Common	Power supply common terminal for PG/pulse string/digital input Insulated from terminal 11.

11.13.4 Screw terminal block board option (E2S compatibility) (OPC-E2-TB1)

This option is used to convert the push-type control terminal block to a screw-type terminal block, similar to that found on conventional Ace (E2) models.

For details on terminal functions, refer to Chapter 2 “2.2.6 Control circuit terminals.”

Terminal configuration



Screw specifications, tightening torque, and recommended wire size

	Screw specifications		Allowable wire sizes	Driver (shape of tip)	Removal size of wire cover ℓ	Wire inlet gauge size
	Size	Tightening torque				
Control circuit terminal	M2	0.19 N · m	0.25 to 1 mm^2 (AWG24 to 18)	Flathead (0.4 mm x 2.5 mm)	5 mm	φ1.6

11.14 Keypad Options

Connecting the keypad options makes it possible to use more functions than with the keypad provided as standard. If performing remote operation, the keypad relay adapter and extension cable are required.

Table 11.14-1

Type	Name	Function overview	Refer to:
TP-E2	Remote keypad	Includes a large 7-segment LED monitor. Memory installed; can read/copy function code data. The FRENIC-Ace (E3) can be connected to FRENIC Loader4 via the USB port. This option is connected to the FRENIC-Ace (E3) with a cable and cannot be mounted directly.	Section 11.14.1
TP-A2SW	Multi-function keypad	Equipped with a backlight large LCD panel. Display available in multiple languages. Memory installed; can read/copy function code data. The FRENIC-Ace (E3) can be connected to FRENIC Loader4 via the USB port. This option is connected to the FRENIC-Ace (E3) with a cable and cannot be mounted directly.	Section 11.14.2
CBAD-CP	Keypad relay adapter (CBAD-CP)	Acts as RJ-45 connector for connecting extension cable.	Section 11.14.2
CB-☐S	Extension Cable for Remote Operation	The extension cable (LAN cable) comes in lengths of 1 m, 3 m, or 5 m.	Section 11.14.2

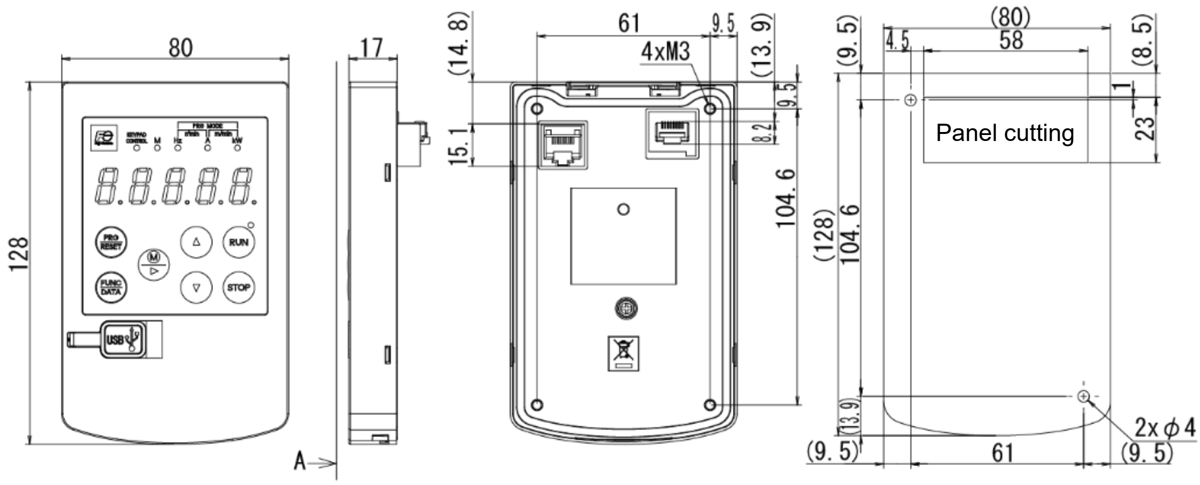
11.14.1 Remote keypad (TP-E2)

When used in combination with the FRENIC-Loader, the data items from the inverter unit can be saved into the keypad memory, making it possible to perform check operations anywhere. This keypad cannot be mounted directly to the FRENIC-Ace unit. Connect it using the relay connector (CBAD-CP) and a LAN cable with the RJ-45 connector.

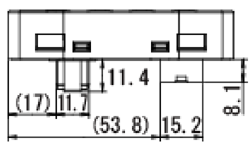
Specifications

Item	Specifications	Remarks
Copy function	Can save one data set.	
USB interface	Type Mini-B	FRENIC Loader support with Windows® 10 or later OS
Applicable inverter	FRENIC-MEGA (G2) series FRENIC-Ace (E3) series	
Connection cable	Conforming to ANSI/TIA/EIA568A Category 5 or higher (for 10BASE-T/100BASE-TX straight connection)	Option type: CB-5S, CB-3S, CB-1S
Cable length	20 m (787 ft) or less	
Connector	RJ-45	
Protective construction	Panel side: IP20, reverse side: IP20	
Weight	107 g (3.8 oz)	

External Dimensions



Panel cutting dimensions drawing (view A)



Unit: mm

11.14.2 Multi-function keypad (TP-A2SW)

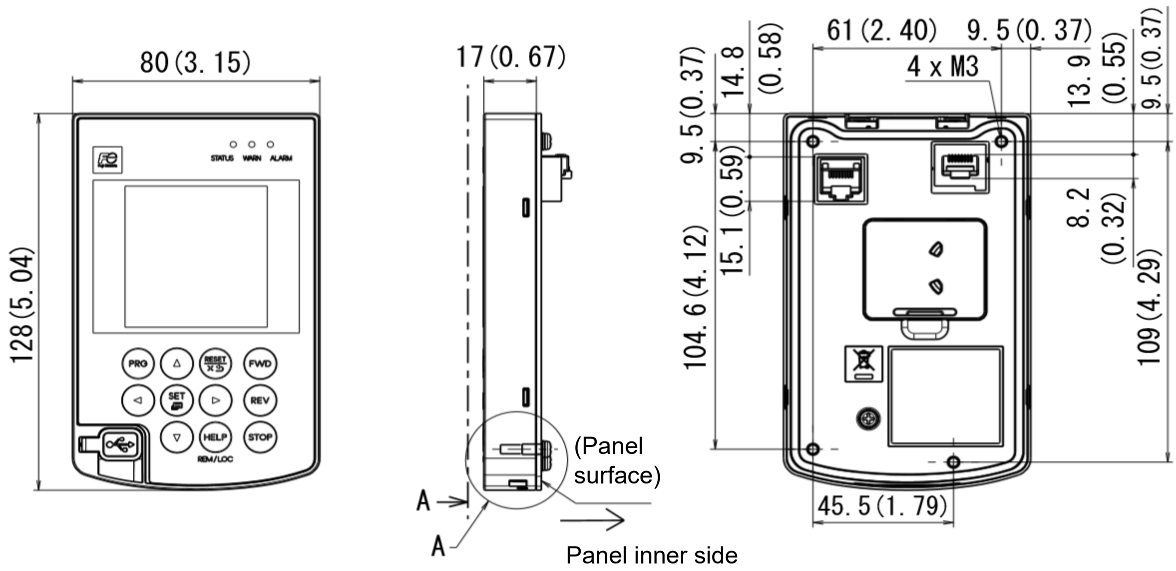
Multi-function keypad TP-A2SW is equipped with an LCD screen with backlight, and displays data names and units in Japanese, English, Chinese, etc. This allows function codes and all internal data to be set and referenced in an easy-to-follow format. This keypad cannot be mounted directly to the FRENIC-Ace unit. Connect it using the relay connector (CBAD-CP) and a LAN cable with a RJ-45 connector.

Specifications

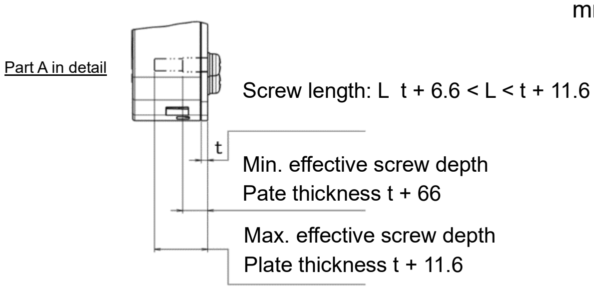
Item	Specifications	Remarks
Available languages	Support for total of 20 languages including Japanese, English, and Chinese	
Copy function	Possible to memorize or copy three function data sets.	
USB interface	Type Mini-B	FRENIC Loader support with Windows® 10 or later OS
Wireless communication	Bluetooth® Ver. 5.0	FRENIC Mobile Loader support with Android 8 or later
microSD card *1	SDHC standard (capacity: max. 32 GB)	Traceback function
Coin battery *1	CR2032	Real-time clock function
Applicable inverter	FRENIC-MEGA (G2) series FRENIC-Ace (E3) series	Cannot be used with Ace (E2).
Connection cable	Conforming to ANSI/TIA/EIA568A Category 5 or higher (for 10BASE-T/100BASE-TX straight connection)	Option type: CB-5S, CB-3S, CB-1S
Cable length	20 m (787 ft) or less	
Connector	RJ-45	
Protective construction	Panel side: IP55, reverse side: IP20	
Weight	135 g (4.8oz)	

***1: This is not built-in as standard, and must be purchased separately.**

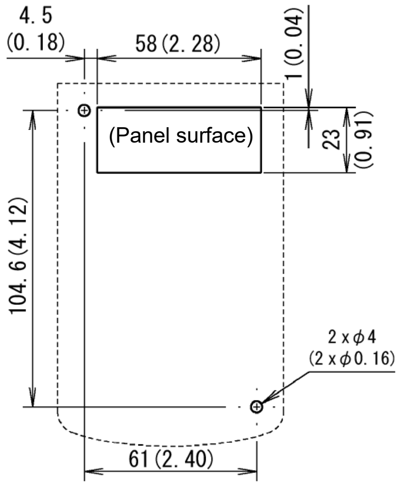
External drawings



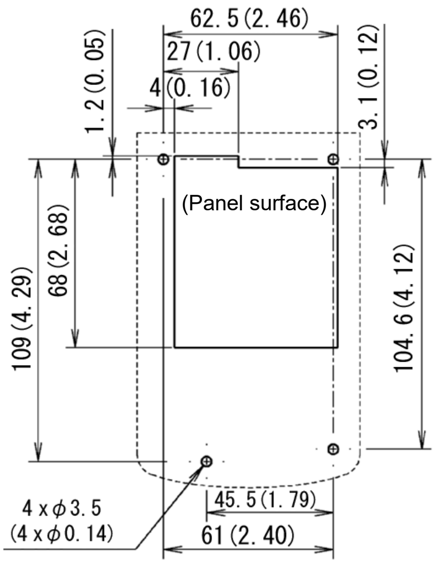
mm (inch)



Panel cutting drawing



When using previous compatible panel cutting

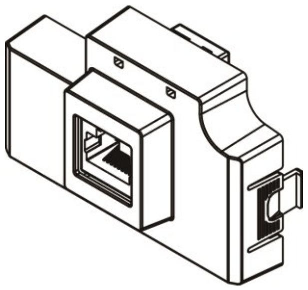


mm (inch)

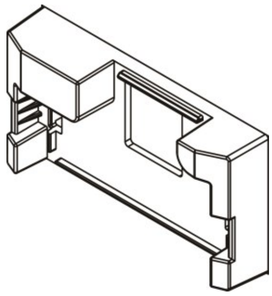
Waterproof + SD card, when replacing battery

11.14.3 Keypad relay adapter (CBAD-CP)

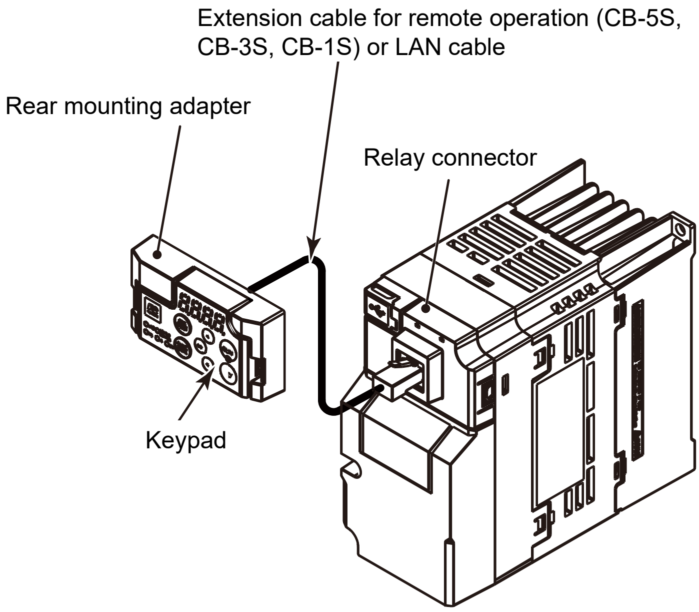
Use this relay adapter and a LAN cable to remotely connect the keypad to the FRENIC-Ace (E3).



Relay connector



Rear mounting adapter



11.14.4 Extension Cable for Remote Operation

This cable is used to connect the inverter unit RJ-45 connector with the keypad or USB-RS-485 converter, etc. The cable is available in lengths of 1 m, 3 m, and 5 m. All cables are straight type.

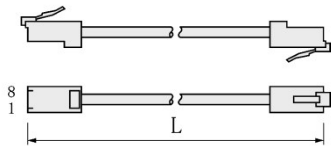


Table 11.14-2 Extension cable length for remote operation

Type	Length (m)
CB-5S	5
CB-3S	3
CB-1S	1

Note Connect the keypad via the optional Keypad relay adapter (CBAD-CP) when operating remotely from the keypad.

Chapter 12
SPECIFICATIONS

This chapter describes the output ratings, input power, basic functions and other specifications of the FRENIC-Ace standard model.

Contents

12.1 Basic type/Ethenet build-in type/EMC filter buit-in type

12.1.1 ND-mode inverters for general load

■ **Three-phase 400V class series**

Item			Specification										
Type (FRN_ _ _ _E3S-4G) Type (FRN_ _ _ _E3N-4G) Type (FRN_ _ _ _E3E-4G)			0002	0004	0006	0007	0012	0022	0029	0037	0044	0059	0072
Nominal applied motor (kW) [HP] (Output rating) (*1)			0.75 [1]	1.5 [2]	2.2 [3]	3 [4]	5.5 [7.5]	11 [15]	15 [20]	18.5 [25]	22 [30]	30 [40]	37 [50]
Output ratings	Rated capacity (kVA) (*2)		1.6	3.1	4.2	5.3	9.1	16	22	28	34	45	55
	Rated voltage (*3)		Three-phase 380 to 480V (with AVR function)										
	Rated current (A) (*4) at Ta=40°C(104°F)		2.1	4.1	5.5	6.9	12.0	21.5	28.5	37	44	59	72
	Overload capability		120%-1 min										
Input power	Voltage, frequency		Three-phase 380 to 480 V,50/60 Hz										
	Allowable voltage / frequency		Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) (*8) Frequency: +5 to -5%										
	Rated current (A) (*5)	With DCR	1.5	2.9	4.2	5.8	10.1	21.1	28.8	35.5	42.2	57.0	68.5
		w/o DCR	2.7	4.8	7.3	11.3	16.8	33	43.8	52.3	60.6	77.9	94.3
	Required capacity (with DCR) (kVA) (*6)		1.1	2.1	3.0	4.1	7.0	15	20	25	29	39	47
Braking	Torque (*7)		53%	50%	48%	29%	27%	12%					
	DC braking		Braking starting frequency: 0.0 to 60.0 Hz, Braking time: 0.0 to 30.0 s, Braking level: 0 to 60%										
	Braking transistor		Built-in as standard										
	Connectable resistance (ohm)		200		160 ~ 200		130 ~ 200	80 min.	60 min.	40 min.	34.4 min.	16 min.	
	Braking resistor		Separately mounted option										
DC reactor (DCR) (*8)			Separately mounted option										
Applicable safety standards			UL61800-5-1, C22.2 No.274-17,IEC/EN 61800-5-1,EN ISO 13849-1 Cat.3 / PL:e, EN 60204-1 Stop category 0, EN 61800-5-2 SIL3 (Functional Safety : STO), EN 62061 SIL3, SEMI F47-0706										
EMC filter built-in type Applicable EMC standards (E3E)			Compliant with EMC Directives. Emission: Category C2. Immunity: 2nd Env. (EN61800-3)					Compliant with EMC Directives. Emission: Category C3. Immunity: 2nd Env. (EN61800-3)					
Enclosure (IEC60529)			IP20, UL open type										
Cooling method (E3S, E3N, E3E)			Natural cooling			Fan cooling							
E3S Weight / Mass (kg) [lbs]			1.1 [2.4]	1.4 [3.1]	1.4 [3.1]	1.4 [3.1]	1.7 [3.7]	3.8 [8.4]	3.8 [8.4]	5.2 [11]	5.4 [12]	11 [24]	11 [24]
E3N Weight / Mass (kg) [lbs]			1.2 [2.6]	1.4 [3.1]	1.5 [3.3]	1.4 [3.1]	1.8 [4.0]	3.7 [8.2]	3.8 [8.4]	5.3 [12]	5.4 [12]	11 [24]	11 [24]
E3E Weight / Mass (kg) [lbs]			1.5 [3.3]	1.7 [3.7]	2.0 [4.4]	2.2 [4.9]	2.2 [4.9]	5.3 [12]	5.4 [12]	7.5 [17]	7.5 [17]	11 [24]	12 [26]

*1 Fuji 4-pole standard motor. At the selection of the inverter rating, consider not only the rating capacity (kW) is enough but also inverter output current is larger than selected the motor's nominal current.

*2 Rated capacity is calculated by assuming the output rated voltage as 440 V.

*3 The output voltage cannot exceed the power supply voltage.

*4 When the carrier frequency (F26) is set to below value or higher, the inverter is sure to be necessary to derate their nominal current.
All type: 4kHz

*5 The value is calculated assuming that the inverter is connected with a power supply with the capacity of 500 kVA (or 10 times the inverter capacity if the inverter capacity exceeds 50 kVA) and %X is 5%.

*6 Obtained when a DC reactor (DCR) is used.

*7 Average braking torque for the motor running alone. (It varies with the efficiency of the motor.)

*8 Voltage unbalance (%) = (Max. voltage (V) - Min. voltage (V))/Three -phase average voltage (V) × 67 (IEC 61800 - 3)
If this value is 2 to 3%, use an optional AC reactor (ACR).

12.1.2 HD-mode inverters for heavy duty load

■ **Three-phase 400V class series**

Item		Specification										
Type (FRN_ _ _ _E3S-4G) Type (FRN_ _ _ _E3N-4G) Type (FRN_ _ _ _E3E-4G)		0002	0004	0006	0007	0012	0022	0029	0037	0044	0059	0072
Nominal applied motor (kW) [HP] (Output rating) (*1)		0.75 [1]	1.1 [1.5]	2.2 [3]	3 [4]	5.5 [7.5]	7.5 [10]	11 [15]	15 [20]	18.5 [25]	22 [30]	30 [40]
Output ratings	Rated capacity (kVA) (*2)	1.4	2.6	3.8	4.8	8.5	13	18	27	31	34	46
Output ratings	Rated voltage (*3)	Three-phase 380 to 480V (with AVR function)										
Output ratings	Rated current (A) (*4) at Ta=40°C(104°F)	1.8	3.4	5	6.3	11.1	17.5	23	35	41	45	60
Output ratings	Overload capability	150%-1 min										
Input power	Voltage, frequency	Three-phase 380 to 480 V, 50/60 Hz										
Input power	Allowable voltage / frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) (*8) Frequency: +5 to -5%										
Input power	Rated current (A) (*5) With DCR	1.5	2.1	4.2	5.8	10.1	14.4	21.1	28.8	35.5	42.2	57.0
Input power	Rated current (A) (*5) w/o DCR	2.7	3.9	7.3	11.3	16.8	23.2	33.0	43.8	52.3	60.6	77.9
Input power	Required capacity (with DCR) (kVA) (*6)	1.1	1.5	3.0	4.1	7.0	10	15	20	25	29	39
Braking	Torque (*7)	53%	68%	48%	29%	27%	15%					
Braking	DC braking	Braking starting frequency: 0.0 to 60.0 Hz, Braking time: 0.0 to 30.0 s, Braking level: 0 to 80%										
Braking	Braking transistor	Built-in as standard										
Braking	Connectable resistance (ohm)	200		160 ~ 200		130 ~ 200	80 min.	60 min.	40 min.	34.4 min.	16 min.	
Braking	Braking resistor	Separately mounted option										
DC reactor (DCR) (*8)		Separately mounted option										
Applicable safety standards		UL61800-5-1, C22.2 No.274-17, IEC/EN 61800-5-1, EN ISO 13849-1 Cat.3 / PL:e, EN 60204-1 Stop category 0, EN 61800-5-2 SIL3 (Functional Safety: STO), EN 62061 SIL3, SEMI F47-0706										
EMC filter built-in type Applicable EMC standards (E3E)		Compliant with EMC Directives. Emission: Category C2. Immunity: 2nd Env. (EN61800-3)					Compliant with EMC Directives. Emission: Category C3. Immunity: 2nd Env. (EN61800-3)					
Enclosure (IEC60529)		IP20, UL open type										
Cooling method (E3S, E3N, E3E)		Natural cooling			Fan cooling							
E3S Weight / Mass (kg) [lbs]		1.1 [2.4]	1.4 [3.1]	1.4 [3.1]	1.4 [3.1]	1.7 [3.7]	3.8 [8.4]	3.8 [8.4]	5.2 [11]	5.4 [12]	11 [24]	11 [24]
E3N Weight / Mass (kg) [lbs]		1.2 [2.6]	1.4 [3.1]	1.5 [3.3]	1.4 [3.1]	1.8 [4.0]	3.7 [8.2]	3.8 [8.4]	5.3 [12]	5.4 [12]	11 [24]	11 [24]
E3E Weight / Mass (kg) [lbs]		1.5 [3.3]	1.7 [3.7]	2.0 [4.4]	2.2 [4.9]	2.2 [4.9]	5.3 [12]	5.4 [12]	7.5 [17]	7.5 [17]	11 [24]	12 [26]

*1 Fuji 4-pole standard motor. At the selection of the inverter rating, consider not only the rating capacity (kW) is enough but also inverter output current is larger than selected the motor's nominal current.

*2 Rated capacity is calculated by assuming the output rated voltage as 440 V.

*3 The output voltage cannot exceed the power supply voltage.

*4 When the carrier frequency (F26) is set to below value or higher, the inverter is sure to be necessary to derate their nominal current.
All type: 4kHz

*5 The value is calculated assuming that the inverter is connected with a power supply with the capacity of 500 kVA (or 10 times the inverter capacity if the inverter capacity exceeds 50 kVA) and %X is 5%.

*6 Obtained when a DC reactor (DCR) is used.

*7 Average braking torque for the motor running alone. (It varies with the efficiency of the motor.)

*8 Voltage unbalance (%) = (Max. voltage (V) - Min. voltage (V))/Three -phase average voltage (V) × 67 (IEC 61800 - 3)
If this value is 2 to 3%, use an optional AC reactor (ACR).

12.1.3 HND-mode inverters for general load

■ **Three-phase 200V class series (HND-mode)**

Item		Specification												
Type (FRN_ _ _ _E3S-2G) Type (FRN_ _ _ _E3N-2G)		0001	0002	0004	0006	0010	0012 (*10)	0020 (*10)	0030	0040	0056	0069	0088	0115
Nominal applied motor (kW) [HP] (Output rating) (*1)		0.2 [1/4]	0.4 [1/2]	0.75 [1]	1.1 [1.5]	2.2 [3]	3 [4]	5.5 [7.5]	7.5 [10]	11 [15]	15 [20]	18.5 [25]	22 [30]	30 [40]
Output ratings	Rated capacity (kVA) (*2)	0.5	0.8	1.3	2.3	3.7	4.6	7.5	11	15	21	26	34	44
	Rated voltage (*3)	Three-phase 200 to 240V (with AVR function)												
	Rated current (A) (*4) at Ta=50°C(122°F)	1.3	2	3.5	6	9.6	12 (*9)	19.6 (*9)	30	40	56	69	88	115
	Overload capability	120%-1 min												
Input power	Voltage, frequency	Three-phase 200 to 240 V, 50/60 Hz												
	Allowable voltage / frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) (*8) Frequency: +5 to -5%												
	Rated current (A) (*5) With DCR	0.93	1.6	3.0	4.3	8.3	11.7	19.9	28.8	42.2	57.6	71.0	84.4	114
	Rated current (A) (*5) w/o DCR	1.8	2.6	4.9	6.7	12.8	17.9	28.5	42.7	60.7	80.1	97.0	112	151
	Required capacity (with DCR) (kVA) (*6)	0.4	0.6	1.1	1.5	2.9	4.1	6.9	10	15	20	25	30	40
Braking	Torque (*7)	75%		53%	68%	48%	29%	27%	15%					
	DC braking	Braking starting frequency: 0.0 to 60.0 Hz, Braking time: 0.0 to 30.0 s, Braking level: 0 to 80% (Type FRN0012E3□-2□ and FRN0020E3□-2□: 0 to 60%)												
	Braking transistor	Built-in as standard												
	Connectable resistance (ohm)	100 ~ 120				40 ~ 120		33 ~ 120	20 min.	15 min.	10 min.	8.6 min.	4 min.	
	Braking resistor	Separately mounted option												
DC reactor (DCR) (*8)		Separately mounted option												
Applicable safety standards		UL61800-5-1, C22.2 No.274-17, IEC/EN 61800-5-1, EN ISO 13849-1 Cat.3 / PL:e, EN 60204-1 Stop category 0, EN 61800-5-2 SIL3 (Functional Safety: STO), EN 62061 SIL3, SEMI F47-0706												
Enclosure (IEC60529)		IP20, UL open type												
Cooling method (E3S, E3N)		Natural cooling				Fan cooling								
E3S Weight / Mass (kg) [lbs]		0.5 [1.1]	0.5 [1.1]	0.6 [1.3]	0.8 [1.8]	1.4 [3.1]	1.4 [3.1]	1.7 [3.7]	3.8 [8.4]	4.0 [8.8]	5.3 [12]	5.4 [12]	11 [24]	12 [26]
E3N Weight / Mass (kg) [lbs]		0.5 [1.1]	0.5 [1.1]	0.7 [1.5]	0.9 [2.0]	1.4 [3.1]	1.4 [3.1]	1.7 [3.7]	3.8 [8.4]	3.9 [8.6]	5.3 [12]	5.4 [12]	11 [24]	12 [26]

*1 Fuji 4-pole standard motor. At the selection of the inverter rating, consider not only the rating capacity (kW) is enough but also inverter output current is larger than selected the motor's nominal current.

*2 Rated capacity is calculated by assuming the output rated voltage as 220 V.

*3 Output voltage cannot exceed the power supply voltage.

*4 When the carrier frequency (F26) is set to below value or higher, the inverter is sure to be necessary to derate their nominal current.
type 0001 to 0020: 4kHz, type 0030 to 0088: 10kHz, 0115: 6kHz

*5 The value is calculated assuming that the inverter is connected with a power supply with the capacity of 500 kVA (or 10 times the inverter capacity if the inverter capacity exceeds 50 kVA) and %X is 5%.

*6 Obtained when a DC reactor (DCR) is used.

*7 Average braking torque for the motor running alone. (It varies with the efficiency of the motor.)

*8 Voltage unbalance (%) = (Max. voltage (V) - Min. voltage (V))/Three -phase average voltage (V) × 67 (IEC 61800 - 3)
If this value is 2 to 3%, use an optional AC reactor (ACR).

*9 The rated output current is decrease 1%/°C when the ambient temperature 40°C (+104°F) or more.

*10 The drive mode (F80) is set to 4.

■ Three-phase 400V class series (HND-mode)

Item		Specification										
Type (FRN_ _ _ _E3S-4G) Type (FRN_ _ _ _E3N4G) Type (FRN_ _ _ _E3E-4G)		0002	0004	0006	0007	0012	0022	0029	0037	0044	0059	0072
Nominal applied motor (kW) [HP] (Output rating) (*1)		0.75 [1]	1.1 [1.5]	2.2 [3]	3 [4]	5.5 [7.5]	7.5 [10]	11 [15]	15 [20]	18.5 [25]	22 [30]	30 [40]
Output ratings	Rated capacity (kVA) (*2)	1.4	2.6	3.8	4.8	8.5	13	18	27	31	34	46
	Rated voltage (*3)	Three-phase 380 to 480V (with AVR function)										
	Rated current (A) (*4) at Ta=50°C(122°F)	1.8	3.4	5	6.3 (*9)	11.1 (*9)	17.5	23	35	41	45	60
	Overload capability	120%-1 min										
Input power	Voltage, frequency	Three-phase 380 to 480 V, 50/60 Hz										
	Allowable voltage / frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) (*8) Frequency: +5 to -5%										
	Rated current (A) (*5) With DCR	1.5	2.1	4.2	5.8	10.1	14.4	21.1	28.8	35.5	42.2	57.0
	Rated current (A) (*5) w/o DCR	2.7	3.9	7.3	11.3	16.8	23.2	33.0	43.8	52.3	60.6	77.9
	Required capacity (with DCR) (kVA) (*6)	1.1	1.5	3.0	4.1	7.0	10	15	20	25	29	39
Braking	Torque (*7)	53%	68%	48%	29%	27%	15%					
	DC braking	Braking starting frequency: 0.0 to 60.0 Hz, Braking time: 0.0 to 30.0 s, Braking level: 0 to 80% (Type FRN0007E3□-4□ and FRN0012E3□-4□: 0 to 60%)										
	Braking transistor	Built-in as standard										
	Connectable resistance (ohm)	200		160 ~ 200		130 ~ 200	80 min.	60 min.	40 min.	34.4 min.	16 min.	
	Braking resistor	Separately mounted option										
DC reactor (DCR) (*8)		Separately mounted option										
Applicable safety standards		UL61800-5-1, C22.2 No.274-17, IEC/EN 61800-5-1, EN ISO 13849-1 Cat.3 / PL:e, EN 60204-1 Stop category 0, EN 61800-5-2 SIL3 (Functional Safety: STO), EN 62061 SIL3, SEMI F47-0706										
EMC filter built-in type Applicable EMC standards (E3E)		Compliant with EMC Directives. Emission: Category C2. Immunity: 2nd Env. (EN61800-3)					Compliant with EMC Directives. Emission: Category C3. Immunity: 2nd Env. (EN61800-3)					
Enclosure (IEC60529)		IP20, UL open type										
Cooling method (E3S, E3N, E3E)		Natural cooling			Fan cooling							
E3S Weight / Mass (kg) [lbs]		1.1 [2.4]	1.4 [3.1]	1.4 [3.1]	1.4 [3.1]	1.7 [3.7]	3.8 [8.4]	3.8 [8.4]	5.2 [11]	5.4 [12]	11 [24]	11 [24]
E3N Weight / Mass (kg) [lbs]		1.2 [2.6]	1.4 [3.1]	1.5 [3.3]	1.4 [3.1]	1.8 [4.0]	3.7 [8.2]	3.8 [8.4]	5.3 [12]	5.4 [12]	11 [24]	11 [24]
E3E Weight / Mass (kg) [lbs]		1.5 [3.3]	1.7 [3.7]	2.0 [4.4]	2.2 [4.9]	2.2 [4.9]	5.3 [12]	5.4 [12]	7.5 [17]	7.5 [17]	11 [24]	12 [26]

*1 Fuji 4-pole standard motor. At the selection of the inverter rating, consider not only the rating capacity (kW) is enough but also inverter output current is larger than selected the motor's nominal current.

*2 Rated capacity is calculated by assuming the output rated voltage as 440 V.

*3 The output voltage cannot exceed the power supply voltage.

*4 When the carrier frequency (F26) is set to below value or higher, the inverter is sure to be necessary to derate their nominal current.
type 0002 to 0012: 8kHz, type 0022 to 0059: 10kHz, type 0072: 6kHz

*5 The value is calculated assuming that the inverter is connected with a power supply with the capacity of 500 kVA (or 10 times the inverter capacity if the inverter capacity exceeds 50 kVA) and %X is 5%.

*6 Obtained when a DC reactor (DCR) is used.

*7 Average braking torque for the motor running alone. (It varies with the efficiency of the motor.)

*8 Voltage unbalance (%) = (Max. voltage (V) - Min. voltage (V))/Three -phase average voltage (V) × 67 (IEC 61800 - 3)
If this value is 2 to 3%, use an optional AC reactor (ACR).

*9 The rated output current is decrease 1%/°C when the ambient temperature 40°C (+104°F) or more.

■ Single-phase 200V class series (HND-mode)

Item			Specification					
Type (FRN_ _ _ _E3S-7G) Type (FRN_ _ _ _E3N-7G)			0001 (*10)	0002 (*10)	0004 (*10)	0006 (*10)	0010 (*10)	0012 (*10)
Nominal applied motor (kW) [HP] (Output rating) (*1)			0.2 [1/4]	0.4 [1/2]	0.55 [3/4]	1.1 [1.5]	2.2 [3] (*8)	3 [4] (*9)
Output ratings	Rated capacity (kVA) (*2)		0.5	0.7	1.3	2.3	3.7	4.6
	Rated voltage (*3)		Three-phase 200 to 240V (with AVR function)					
	Rated current (A) (*4) at Ta=50℃ (122°F)		1.2	1.9	3.5 (*11)	6 (*11)	9.6 (*11)	12 (*11)
	Overload capability		120%-1 min					
Input power	Voltage, frequency		Single-phase 200 to 240 V, 50/60 Hz					
	Allowable voltage / frequency		Voltage: +10 to -10%, Frequency: +5 to -5%					
	Rated current (A) (*5)	With DCR	2.2	3.7	4.6	9.4	17.9	25
		w/o DCR	3.3	4.9	7.3	13.8	20.2	26
	Required capacity (with DCR) (kVA) (*6)		0.5	0.8	1.0	1.9	3.6	5.0
Braking	Torque (*7)		75%		73%	68%	48%	29%
	DC braking		Braking starting frequency: 0.0 to 60.0 Hz, Braking time: 0.0 to 30.0 s, Braking level: 0 to 60%					
	Braking transistor		Built-in as standard					
	Connectable resistance (ohm)		100 ~ 120				40 ~ 120	
	Braking resistor		Separately mounted option					
DC reactor (DCR)			Separately mounted option					
Applicable safety standards			UL61800-5-1, C22.2 No.274-17, IEC/EN 61800-5-1, EN ISO 13849-1 Cat.3 / PL:e, EN 60204-1 Stop category 0, EN 61800-5-2 SIL3 (Functional Safety: STO), EN 62061 SIL3, SEMI F47-0706					
Enclosure (IEC60529)			IP20, UL open type					
Cooling method (E3S, E3N)			Natural cooling				Fan cooling	
E3S Weight / Mass (kg) [lbs]			0.5 [1.1]	0.5 [1.1]	0.6 [1.3]	0.9 [2.0]	1.4 [3.1]	1.7 [3.7]
E3N Weight / Mass (kg) [lbs]			0.5 [1.1]	0.5 [1.1]	0.7 [1.5]	0.9 [2.0]	1.5 [3.3]	1.7 [3.7]

*1 Fuji 4-pole standard motor. At the selection of the inverter rating, consider not only the rating capacity (kW) is enough but also inverter output current is larger than selected the motor's nominal current.

*2 Rated capacity is calculated by assuming the output rated voltage as 220 V.

*3 Output voltage cannot exceed the power supply voltage.

*4 When the carrier frequency (F26) is set to below value or higher, the inverter is sure to be necessary to derate their nominal current.
All type: 4kHz

*5 The value is calculated assuming that the inverter is connected with a power supply with the capacity of 500 kVA (or 10 times the inverter capacity if the inverter capacity exceeds 50 kVA) and %X is 5%.

*6 Obtained when a DC reactor (DCR) is used.

*7 Average braking torque for the motor running alone. (It varies with the efficiency of the motor.)

*8 Input voltage is less than 220V, nominal applied motor is 2.0 kW.

*9 Input voltage is less than 220V, nominal applied motor is 2.7 kW.

*10 The drive mode (F80) is set to 4.

*11 The rated output current is decrease 2%/°C when the ambient temperature 40°C (+104°F) or more.

12.1.4 HHD-mode inverters for heavy duty load

■ **Three-phase 200V class series (HHD-mode)**

Item			Specification												
Type (FRN_ _ _ _E3S-2G) Type (FRN_ _ _ _E3N-2G)			0001	0002	0004	0006	0010	0012	0020	0030	0040	0056	0069	0088	0115
Nominal applied motor (kW) [HP] (Output rating) (*1)			0.1 [1/8]	0.2 [1/4]	0.4 [1/2]	0.75 [1]	1.5 [2]	2.2 [3]	3.7 [5]	5.5 [7.5]	7.5 [10]	11 [15]	15 [20]	18.5 [25]	22 [30]
Output ratings	Rated capacity (kVA) (*2)		0.4	0.6	1.1	1.9	3.0	4.2	6.7	9.5	13	18	23	29	34
	Rated voltage (*3)		Three-phase 200 to 240V (with AVR function)												
	Rated current (A) (*4) at Ta=50°C(122°F)		1	1.6	3	5	8	11	17.5	25	33	47	60	76	90
	Overload capability		150%-1 min, 200%-0.5 s												
Input power	Voltage, frequency		Three-phase 200 to 240 V, 50/60 Hz												
	Allowable voltage / frequency		Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) (*8) Frequency: +5 to -5%												
	Rated current (A) (*5)	With DCR	0.57	0.93	1.6	3.0	5.7	8.3	14.0	21.1	28.8	42.2	57.6	71.0	84.4
		w/o DCR	1.1	1.8	3.1	5.3	9.5	13.2	22.2	31.5	42.7	60.7	80.1	97.0	112
	Required capacity (with DCR) (kVA) (*6)		0.2	0.4	0.6	1.1	2.0	2.9	4.9	7.3	10	15	20	25	30
Braking	Torque (*7)		150%		100%		70%	40%		20%					
	DC braking		Braking starting frequency: 0.0 to 60.0 Hz, Braking time: 0.0 to 30.0 s, Braking level: 0 to 100%												
	Braking transistor		Built-in as standard												
	Connectable resistance (ohm)		100 ~ 120				40 ~ 120		33 ~ 120	20 min.	15 min.	10 min.	8.6 min.	4 min.	
	Braking resistor		Separately mounted option												
DC reactor (DCR) (*8)			Separately mounted option												
Applicable safety standards			UL61800-5-1, C22.2 No.274-17, IEC/EN 61800-5-1, EN ISO 13849-1 Cat.3 / PL:e, EN 60204-1 Stop category 0, EN 61800-5-2 SIL3 (Functional Safety: STO), EN 62061 SIL3, SEMI F47-0706												
Enclosure (IEC60529)			IP20, UL open type												
Cooling method (E3S, E3N)			Natural cooling				Fan cooling								
E3S Weight / Mass (kg) [lbs]			0.5 [1.1]	0.5 [1.1]	0.6 [1.3]	0.8 [1.8]	1.4 [3.1]	1.4 [3.1]	1.7 [3.7]	3.8 [8.4]	4.0 [8.8]	5.3 [12]	5.4 [12]	11 [24]	12 [26]
E3N Weight / Mass (kg) [lbs]			0.5 [1.1]	0.5 [1.1]	0.7 [1.5]	0.9 [2.0]	1.4 [3.1]	1.4 [3.1]	1.7 [3.7]	3.8 [8.4]	3.9 [8.6]	5.3 [12]	5.4 [12]	11 [24]	12 [26]

*1 Fuji 4-pole standard motor. At the selection of the inverter rating, consider not only the rating capacity (kW) is enough but also inverter output current is larger than selected the motor's nominal current.

*2 Rated capacity is calculated by assuming the output rated voltage as 220 V.

*3 Output voltage cannot exceed the power supply voltage.

*4 When the carrier frequency (F26) is set to below value or higher, the inverter is sure to be necessary to derate their nominal current.
type 0001 to 0020: 8kHz, type 0030 to 0115: 10kHz,

*5 The value is calculated assuming that the inverter is connected with a power supply with the capacity of 500 kVA (or 10 times the inverter capacity if the inverter capacity exceeds 50 kVA) and %X is 5%.

*6 Obtained when a DC reactor (DCR) is used.

*7 Average braking torque for the motor running alone. (It varies with the efficiency of the motor.)

*8 Voltage unbalance (%) = (Max. voltage (V) - Min. voltage (V))/Three -phase average voltage (V) × 67 (IEC 61800 - 3)
If this value is 2 to 3%, use an optional AC reactor (ACR).

■ Three-phase 400V class series (HHD-mode)

Item		Specification										
Type (FRN_ _ _ _E3S-4G) Type (FRN_ _ _ _E3E-4G) Type (FRN_ _ _ _E3N-4G)		0002	0004	0006	0007	0012	0022	0029	0037	0044	0059	0072
Nominal applied motor (kW) [HP] (Output rating) (*1)		0.4 [1/2]	0.75 [1]	1.5 [2]	2.2 [3]	3.7 [5]	5.5 [7.5]	7.5 [10]	11 [15]	15 [20]	18.5 [25]	22 [30]
Output ratings	Rated capacity (kVA) (*2)	1.1	1.9	3.2	4.2	7.0	11	14	18	24	30	34
	Rated voltage (*3)	Three-phase 380 to 480V (with AVR function)										
	Rated current (A) (*4) at Ta=50°C(122°F)	1.5	2.5	4.2	5.5	9.2	14.8	18	24	31	39	45
	Overload capability	150%-1 min, 200%-0.5 s										
Input power	Voltage, frequency	Three-phase 380 to 480 V, 50/60 Hz										
	Allowable voltage / frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) (*8) Frequency: +5 to -5%										
	Rated current (A) (*5) With DCR	0.85	1.6	3.0	4.4	7.3	10.6	14.4	21.1	28.8	35.5	42.2
	Rated current (A) (*5) w/o DCR	1.7	3.1	5.9	8.2	13.0	17.3	23.2	33	43.8	52.3	60.6
	Required capacity (with DCR) (kVA) (*6)	0.6	1.2	2.1	3.1	5.1	7.3	10	15	20	25	29
Braking	Torque (*7)	100%		70%	40%		20%					
	DC braking	Braking starting frequency: 0.0 to 60.0 Hz, Braking time: 0.0 to 30.0 s, Braking level: 0 to 100%										
	Braking transistor	Built-in as standard										
	Connectable resistance (ohm)	200		160 ~ 200		130 ~ 200	80 min.	60 min.	40 min.	34.4 min.	16 min.	
	Braking resistor	Separately mounted option										
DC reactor (DCR) (*8)		Separately mounted option										
Applicable safety standards		UL61800-5-1, C22.2 No.274-17, IEC/EN 61800-5-1, EN ISO 13849-1 Cat.3 / PL:e, EN 60204-1 Stop category 0, EN 61800-5-2 SIL3 (Functional Safety: STO), EN 62061 SIL3, SEMI F47-0706										
EMC filter built-in type Applicable EMC standards		Compliant with EMC Directives. Emission: Category C2. Immunity: 2nd Env. (EN61800-3)					Compliant with EMC Directives. Emission: Category C3. Immunity: 2nd Env. (EN61800-3)					
Enclosure (IEC60529)		IP20, UL open type										
Cooling method (E3S, E3N, E3E)		Natural cooling			Fan cooling							
E3S Weight / Mass (kg) [lbs]		1.1 [2.4]	1.4 [3.1]	1.4 [3.1]	1.4 [3.1]	1.7 [3.7]	3.8 [8.4]	3.8 [8.4]	5.2 [11]	5.4 [12]	11 [24]	11 [24]
E3N Weight / Mass (kg) [lbs]		1.2 [2.6]	1.4 [3.1]	1.5 [3.3]	1.4 [3.1]	1.8 [4.0]	3.7 [8.2]	3.8 [8.4]	5.3 [12]	5.4 [12]	11 [24]	11 [24]
E3E Weight / Mass (kg) [lbs]		1.5 [3.3]	1.7 [3.7]	2.0 [4.4]	2.2 [4.9]	2.2 [4.9]	5.3 [12]	5.4 [12]	7.5 [17]	7.5 [17]	11 [24]	12 [26]

*1 Fuji 4-pole standard motor. At the selection of the inverter rating, consider not only the rating capacity (kW) is enough but also inverter output current is larger than selected the motor's nominal current.

*2 Rated capacity is calculated by assuming the output rated voltage as 440 V.

*3 The output voltage cannot exceed the power supply voltage.

*4 When the carrier frequency (F26) is set to below value or higher, the inverter is sure to be necessary to derate their nominal current.
type 0002 to 0012: 8 kHz, type 0022 to 0072: 10 kHz

*5 The value is calculated assuming that the inverter is connected with a power supply with the capacity of 500 kVA (or 10 times the inverter capacity if the inverter capacity exceeds 50 kVA) and %X is 5%.

*6 Obtained when a DC reactor (DCR) is used.

*7 Average braking torque for the motor running alone. (It varies with the efficiency of the motor.)

*8 Voltage unbalance (%) = (Max. voltage (V) - Min. voltage (V))/Three -phase average voltage (V) × 67 (IEC 61800 - 3)
If this value is 2 to 3%, use an optional AC reactor (ACR).

■ Single-phase 200V class series (HHD-mode)

Item			Specification					
Type (FRN_ _ _ _E3S-7G) Type (FRN_ _ _ _E3N-7G)			0001	0002	0004	0006	0010	0012
Type (FRN_ _ _ _E3E-7G)			0001	0002	0003	0005	0008	0011
Nominal applied motor (kW) [HP] (Output rating) (*1)			0.1 [1/8]	0.2 [1/4]	0.4 [1/2]	0.75 [1]	1.5 [2]	2.2 [3]
Output ratings	Rated capacity (kVA) (*2)		0.4	0.6	1.1	1.9	3.0	4.2
	Rated voltage (*3)		Three-phase 200 to 240V (with AVR function)					
	Rated current (A) (*4) at Ta=50°C(122°F)		1	1.6	3	5	8	11
	Overload capability		150%-1 min, 200%-0.5 s					
Input power	Voltage, frequency		Single-phase 200 to 240 V, 50/60 Hz					
	Allowable voltage / frequency		Voltage: +10 to -10%, Frequency: +5 to -5%					
	Rated current (A) (*5)	With DCR	1.1	2.0	3.5	6.4	11.6	17.5
		w/o DCR	1.8	3.3	5.4	9.7	16.4	22
	Required capacity (with DCR) (kVA) (*6)		0.3	0.4	0.7	1.3	2.4	3.5
Braking	Torque (*7)		150%		100%		70%	40%
	DC braking		Braking starting frequency: 0.0 to 60.0 Hz, Braking time: 0.0 to 30.0 s, Braking level: 0 to 100%					
	Braking transistor		Built-in as standard					
	Connectable resistance (ohm)		100 ~ 120				40 ~ 120	
	Braking resistor		Separately mounted option					
DC reactor (DCR) (*8)			Separately mounted option					
Applicable safety standards			UL61800-5-1, C22.2 No.274-17, IEC/EN 61800-5-1, EN ISO 13849-1 Cat.3 / PL:e, EN 60204-1 Stop category 0, EN 61800-5-2 SIL3 (Functional Safety: STO), EN 62061 SIL3, SEMI F47-0706					
EMC filter built-in type Applicable EMC standards (E3E)			Compliant with EMC Directives. Emission: Category C2. Immunity: 2nd Env. (EN61800-3)					
Enclosure (IEC60529)			IP20, UL open type					
Cooling method (E3S, E3N)			Natural cooling				Fan cooling	
Cooling method (E3E)			Natural cooling					Fan cooling
E3S Weight / Mass (kg) [lbs]			0.5 [1.1]	0.5 [1.1]	0.6 [1.3]	0.9 [2.0]	1.4 [3.1]	1.7 [3.7]
E3N Weight / Mass (kg) [lbs]			0.5 [1.1]	0.5 [1.1]	0.7 [1.5]	0.9 [2.0]	1.5 [3.3]	1.7 [3.7]
E3E Weight / Mass (kg) [lbs]			0.6 [1.3]	0.6 [1.3]	0.8 [1.8]	1.2 [2.6]	2.0 [4.4]	2.2 [4.9]

*1 Fuji 4-pole standard motor. At the selection of the inverter rating, consider not only the rating capacity (kW) is enough but also inverter output current is larger than selected the motor's nominal current.

*2 Rated capacity is calculated by assuming the output rated voltage as 220 V.

*3 Output voltage cannot exceed the power supply voltage.

*4 When the carrier frequency (F26) is set to below value or higher, the inverter is sure to be necessary to derate their nominal current.
type 0001 to 0011: 8 kHz

*5 The value is calculated assuming that the inverter is connected with a power supply with the capacity of 500 kVA (or 10 times the inverter capacity if the inverter capacity exceeds 50 kVA) and %X is 5%.

*6 Obtained when a DC reactor (DCR) is used.

*7 Average braking torque for the motor running alone. (It varies with the efficiency of the motor.)

12.2 Common Specifications

Table 12.2-1

Item				Description	Remarks
Output	Setting range	Maximum output frequency		5 to 599 Hz variable	
Output	Setting range	Base frequency		5 to 599 Hz variable	
Output	Setting range	Number of motor poles setting		2 to 128 poles	
Output	Setting range	Starting frequency		0.1 to 60.0 Hz variable (0.0 Hz under vector control (with or without sensor))	
Output	Setting range	Carrier frequency		FRN***E3S/N-2G • 0.75 to 16kHz variable setting HHD mode:***=0001 to 0115 HND mode:***=0001 to 0010,0030 to 0088 • 0.75 to 10kHz variable setting HND mode:***=0012,0020,0115 FRN***E3S/N/E-4G • 0.75 to 16kHz variable setting HHD mode:***=0002 to 0072 HND mode:***=0002 to 0059 HD mode:***=0002 to 0059 • 0.75 to 10kHz variable setting HND mode:***=0072 HD mode:***=0072 ND mode:***=0002 to 0059 • 0.75 to 6kHz variable setting ND mode:***=0072 FRN***E3S/N/E -7G • 0.75 to 16kHz variable setting HHD mode:***=0001 to 0012 FRN***E3S/N-7G • 0.75 to 10kHz variable setting HND mode:***=0001 to 0012 Note) The carrier frequency may automatically lower depending upon the ambient temperature or the output current to protect the inverter. (The automatic lowering function can be disabled.)	
Output	Output frequency accuracy (Stability)			• Analog setting: ±0.2% of maximum frequency (at 25±10 °C) (77±18 °F) • Keypad setting: ±0.01% of maximum frequency (at -10 to +50 °C) (14±22 °F)	(*1)
Output	Frequency setting resolution			• Analog setting: 1/3000 of maximum frequency • Keypad setting: 0.01 Hz • Link setting: 1/2000 of maximum frequency or 0.01 Hz (fixed)	(*1)
Output	Induction motor	At V/f control with speed sensor (*1) At dynamic torque vector control with speed sensor (*2)	Speed control range	• 1:20 (*1) (Minimum speed: Nominal speed) • 1:100 (*2) (Minimum speed: Nominal speed) • 1:2 (constant torque range: constant output range)	(*2)
Output	Induction motor	At V/f control with speed sensor (*1) At dynamic torque vector control with speed sensor (*2)	Speed control accuracy	• Analog setting: ±0.2% of maximum frequency or below (at 25 ±10 °C) (77±18 °F) • Digital setting: ±0.01% of maximum frequency or below (at -10 to +50 °C) (14 to 122 °F)	(*2)
Output	Induction motor	At Vector control without speed sensor	Speed control accuracy	• 1:200 (Minimum speed: Nominal speed) • 1:2 (constant torque range: constant output range)	
Output	Induction motor	At Vector control without speed sensor	Speed control range	• Analog setting: ±0.5% of base frequency or below (at 25 ±10 °C) (77±18 °F) • Digital setting: ±0.5% of base frequency or below (at -10 to +50 °C) (14 to 122 °F)	
Output	Induction motor	At Vector control with speed sensor	Speed control accuracy	• 1:1500 (Minimum speed: Nominal speed) • 1:16 (constant torque range: constant output range)	(*2)
Output	Induction motor	At Vector control with speed sensor	Speed control range	• Analog setting: ±0.2% of maximum frequency or below (at 25 ±10 °C) (77±18 °F) • Digital setting: ±0.01% of maximum frequency or below (at -10 to +50 °C) (14 to 122 °F)	(*2)
Output	PMSM	At Vector control without speed sensor	Speed control accuracy	• 1:10 (Minimum speed: Nominal speed) • 1:2 (constant torque range: constant output range)	
Output	PMSM	At Vector control without speed sensor	Speed control range	• Analog setting: ±0.5% of base frequency or below (at 25 ±10 °C) (77±18 °F) • Digital setting: ±0.5% of base frequency or below (at -10 to +50 °C) (14 to 122 °F)	
Output	PMSM	At Vector control with speed sensor	Speed control accuracy	• 1:1500 (Minimum speed: Nominal speed) • 1:2 (constant torque range: constant output range)	(*2)

Item				Description	Remarks
			Speed control range	• Analog setting: ±0.2% of maximum frequency or below (at 25 ±10 °C) (77±18 °F) • Digital setting: ±0.01% of maximum frequency or below (at -10 to +50 °C) (14 to 122 °F)	
Control	Control method			• V/f control • Dynamic torque vector control • V/f control with speed sensor, Dynamic torque vector control with speed sensor (*2) • Vector control without speed sensor • Vector control with speed sensor (*2) • Vector control without speed sensor (PMSM) • Vector control with speed sensor (PMSM)	

Table 12.2-2

Item			Description	Remarks
Control	Voltage / frequency characteristics	200 V series	• The base frequency and maximum output frequency are common, and the voltage can be set between 80 and 240 V. • AVR control can be turned ON or OFF. • Linear V/f setting (3 points): The voltage can be set freely from 0 to 240 V, and the frequency can be set from 0 to 599 Hz.	
		400 V series	• The base frequency and maximum output frequency are common, and the voltage can be set between 160 and 500 V. • AVR control can be turned ON or OFF. • Linear V/f setting (3 points): The voltage can be set freely from 0 to 500 V (400V series), and the frequency can be set from 0 to 599 Hz.	
	Torque boost	• Auto torque boost (for constant torque load) • Manual torque boost: The torque boost value can be set between 0.0 and 20.0%. • The applicable load can be selected. (for constant torque load, quadratic-torque load)		
	Starting torque	200% or higher/reference frequency 0.5 Hz (HHD-mode) 150% or higher/reference frequency 0.5 Hz (HD-mode) 120% or higher/ reference frequency 0.5 Hz (HND-mode and ND-mode) At V/f control (base frequency: 50Hz with slip compensation and Auto torque boost)		
	Start/stop operation	Key operation: Run/stop with RUN and STOP keys (standard keypad) Run/stop with FWD,REV and STOP keys (multi-function keypad: option)		(*1)
		External signals: Forward (Reverse) rotation, stop command (capable of 3-wire operation) (digital inputs), coast-to-stop command, external alarm, alarm reset, etc.		
		Link operation: Operation through RS-485 (built-in as standard) or field bus communications link		
		Switching run command: Remote/local switching, link switching		(*1)
	Frequency settings	Keypad: Using ▲ and ▼ keys		(*1)
		External potentiometer: Using external frequency command potentiometer. (External resistor of 1 to 5 kΩ 1/2 W)		
		Analog input: Voltage input (terminal [12]) 0 to ±10 VDC (±5 VDC)/0 to ±100% 0 to +10 VDC (+5 VDC)/0 to +100% (+1 to +5 VDC available by bias or analog input gain setting) Voltage input ([C1] (V2function)) 0 to +10 VDC (+5 VDC)/0 to +100% 0 to +10 VDC (+5 VDC)/ - 100 to +100% (+1 to +5 VDC available by bias or analog input gain setting) Current input (terminal [C1] (C1 function)) 4 to 20 mA DC /0 to 100%,0 to 20 mA DC /0 to 100% 4 to 20 mA DC / - 100 to +100%,0 to 20 mA DC /-100 to +100%		
		UP/DOWN operation: Frequency can be increased or decreased while the digital input signal is ON. The frequency recorded with digital input “STZ” can be cleared.		
		Multistep frequency: Selectable from 16 different frequencies (step 0 to 15)		
		Pattern operation: The inverter runs automatically according to the previously specified run time, rotation direction, acceleration/deceleration time and reference frequency. Up to 7 stages can be specified.		
		Link operation: Operation through RS-485 (built-in as standard) or field bus communications link		

Item		Description	Remarks
		Frequency setting: Two types of frequency settings can be switched with an external signal (digital input). Remote/local switching, link switching	(*1)
		Auxiliary frequency setting: Inputs at terminal [12], [C1] (C1 function) or [C1] (V2 function) can be added to the main setting as auxiliary frequency settings.	
		Operation at a specified ratio: The ratio can be set by analog input signal.	
		Inverse operation: Switchable from “0 to +10 VDC/0 to 100%” to “+10 to 0 VDC/0 to 100%” for the external command Switchable from “4 to +20 mA DC/0 to 100%” to “20 to 4 mA DC/0 to 100%” for the external command Switchable from “0 to +20 mA DC/0 to 100%” to “20 to 0 mA DC/0 to 100%” for the external command	

Table 12.2-3

Item		Description		Remarks
Control	Frequency settings	Pulse train input (standard):	Pulse input = Terminal [X5], CW/CCW pulse, pulse + rotational direction Complementary output: Max. 100 kHz, Open collector output: Max. 30 kHz	(*2)
		Pulse train input (option):	A PG option card is required. CW/CCW pulse, pulse + rotational direction Complementary output: Max. 100 kHz, Open collector output: Max. 30 kHz	(*2)
	Acceleration/deceleration time	Setting range: Between 0.00 and 6000 s		
		Switching: The four types of acceleration/deceleration time can be set or selected individually (switchable during operation).		
		Acceleration/deceleration pattern: Linear acceleration/deceleration, S-curve acceleration/deceleration (weak, arbitrary (strong), curvilinear acceleration/deceleration (max. acceleration/deceleration at rated output)		
		Deceleration mode (coast-to-stop): Shutoff of the run command lets the motor coast to a stop.		
		Forcible stop deceleration time: Deceleration stop in exclusive deceleration time by the forcible stop ***STOP***.		
		Acceleration/deceleration time exclusive to jogging		
		It is possible to switch between acceleration/deceleration time = 0 with acceleration/deceleration operation cancel “BPS”.		
	Frequency limiter (Upper limit and lower limit frequencies)	• Specifies the upper and lower limits in Hz. • “Keep the reference frequency to the lower limit” or “Decelerate to a stop” selectable when the reference frequency (F16) drops below the lower limit. • Setting is possible with analog input (terminal [12], [C1] (C1 function and V2function).		
	Frequency/PID command bias	Bias of reference frequency and PID command can be independently set (setting range: 0 to ±100%).		
	Analog input	• Gain: Setting range from 0 to 400% • Offset: Setting range from -5.0 to +5.0% • Filter: Setting range from 0.00 s to 5.00 s • Polarity selection (±/+)		
	Jump frequency	Six operation points and their common jump width (0 to 30.0 Hz) can be set.		
	Timed operation	The inverter drives the motor for the run time specified from the keypad and stops its output. (Single-cycle operation)		(*1)
	Jogging operation	Operation with RUN key (standard keypad), FWD/REV key (multi-function keypad), or digital input signal FWD or REV (Exclusive acceleration/deceleration time setting, exclusive frequency setting)		(*1)
	Auto-restart after momentary power failure	• Trip immediately: Trip immediately at the time of power failure. • Trip after a recovery from power failure: Coast to a stop at the time of power failure and trip when the power is recovered. • Trip after decelerate-to-stop: Deceleration stop at power failure, and trip after stoppage • Continue to run: Operation is continued using the load inertia energy. • Start at the frequency selected before momentary power failure: Coast-to-stop at power failure and start after power recovery at the frequency selected before momentary stop. • Start at starting frequency: Coast-to-stop at power failure and start at the starting frequency after power recovery.		
	Hardware current limiter	Limits the current by hardware to prevent an overcurrent trip from being caused by fast load variation or momentary power failure, which cannot be covered by the software current limiter. This limiter can be canceled.		

	Software current limiter	• Automatically reduces the frequency so that the output current becomes lower than the preset operation level. (This limiter can be canceled.) • The operation can be selected (operation at constant speed only, operation when accelerating and at constant speed).	
	Operation by commercial power supply	With commercial power selection commands (***SW50***, ***SW60***), the inverter outputs 50/60 Hz.	
	Slip compensation	Compensates for decrease in speed according to the load	
	Droop control	Decreases the speed according to the load torque.	
	Torque limiter	• Switchable between 1st and 2nd torque limit values • Torque limit values can be set individually for each of the four quadrants (torque limiting/ torque current limiting/power limiting) • Torque limit by analog input.	
	Torque current limiter (Software current limiter)	Automatically reduces the frequency so that the output current becomes lower than the preset operation level.	

Table 12.2-4

	Item	Description	Remarks
Control	PID control	• PID processor for process control/dancer control • Normal operation/inverse operation • PID command: Keypad, analog input (from terminals [12], [C1] (C1 function) and [C1] (V2 function)), multistep frequency (3 steps), RS-485 communication, field bus communication • PID feedback value: Analog input (from terminals [12], [C1] (C1 function) and [C1] (V2 function)) • Alarm output (absolute value alarm, deviation alarm) • Low liquid level stop function (pressurized operation possible before low liquid level stop) • PID output limiter • Integration reset/hold • Anti-reset wind-up function	
	Retry	• Even if a protective function subject to a retry is triggered, an attempt is made to automatically cancel the trip condition up to the number of set times to resume operation without outputting an integrated alarm. • The number of attempts can be set up to 20 times (can be set with function code) • The latency between stop and reset can be specified. • The alarm targeted by the retry can be set.	
	Auto search for idling motor speed	The inverter automatically searches for the idling motor speed and starts to drive it without stopping it. (Motor parameters require tuning. (Offline tuning))	
	Automatic deceleration	• If the DC link bus voltage or calculated torque exceeds the automatic deceleration level during deceleration, the inverter automatically prolongs the deceleration time to avoid overvoltage trip. (It is possible to select forcible deceleration actuated when the deceleration time becomes three times longer.) • If the calculated torque exceeds automatic deceleration level during constant speed operation, the inverter avoids overvoltage trip by increasing the frequency.	
	Deceleration characteristic (improved braking capacity)	The motor loss is increased during deceleration to reduce the regenerative energy in the inverter to avoid overvoltage trip.	
	Auto energy saving operation	Controls the output voltage to minimize the total sum of the motor loss and inverter loss. (Auto energy saving control can be set ON/OFF externally using digital input signals.)	
	Overload prevention control	If the surrounding temperature or IGBT junction temperature increases due to overload, the inverter lowers the output frequency to avoid overload.	
	Offline tuning	Measures the motor constant when the motor is stopped or rotating, and sets it in a motor constant function code. (induction motors, PMSM (permanent magnet synchronous motor) s Tunes the motor while the motor is stopped or running, for setting up motor parameters.	
	Online tuning	Controls the motor speed variation caused by the motor temperature rise during running.	
	Cooling fan ON/OFF control	• Detects inverter internal temperature and stops cooling fan when the temperature is low. • Possible to output a fan control signal to an external device.	
	1st to 2nd motor settings	• Switchable between two motors (PMSM cannot be switched.) • It is possible to set the base frequency, rated current, torque boost, and electronic thermal slip compensation as the data for 1st and 2nd motors.	
	Universal DI	Transfers the status of an external digital signal connected with the general-purpose digital input terminal to the host controller.	
	Universal DO	Outputs a digital command signal sent from the host controller to the general-purpose digital output terminal.	
	Universal AO	Outputs an analog command signal sent from the host controller to the analog output terminal.	

Table 12.2-5

	Item	Description	Remarks
Control	Speed control	• Selectable among the four set of the auto speed regulator (ASR) parameters. • Notch filter for vibration control	
	Line speed control	In a machine such as winder/unwinder, regulates the motor speed to keep the peripheral speed of the spool constant. (a PG option card is required.)	(*2)
	Master-follower operation	Enables synchronous operation of two motors equipped with a pulse generator (PG). (a PG option card is required.)	(*2)
	Pre-excitation	Excitation is carried out to create the motor flux before starting the motor.	
	Zero speed control	The motor speed is held to zero by forcibly zeroing the speed command.	
	Servo lock	Stops the motor and holds the motor in the stopped position	(*2)
	DC braking	Applies DC current to the motor at the operation start time or at the time of inverter stop to generate braking torque.	
	Mechanical brake control	• Possible to output mechanical brake control signals with the brake ON/OFF timing adjusted by the output current, torque command, output frequency and timer. • The output timing of control signals can be adjusted individually when performing forward rotation (hoisting) and reverse rotation (lowering). • Mechanical brake application check input.	
	Torque control	• Analog torque/torque current command input • Speed limit function is provided to prevent the motor from becoming out of control. • Torque bias (analog setting, digital setting)	
	Rotation direction control	Select either of reverse or forward rotation prevention	
	Condensation prevention	Current flows automatically when the motor is stopped, and the motor temperature is raised to prevent condensation.	
	Customizable logic interface	Possible to select or connect digital logic circuits or analog operation circuits with digital/analog I/O signals, configure a simple relay sequence, and operate it freely (The maximum number of steps is 260).	
	Battery/UPS operation	Cancels the undervoltage protection so that the inverter under an undervoltage condition runs the motor with battery/UPS power. (Battery operation is possible at either FRN0088E3☐-2G to FRN0115E3☐-2G and FRN0059E3☐-4G to FRN0072E3☐-4G)	
	Simplified position control	Feedback pulses are counted from the preset count start point, and the motor automatically decelerates to the creep speed and stops at the target stop point (A PG option card is required.)	(*2)
	Orientation function	This function makes it possible for rotors such as the machine tool spindle to be positioned. Stop target position: 8 points are available by setting function code.	(*2)
	Favorites Function code	The function codes can be registered in “Favorites” and displayed. (Applicable to all function codes)	(*1)
	Data initialization	All function codes and limited function codes can be initialized. • Initializes only for the function codes related to motor parameter (each of motor 1 to 2). • Initializes the function codes with the exception of communication function. • Initializes only for the function codes related to the customizable logic. • Initializes only for the function codes registered in “Favorites” are initialized.	
	Start check function	To ensure safety, it is available to check for the existence of run commands when turning the power ON, when resetting alarms, and when changing the run command method, and display an alarm if a run command has been input.	
	Multifunction key	During the operation mode, the "SHIFT" key on standard keypads can be used as an input source to activate the input terminal function like the X terminal.	(*1)
	Traceback	The data from just before the trip (selectable by the user), such as the frequency, voltage, and current, can be analyzed when saving.	

Table 12.2-6

Item		Description	Remarks
Indicates	Running/stopping	Speed monitor (reference frequency, output frequency, motor speed, load shaft speed, feeding speed(line speed), and speed indication with percent), output current (A), output voltage (V), calculated torque (%), input power (kW), PID command value, PID feedback amount, PID output, load factor (%), and motor output (kW), Torque current [%] , Magnetic flux command [%], Analog input monitor, input watt-hour, constant feeding rate time (min.), and remaining time for timed operation (s) can be displayed.	(*1)
	Inverter lifetime alarm	• Deterioration diagnosis can be carried out for main circuit capacitors, electrolytic capacitors on PCBs, cooling fans, and IGBTs. • Lifetime alarms data can be output externally. • Operating temperature: 40 °C (104 °F) Load factor: Inverter rated current of 100% (HHD mode), 80% (HND/HD/ND mode)	(*1)
	Cumulative run time	• Cumulative operation time of the inverter, input watt-hours, cumulative operation time of the motor/number of startups (by motor) are displayed. • A warning is output if the maintenance time or the number of startups set in advance is exceeded.	(*1)
	Trip	Displays the cause of a trip by codes.	
	Warning	Shows the warning display L-AL.	
	During running or at the time of a trip	• Trip history: Saves and displays the cause of the last ten trips (with a code). • Saves and displays the detailed running status data of the last four trips. • It is possible to display the date in the history by using the clock function (TP-A2SW).	(*1)
Protective/detecting functions	Refer to Chapter 6 “TROUBLESHOOTING”.		
Environment	Refer to Chapter 1 “1.3.1 Operating environment.”		

*1 Since the Ethernet built-in type does not support keypad connection, it is not possible to input run commands, set frequencies, use timed operation, switch between remote and local, display or configure the function code settings, or display the monitored values using the keypad.

*2 Since the Ethernet built-in type does not support the pulse train input function or the PG interface option, it is not possible to use motor control with sensor, set the frequency with pulse train input, or use the application functions that use the PG interface card, such as simplified position control.

Chapter 13
EXTERNAL DIMENSIONS

This chapter gives external dimensions of the inverter.

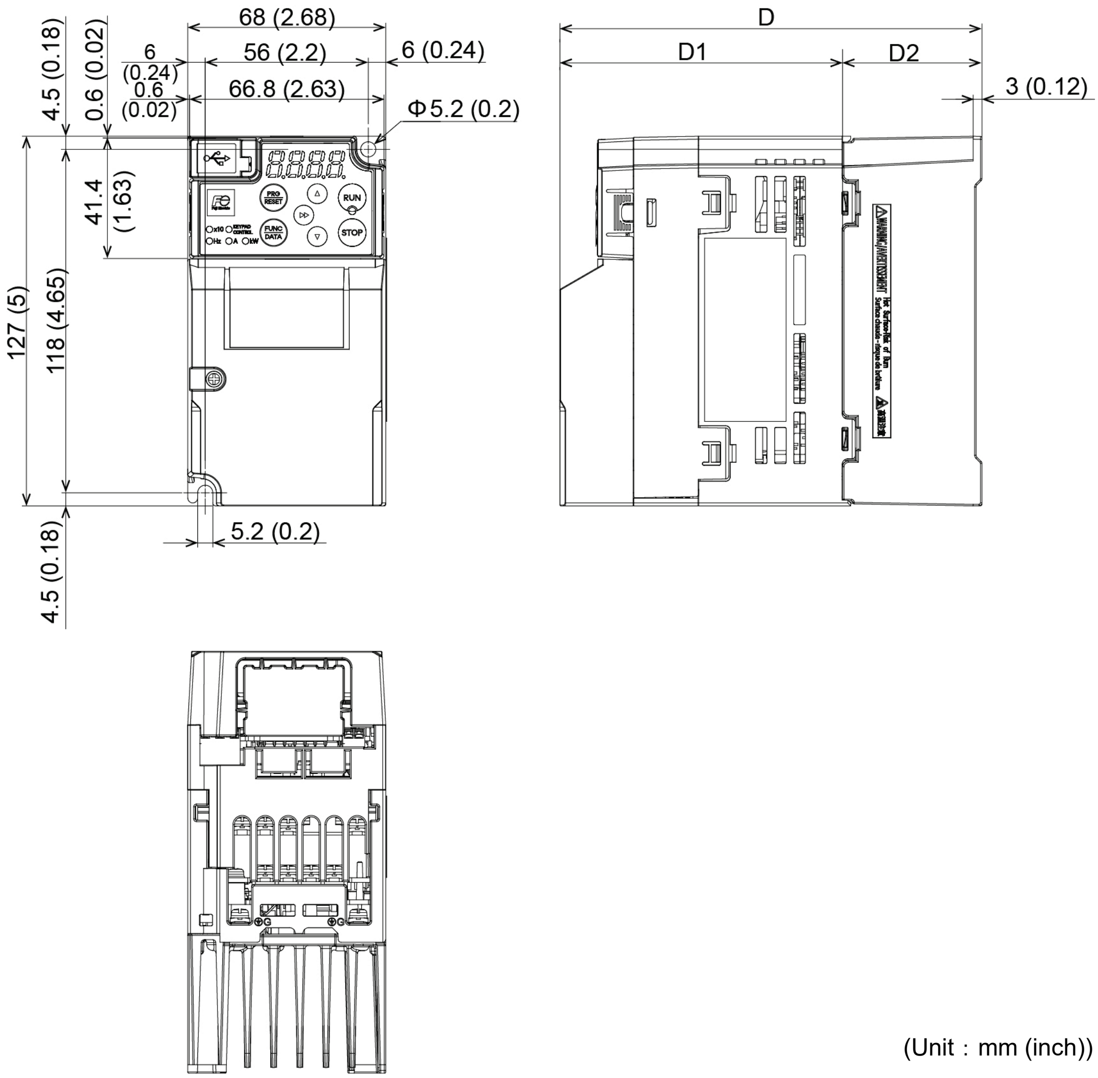
Contents

13.1 Basic Type

External dimension drawings for each inverter capacity are shown below.

* Models FRN0030E3S/N-2G/FRN0022E3S/N-4G and above can be installed with an optional external cooling attachment, where the cooling fins protrude outside the equipment or cabinet. Dimensions for cutting the paneling to install external cooling are shown on the bottom right of the figures for these models. For the external dimensions drawings, refer to Chapter 11 “11.11 External Cooling Attachments.”

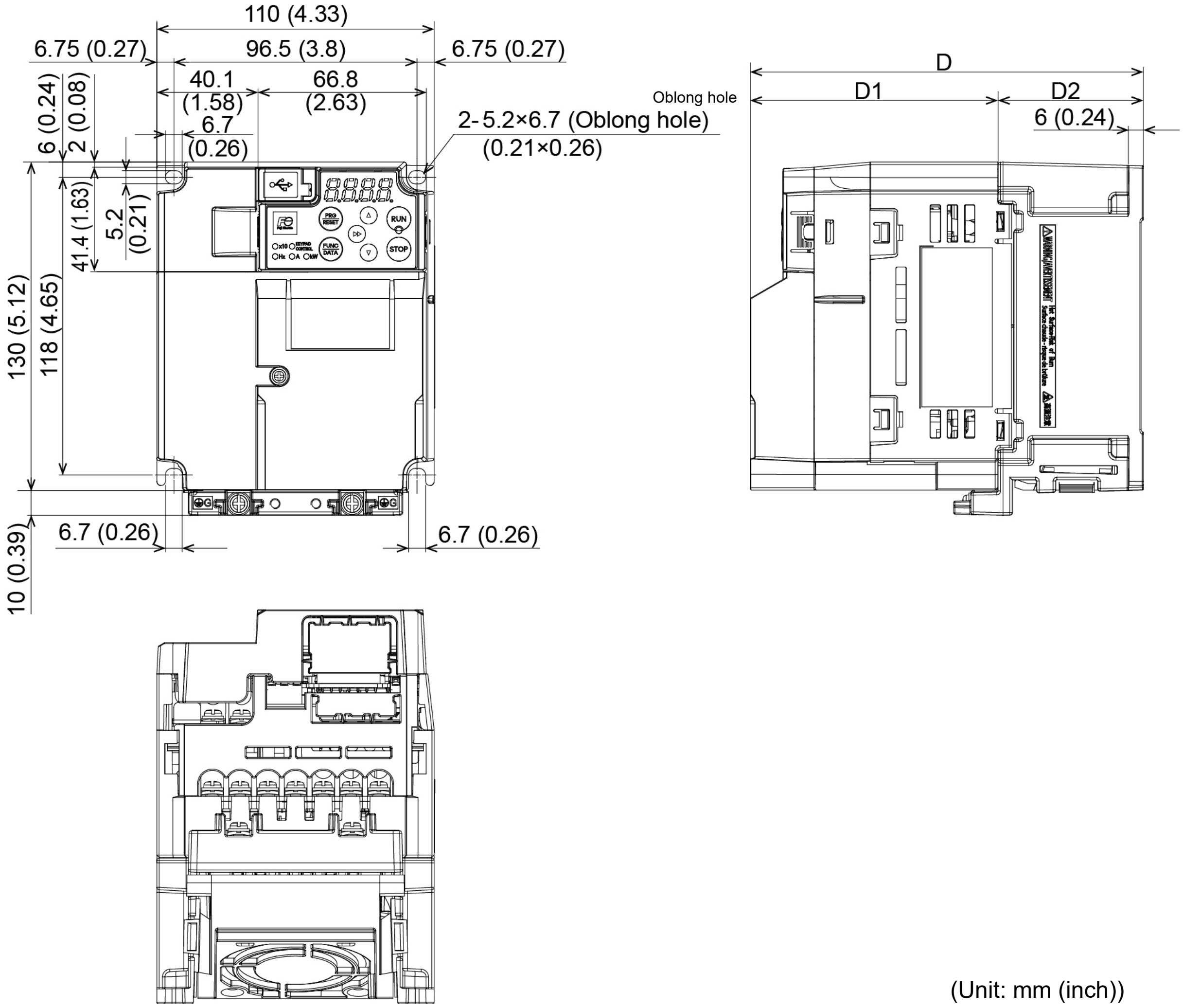
Figure A



(Unit：mm (inch))

Power supply voltage	Inverter type	Dimensions (Unit: mm (inch)		
		D	D1	D2
Three-phase 200 V	FRN0001E3S-2G	98 (3.86)	90 (3.54)	8 (0.31)
	FRN0002E3S-2G	98 (3.86)	90 (3.54)	8 (0.31)
	FRN0004E3S-2G	113 (4.45)	90 (3.54)	23 (0.91)
	FRN0006E3S-2G	145 (5.71)	97 (3.82)	48 (1.89)
Single-phase 200 V	FRN0001E3S-7G	98 (3.86)	90 (3.54)	8 (0.31)
	FRN0002E3S-7G	98 (3.86)	90 (3.54)	8 (0.31)
	FRN0004E3S-7G	120 (4.72)	97 (3.82)	23 (0.91)
	FRN0006E3S-7G	165 (6.5)	117 (4.61)	48 (1.89)

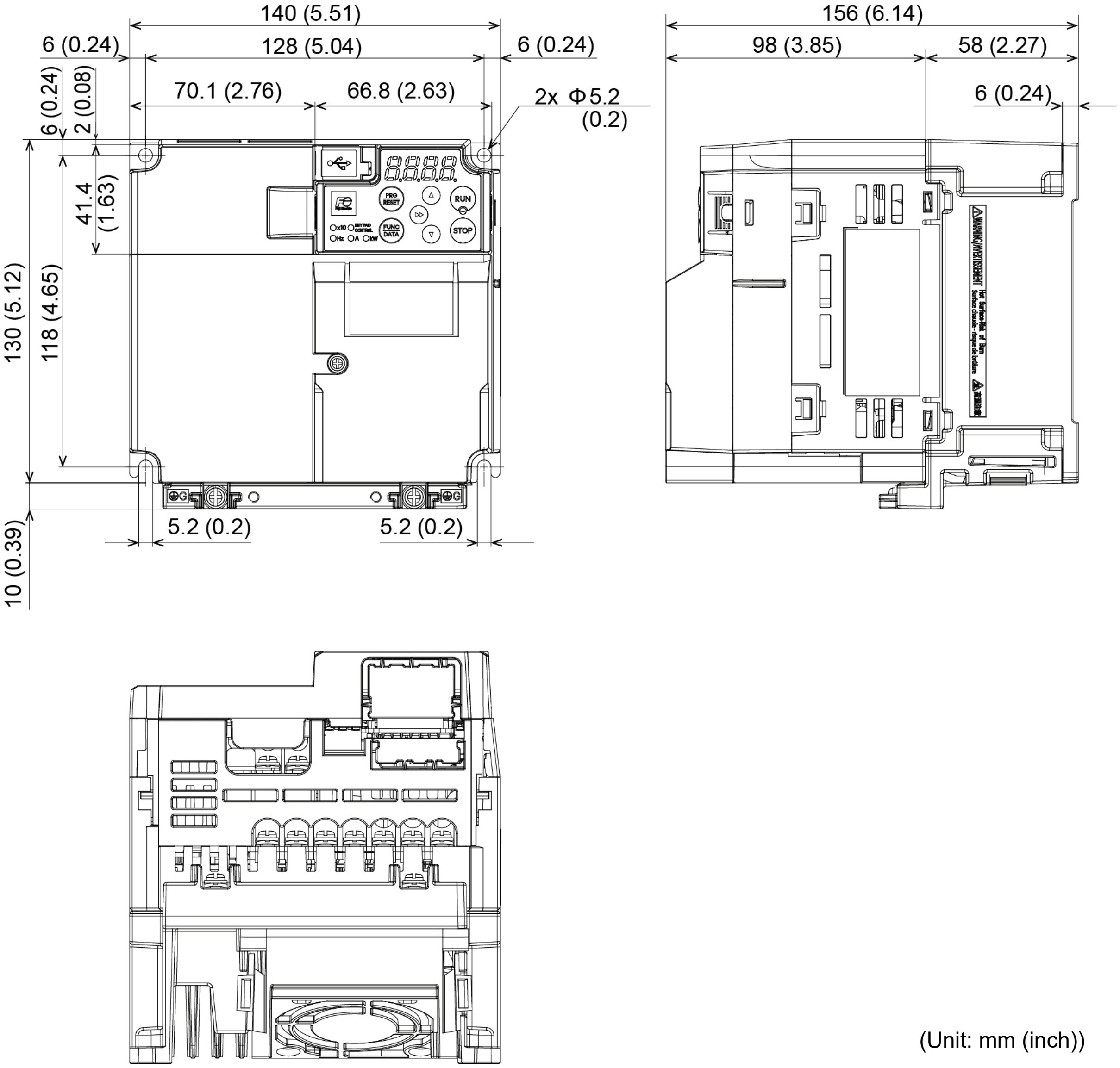
Figure B



(Unit: mm (inch))

Power supply voltage	Inverter type	Dimensions (Unit: mm (inch))		
		D	D1	D2
Three-phase 200 V	FRN0010E3S-2G	156 (6.14)	98 (3.86)	58 (2.28)
	FRN0012E3S-2G	156 (6.14)	98 (3.86)	58 (2.28)
Three-phase 400 V	FRN0002E3S-4G	132 (5.2)	98 (3.86)	34 (1.34)
	FRN0004E3S-4G	156 (6.14)	98 (3.86)	58 (2.28)
	FRN0006E3S-4G	156 (6.14)	98 (3.86)	58 (2.28)
	FRN0007E3S-4G	156 (6.14)	98 (3.86)	58 (2.28)
Single-phase 200 V	FRN0010E3S-7G	166 (6.54)	108 (4.25)	58 (2.28)

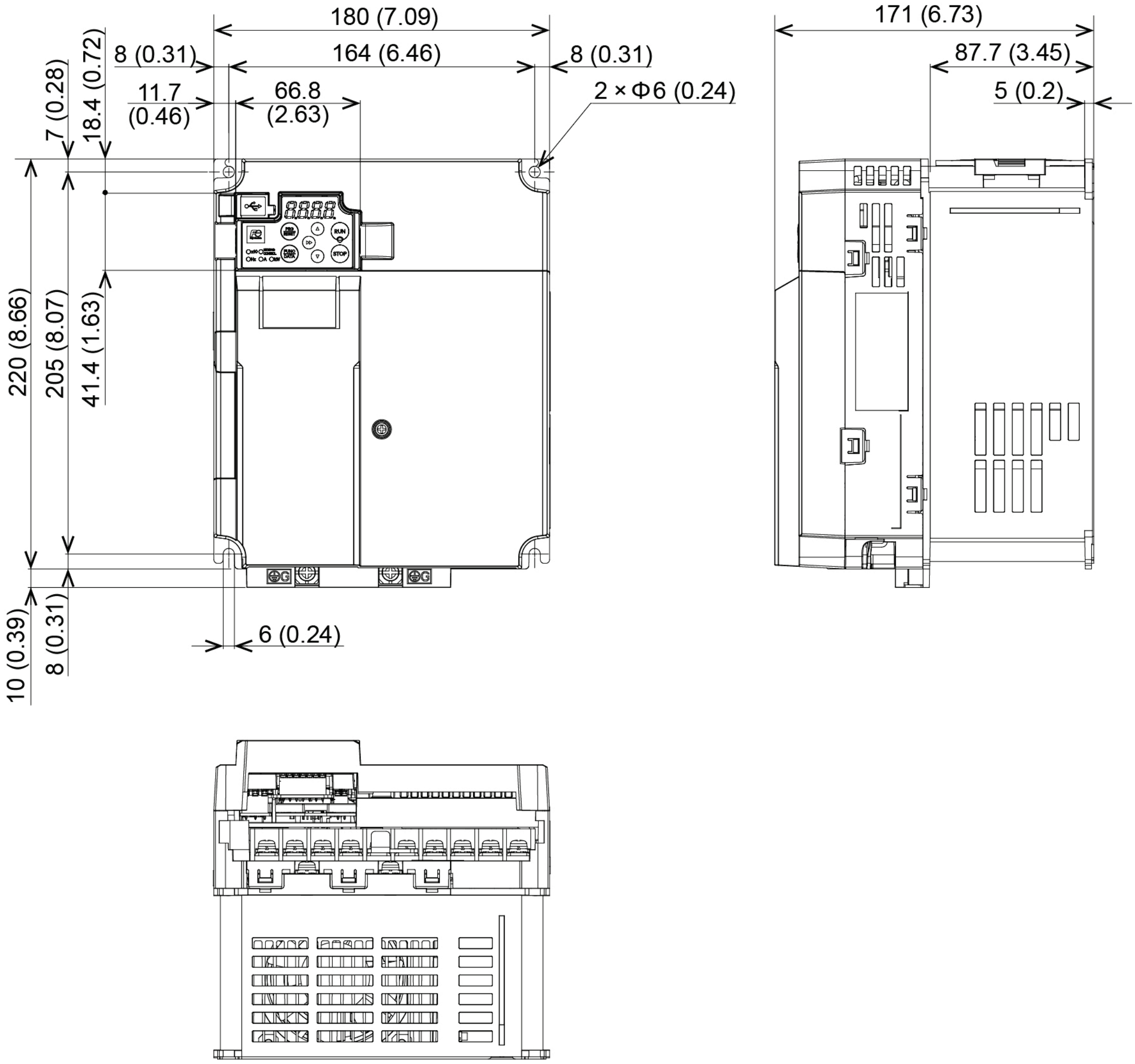
Figure C



(Unit: mm (inch))

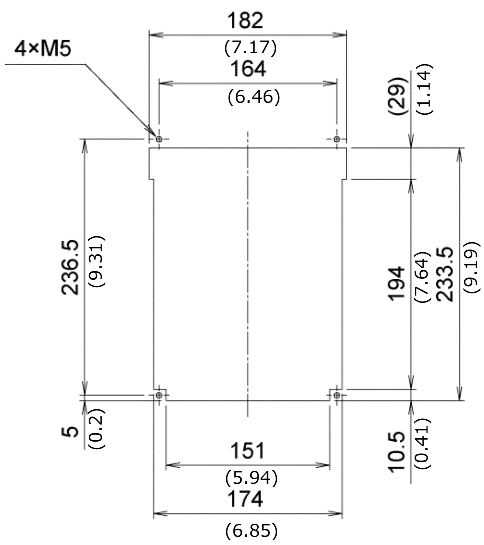
Power supply voltage	Inverter type
Three-phase 200 V	FRN0020E3S-2G
Three-phase 400 V	FRN0012E3S-4G
Single-phase 200 V	FRN0012E3S-7G

Figure D



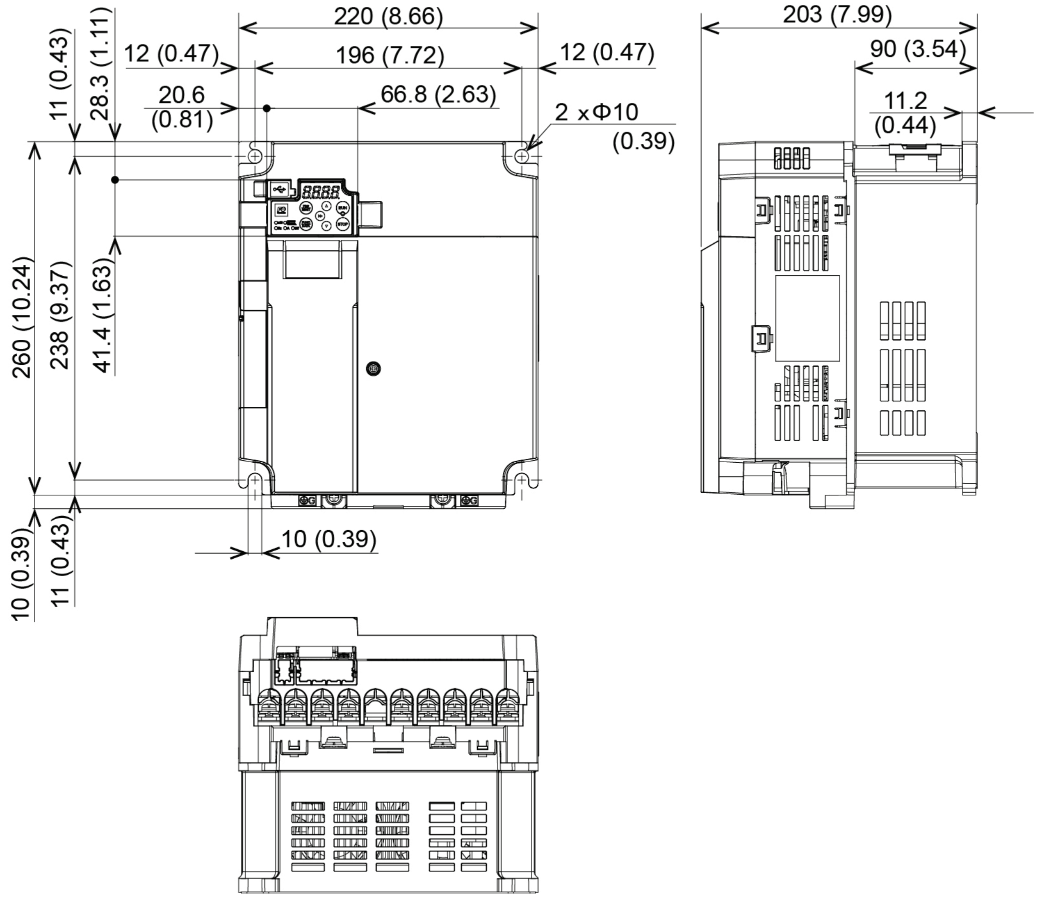
(Unit: mm (inch))

Power supply voltage	Inverter type
Three-phase 200 V	FRN0030E3S-2G
	FRN0040E3S-2G
Three-phase 400 V	FRN0022E3S-4G
	FRN0029E3S-4G

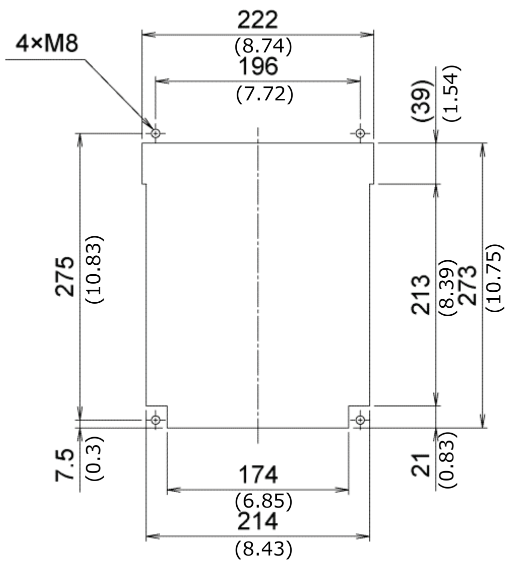


(Panel cutting drawing)

Figure E



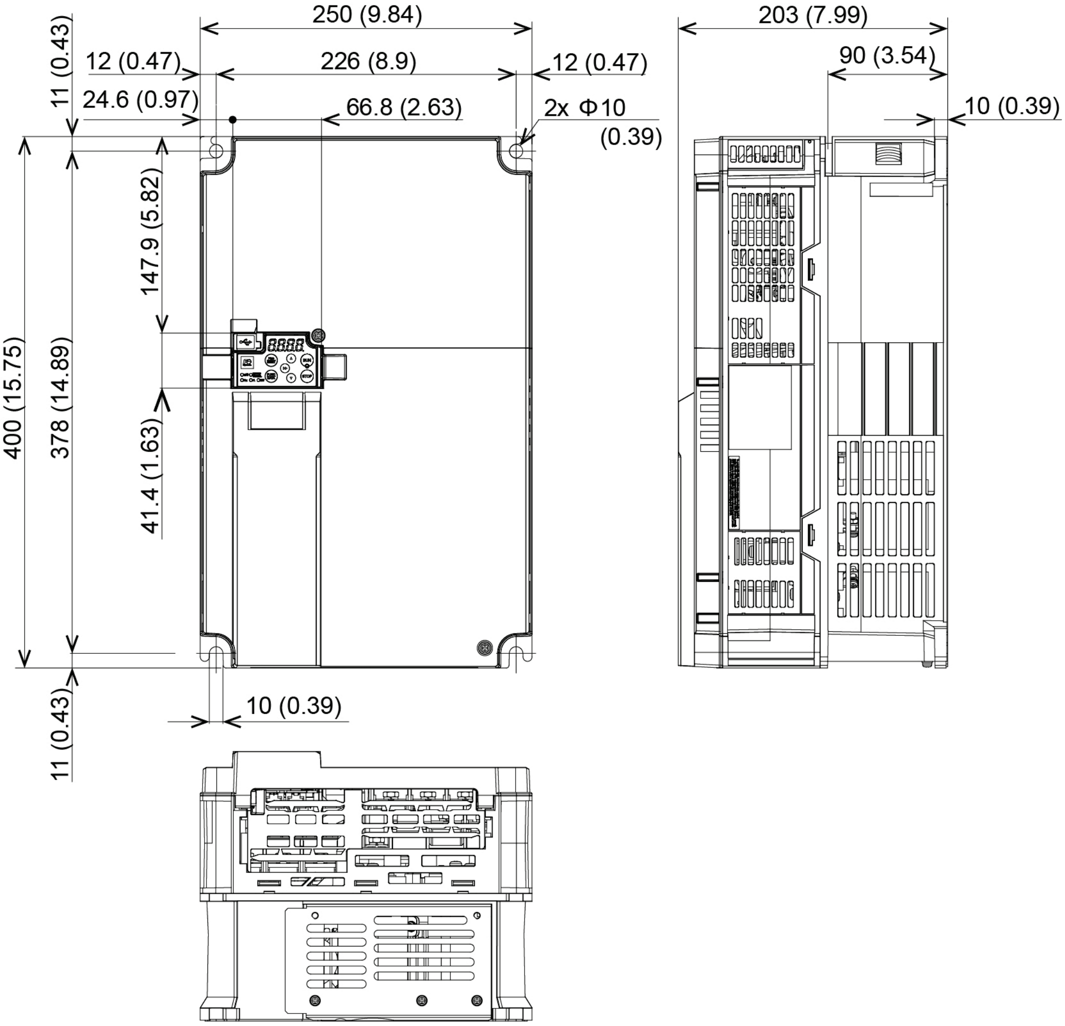
(Unit: mm (inch))



(Panel cutting drawing)

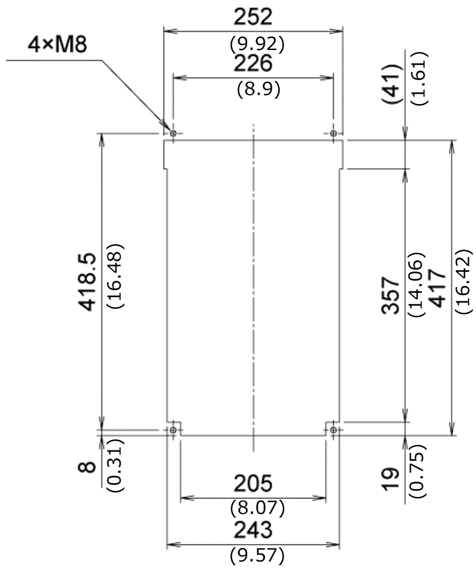
Power supply voltage	Inverter type
Three-phase 200 V	FRN0056E3S-2G
	FRN0069E3S-2G
Three-phase 400 V	FRN0037E3S-4G
	FRN0044E3S-4G

Figure F



(Unit: mm (inch))

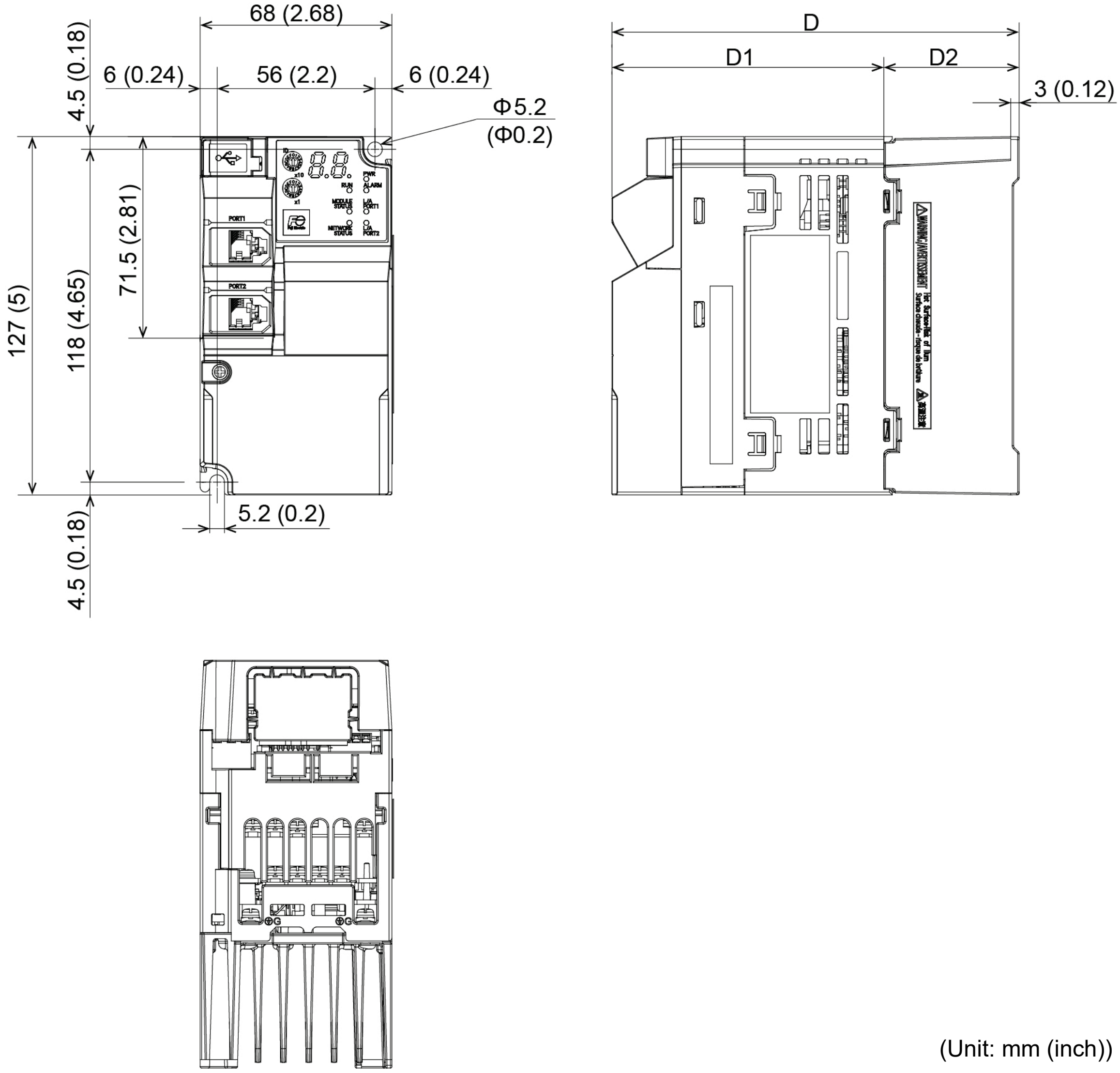
Power supply voltage	Inverter type
Three-phase 200 V	FRN0088E3S-2G
	FRN0115E3S-2G
Three-phase 400 V	FRN0059E3S-4G
	FRN0072E3S-4G



(Panel cutting drawing)

13.2 Ethernet Built-in Type

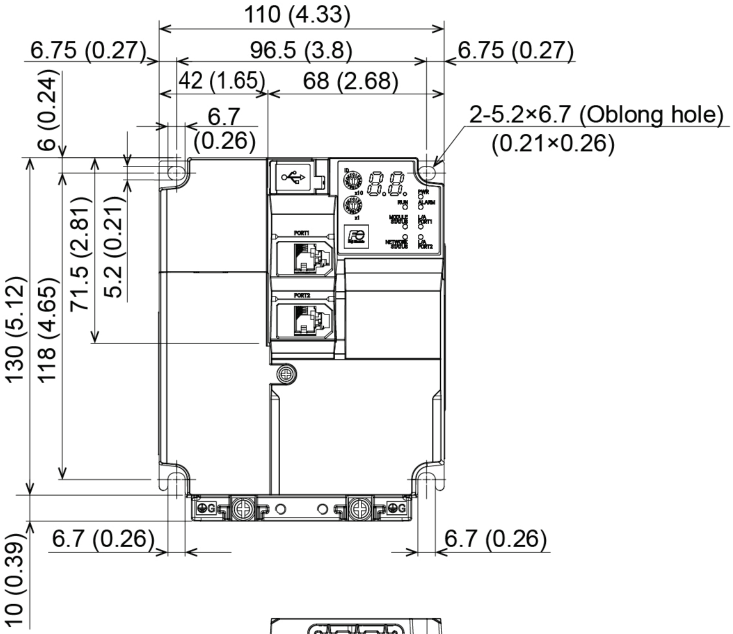
Figure A

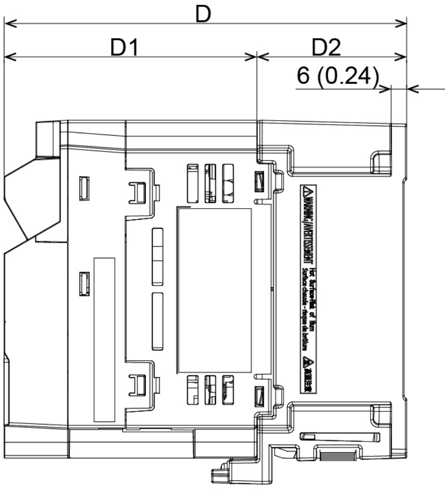


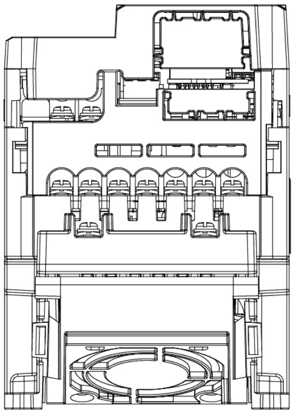
(Unit: mm (inch))

Power supply voltage	Inverter type	Dimensions (Unit: mm (inch))		
		D	D1	D2
Three-phase 200 V	FRN0001E3N-2G	98 (3.86)	90 (3.54)	8 (0.31)
	FRN0002E3N-2G	98 (3.86)	90 (3.54)	8 (0.31)
	FRN0004E3N-2G	113 (4.45)	90 (3.54)	23 (0.91)
	FRN0006E3N-2G	145 (5.71)	97 (3.82)	48 (1.89)
Single-phase 200 V	FRN0001E3N-7G	98 (3.86)	90 (3.54)	8 (0.31)
	FRN0002E3N-7G	98 (3.86)	90 (3.54)	8 (0.31)
	FRN0004E3N-7G	120 (4.72)	97 (3.82)	23 (0.91)
	FRN0006E3N-7G	165 (6.5)	117 (4.61)	48 (1.89)

Figure B



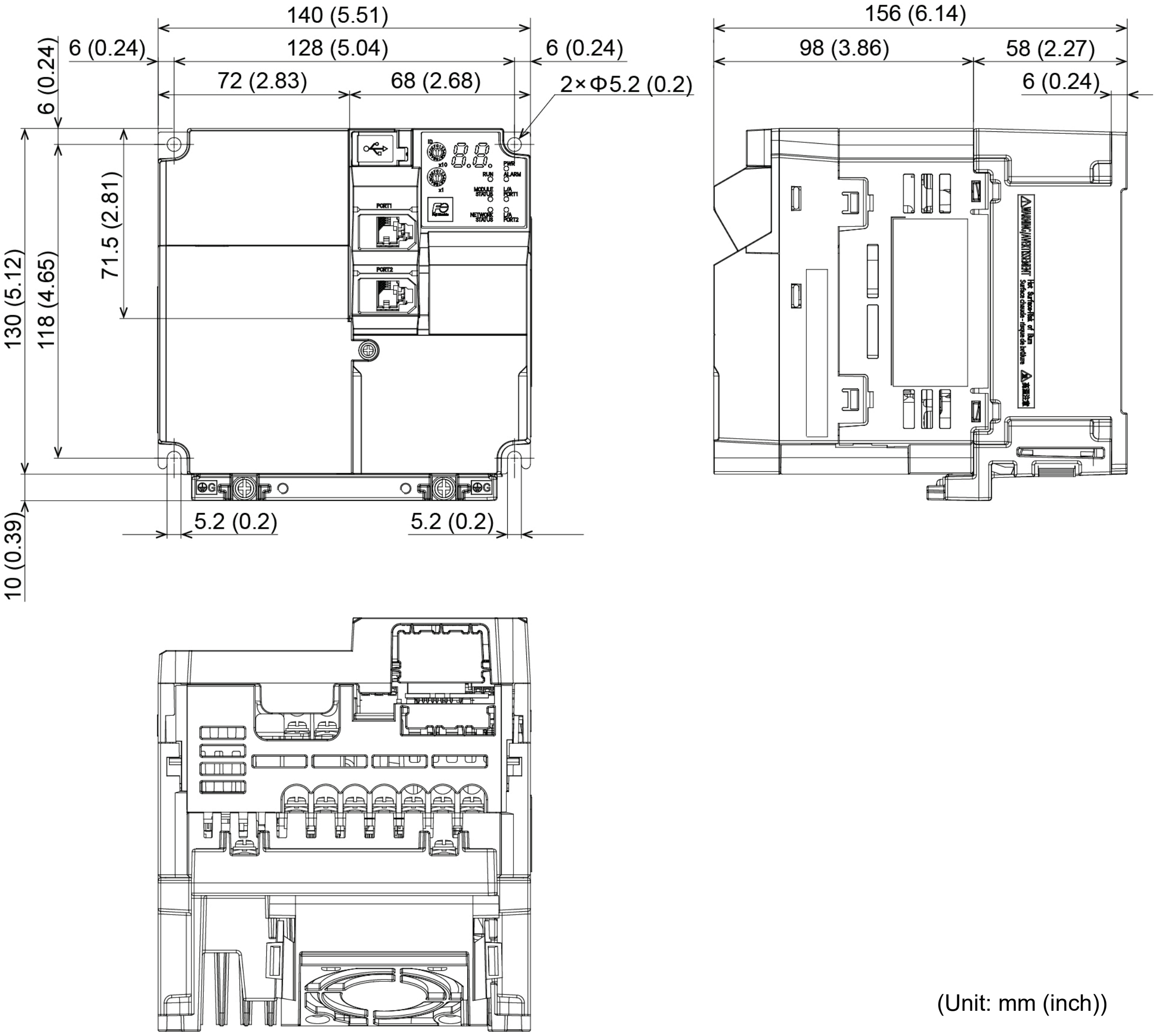




(Unit: mm (inch))

Power supply voltage	Inverter type	Dimensions (Unit: mm (inch)		
		D	D1	D2
Three-phase 200 V	FRN0010E3N-2G	156 (6.14)	98 (3.86)	58 (2.28)
	FRN0012E3N-2G	156 (6.14)	98 (3.86)	58 (2.28)
Three-phase 400 V	FRN0002E3N-4G	132 (5.2)	98 (3.86)	34 (1.34)
	FRN0004E3N-4G	156 (6.14)	98 (3.86)	58 (2.28)
	FRN0006E3N-4G	156 (6.14)	98 (3.86)	58 (2.28)
	FRN0007E3N-4G	156 (6.14)	98 (3.86)	58 (2.28)
Single-phase 200 V	FRN0010E3N-7G	166 (6.54)	108 (4.25)	58 (2.28)

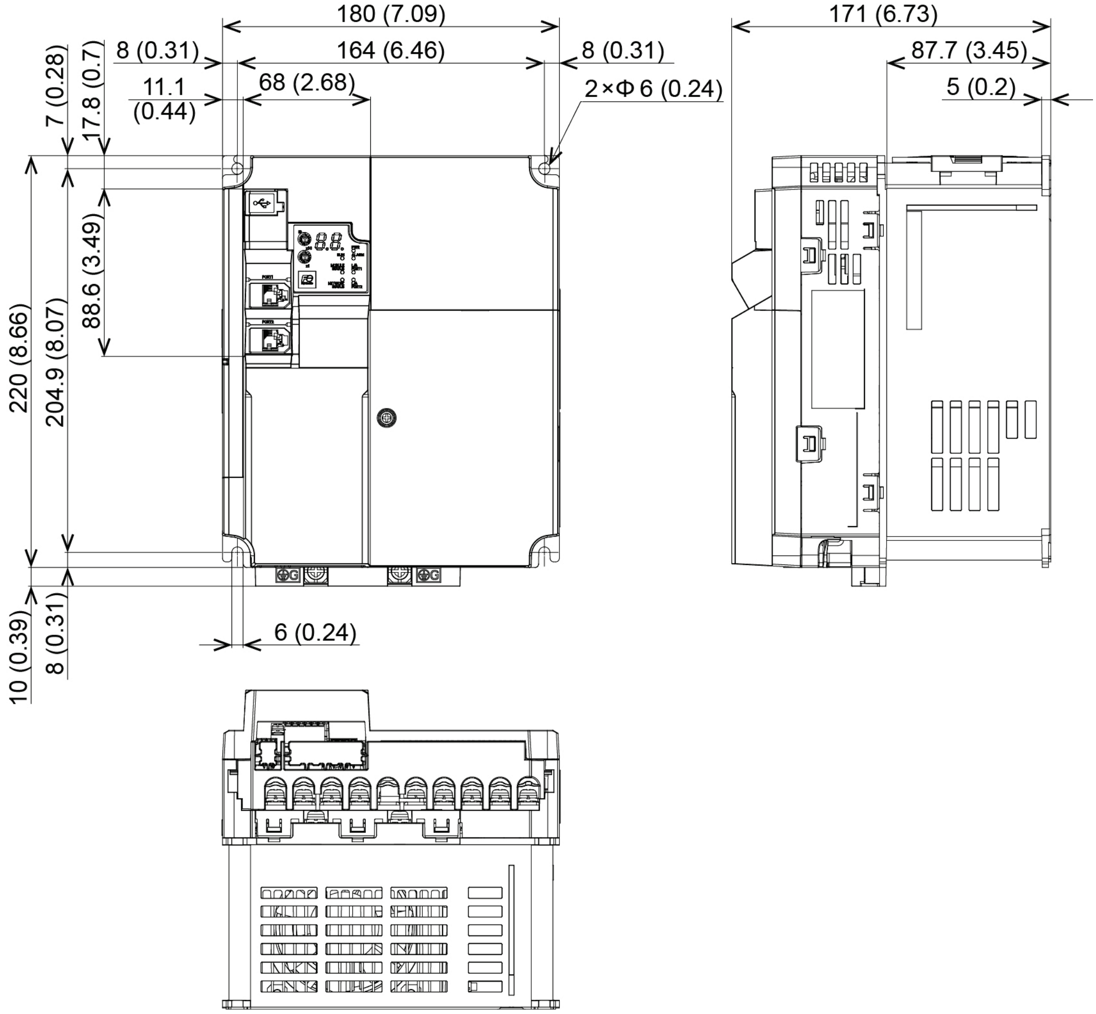
Figure C



(Unit: mm (inch))

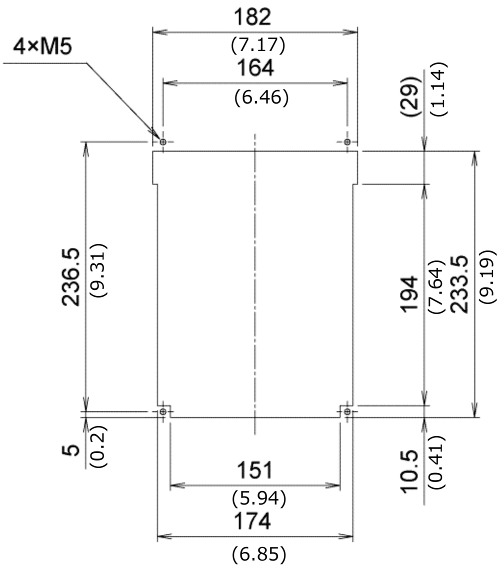
Power supply voltage	Inverter type
Three-phase 200 V	FRN0020E3N-2G
Three-phase 400 V	FRN0012E3N-4G
Single-phase 200 V	FRN0012E3N-7G

Figure D



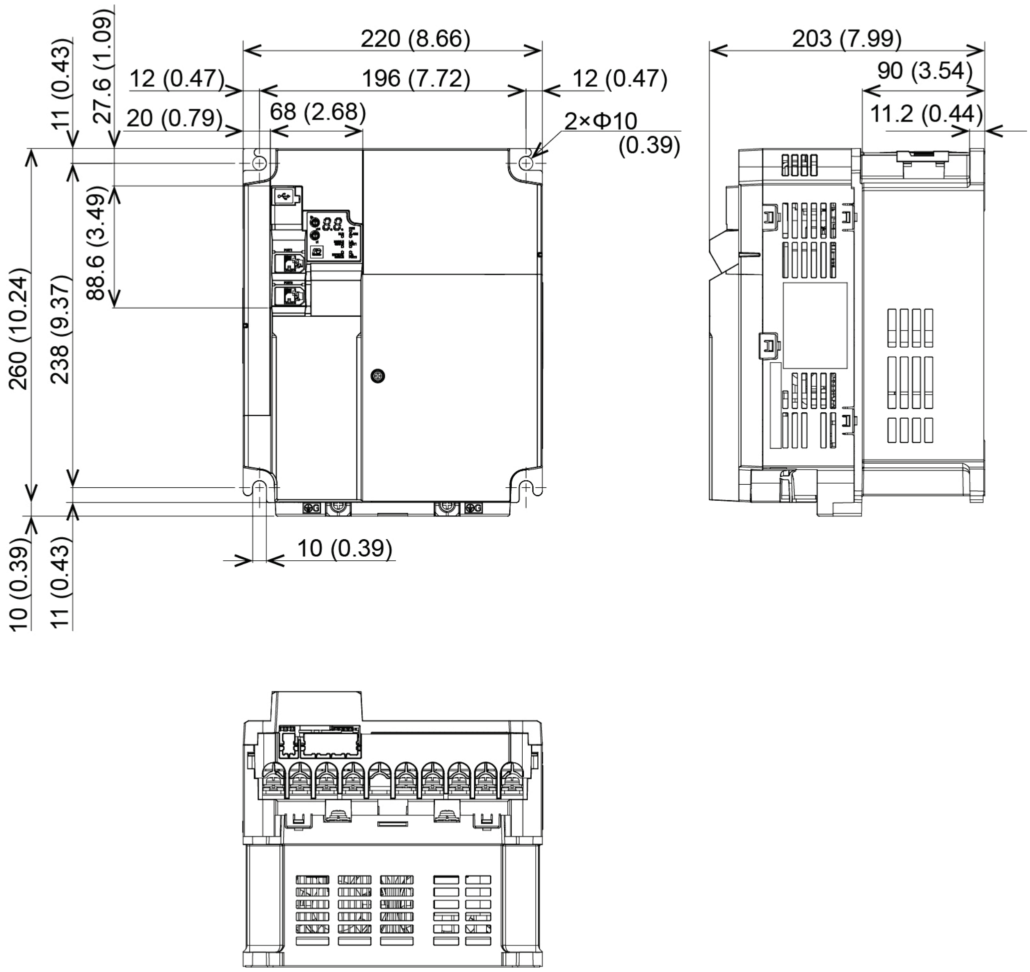
(Unit: mm (inch))

Power supply voltage	Inverter type
Three-phase 200 V	FRN0030E3N-2G
	FRN0040E3N-2G
Three-phase 400 V	FRN0022E3N-4G
	FRN0029E3N-4G



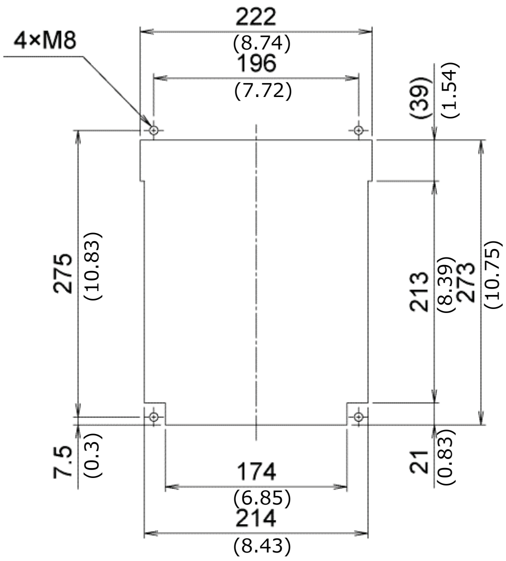
(Panel cutting drawing)

Figure E



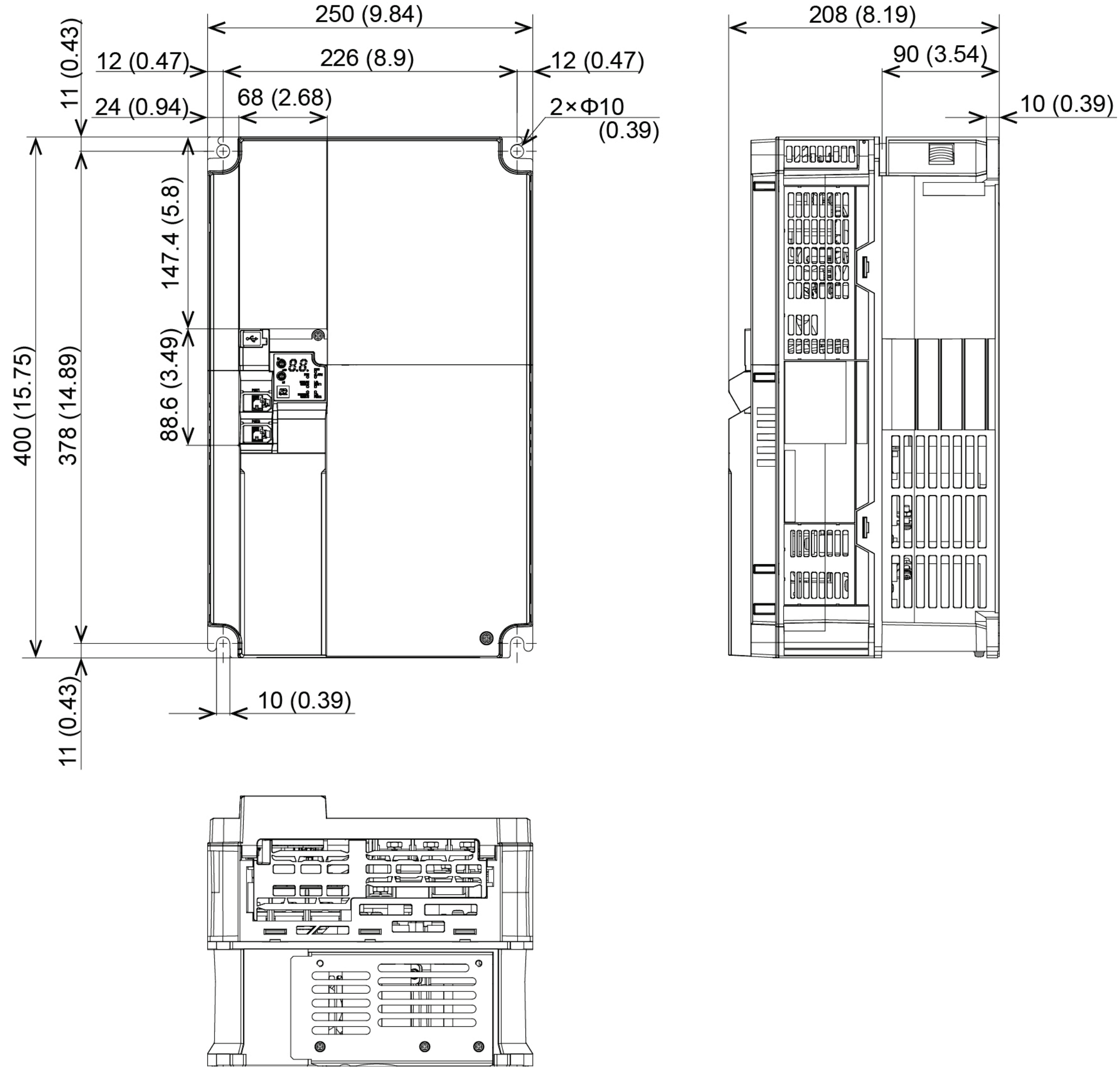
(Unit: mm (inch))

Power supply voltage	Inverter type
Three-phase 200 V	FRN0056E3N-2G
	FRN0069E3N-2G
Three-phase 400 V	FRN0037E3N-4G
	FRN0044E3N-4G



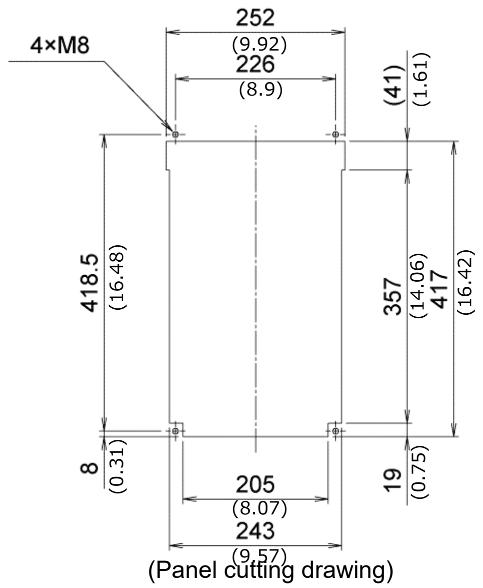
(Panel cutting drawing)

Figure F



(Unit: mm (inch))

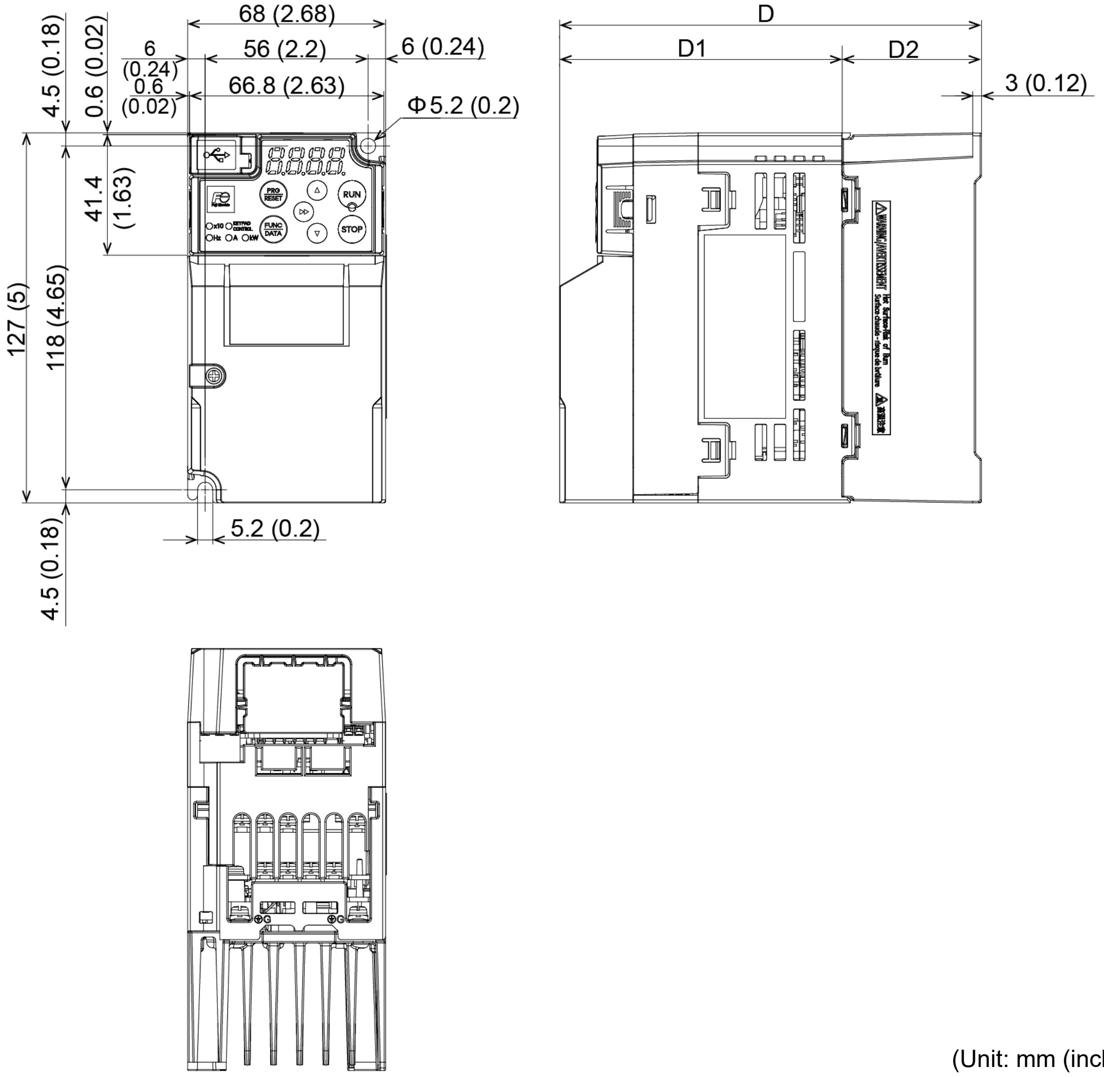
Power supply voltage	Inverter type
Three-phase 200 V	FRN0088E3N-2G
	FRN0115E3N-2G
Three-phase 400 V	FRN0059E3N-4G
	FRN0072E3N-4G



(Panel cutting drawing)

13.3 EMC Filter Built-in Type

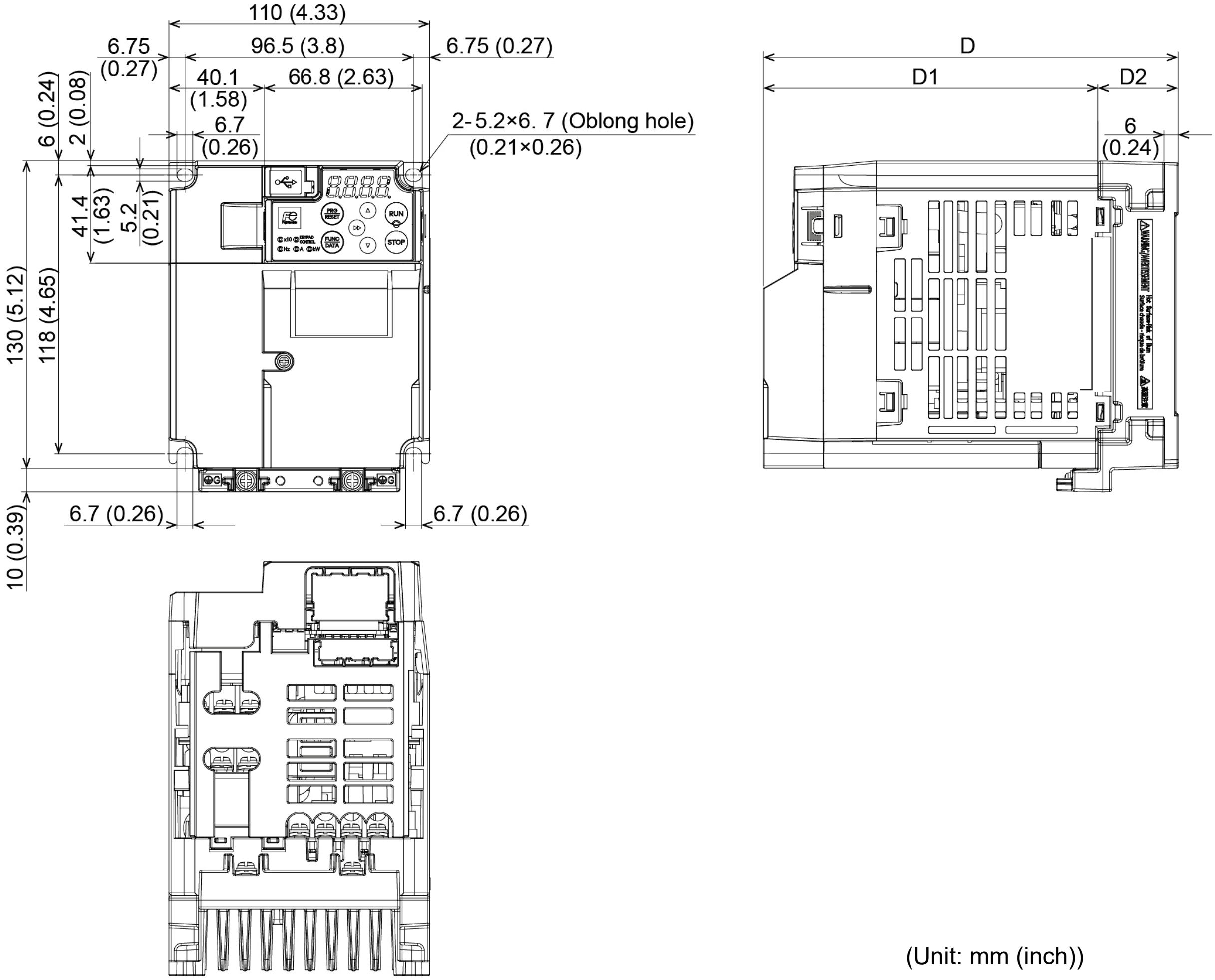
Figure A



(Unit: mm (inch))

Power supply voltage	Inverter type	Dimensions (Unit: mm (inch))		
		D	D1	D2
Single-phase 200 V	FRN0001E3E-7G	125 (4.92)	117 (4.61)	8 (0.31)
	FRN0002E3E-7G	125 (4.92)	117 (4.61)	8 (0.31)
	FRN0003E3E-7G	140 (5.51)	117 (4.61)	23 (0.91)

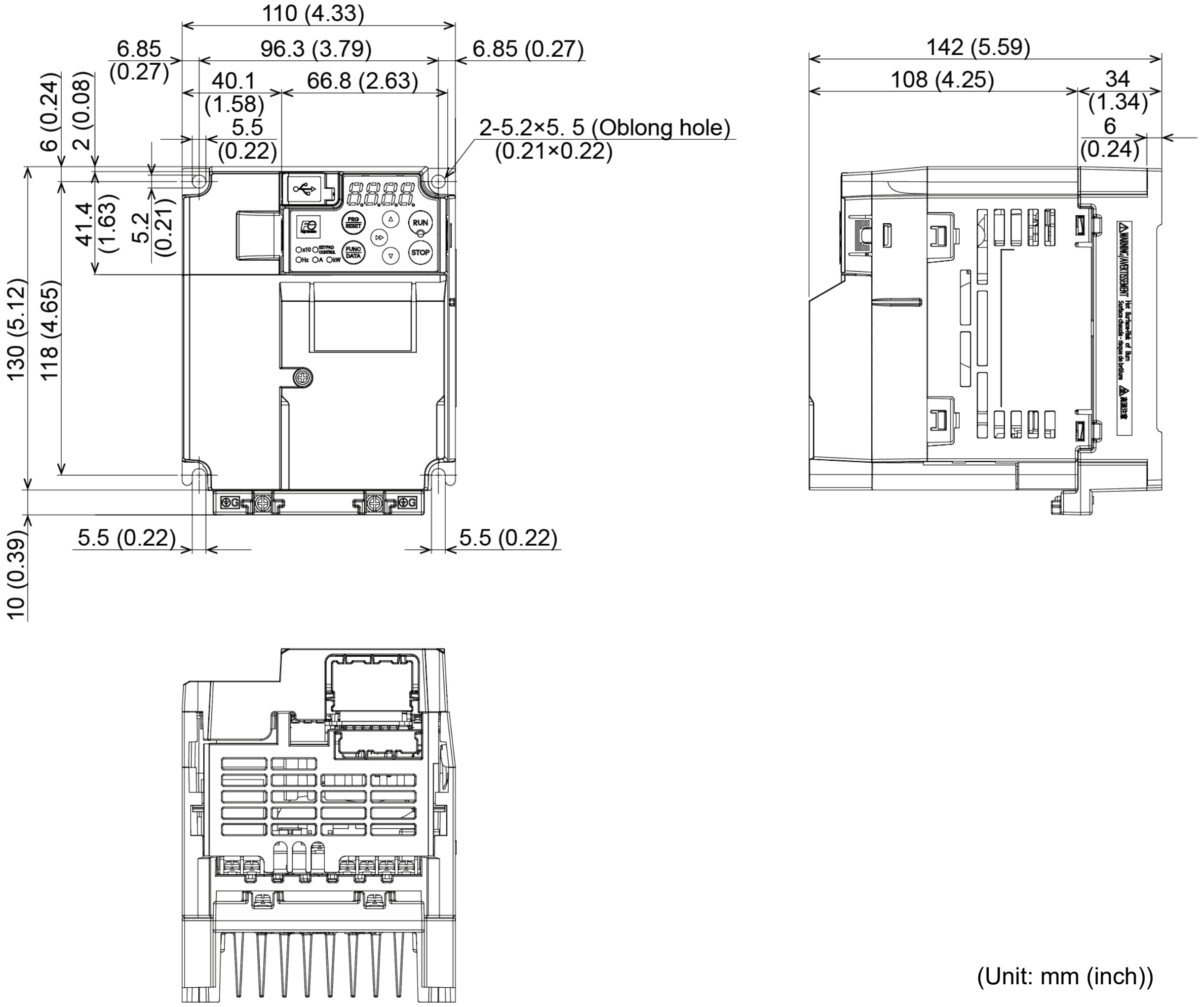
Figure B



(Unit: mm (inch))

Power supply voltage	Inverter type	Dimensions (Unit: mm (inch))		
		D	D1	D2
Three-phase 400 V	FRN0002E3E-4G	175 (6.89)	141 (5.55)	34 (1.34)
	FRN0004E3E-4G	199 (7.83)	141 (5.55)	58 (2.28)

Figure C



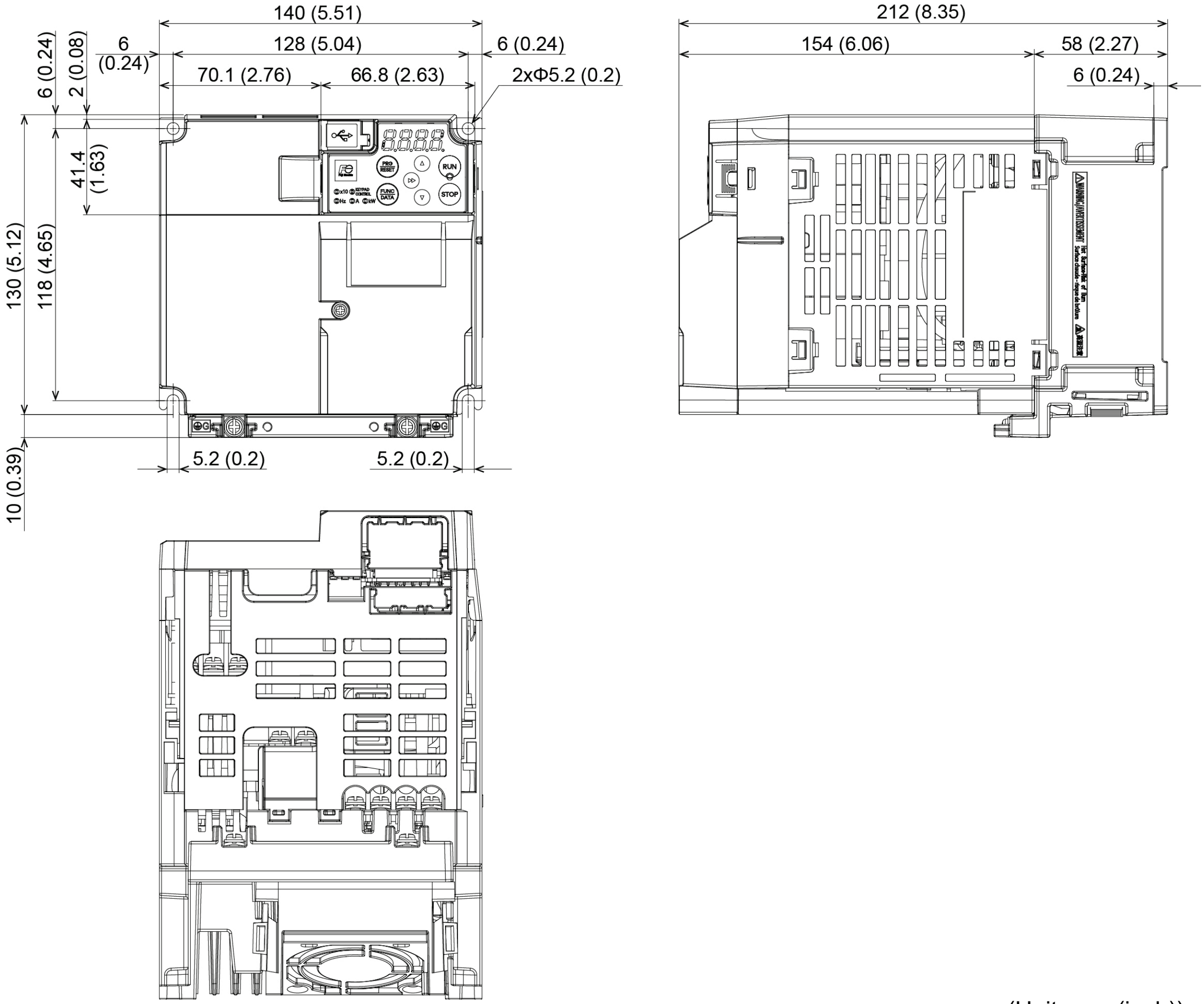
(Unit: mm (inch))

Power supply voltage	Inverter type
Single-phase 200 V	FRN0005E3E-7G

EXTERNAL DIMENSIONS

Chap 13

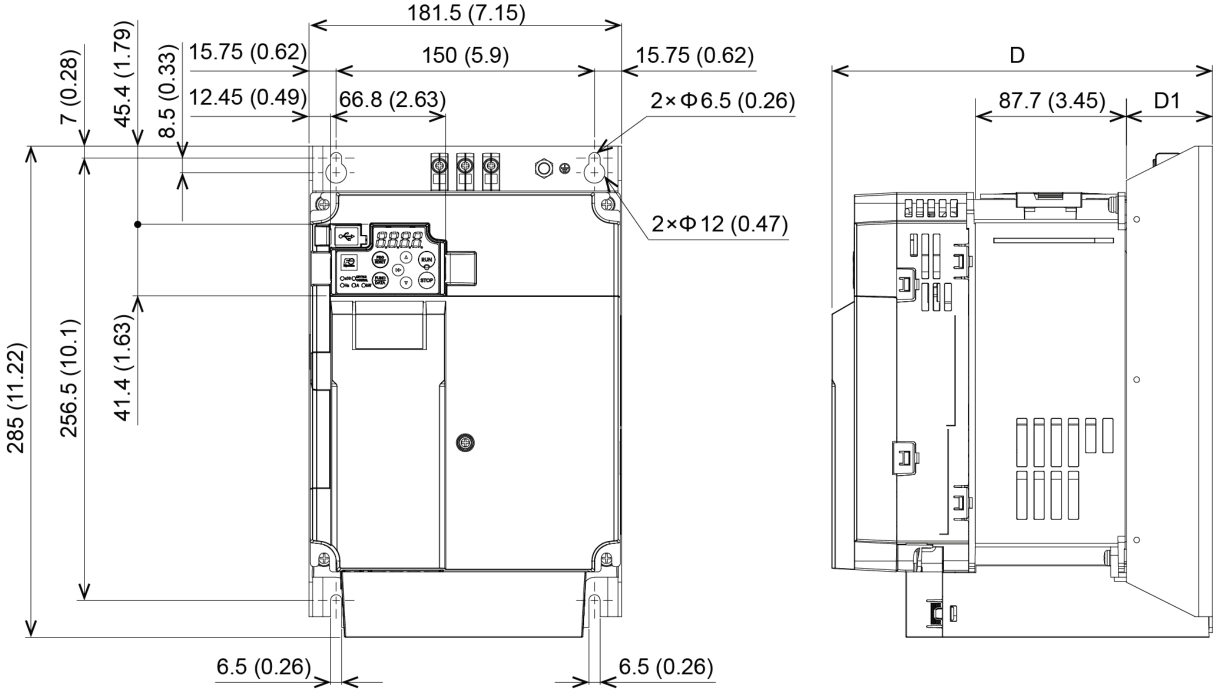
Figure D

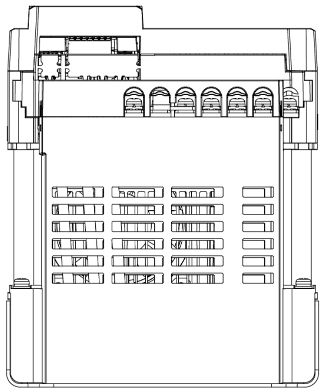


(Unit: mm (inch))

Power supply voltage	Inverter type
Three-phase 400 V	FRN0006E3E-4G
	FRN0007E3E-4G
	FRN0012E3E-4G
Single-phase 200 V	FRN0008E3E-7G
	FRN0011E3E-7G

Figure E

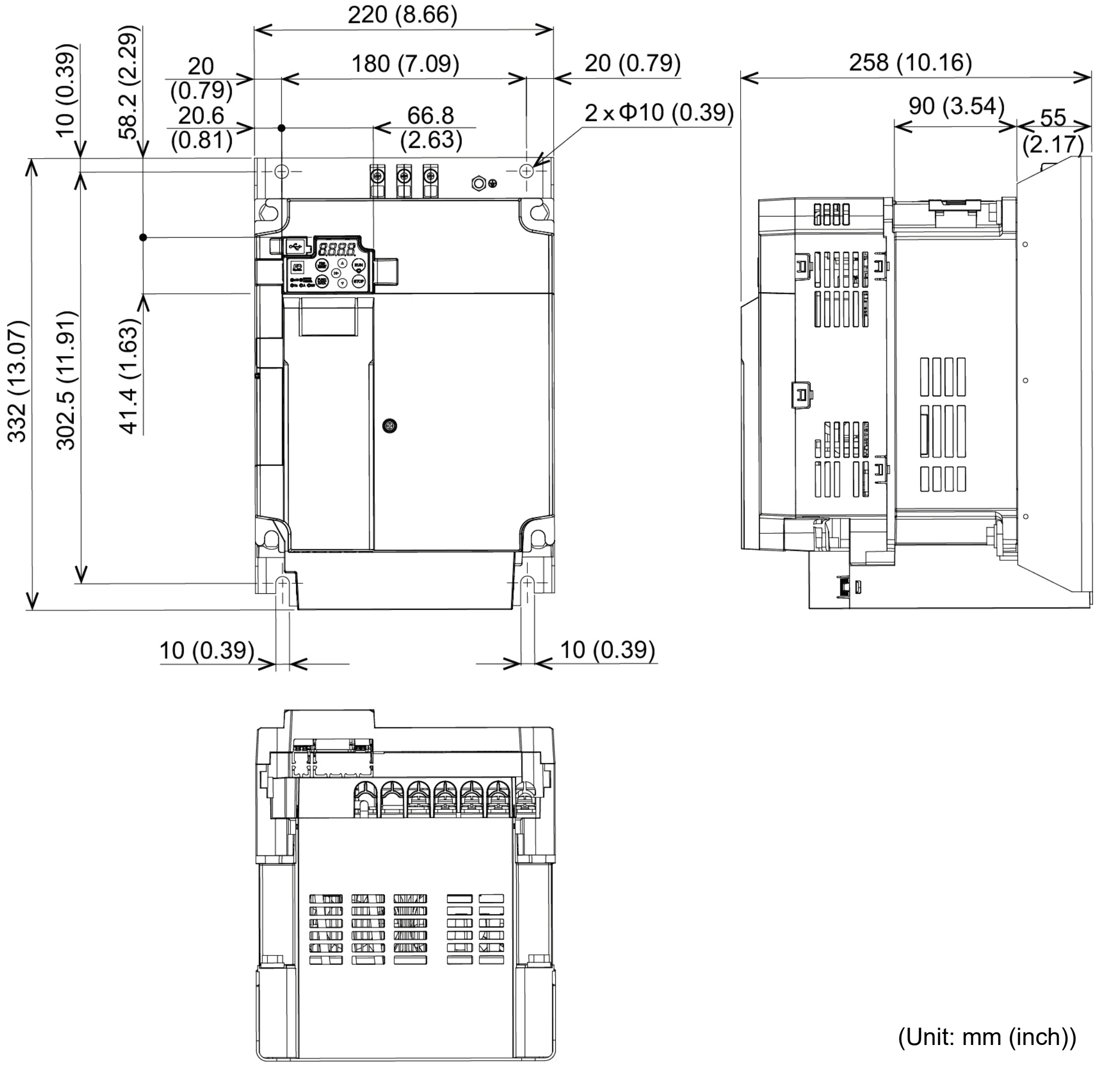




(Unit: mm (inch))

Power supply voltage	Inverter type
Three-phase 400 V	FRN0022E3E-4G
	FRN0029E3E-4G

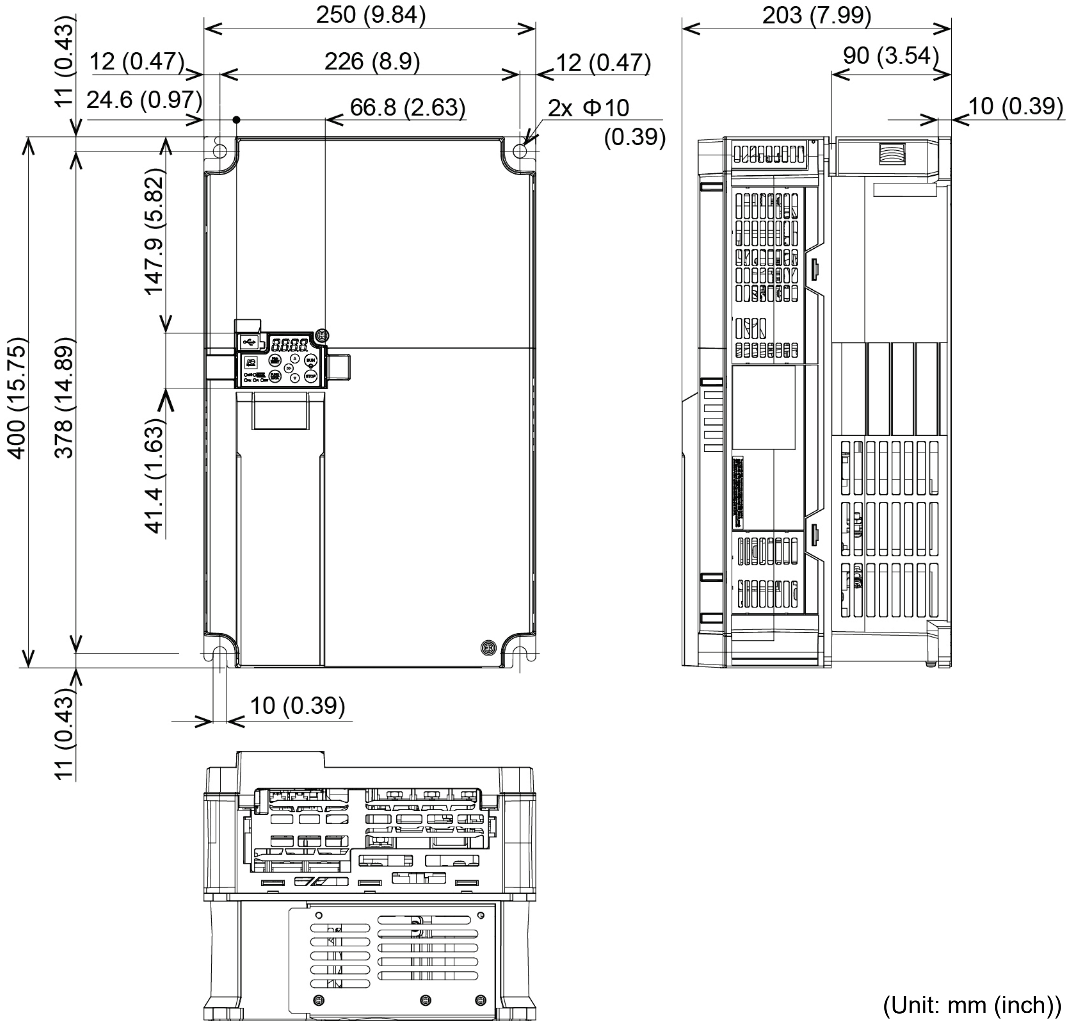
Figure F



(Unit: mm (inch))

Power supply voltage	Inverter type
Three-phase 400 V	FRN0037E3E-4G
	FRN0044E3E-4G

Figure G

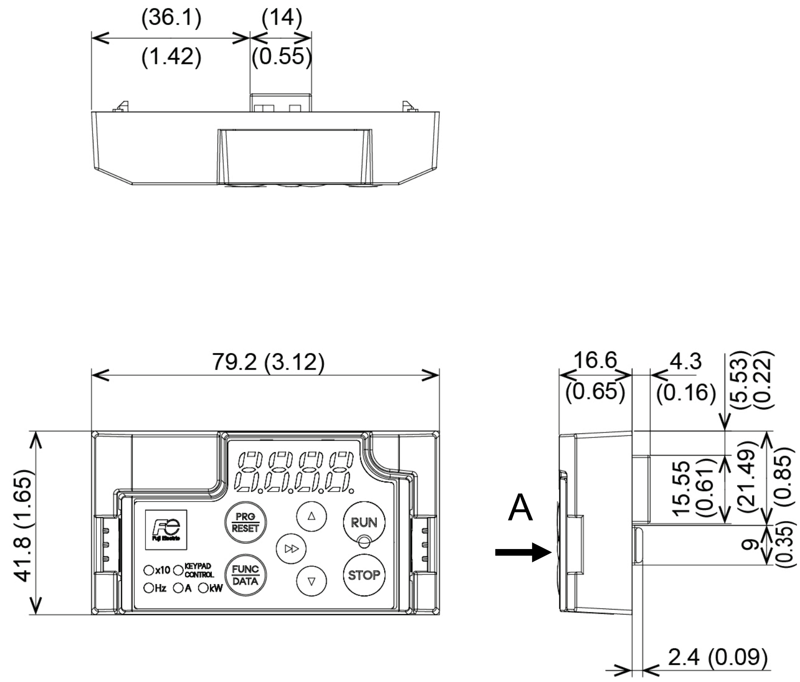


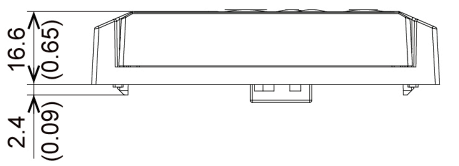
(Unit: mm (inch))

Power supply voltage	Inverter type
Three-phase 400 V	FRN0059E3E-4G
	FRN0072E3E-4G

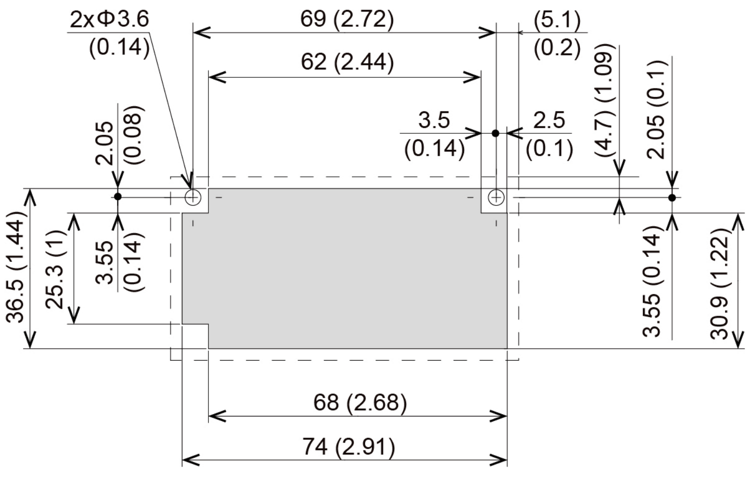
13.4 Keypad (CBAD-CP: When keypad rear cover is attached)

(Unit: mm (inch))





When operating the keypad remotely or mounting it in a panel
(Keypad rear cover attached)



Panel cutting dimensions drawing (view A)

*The keypad rear cover is optional.

APPENDIX

Contents

Appendix A Trouble-free Use of Inverters (Notes on Electrical Noise)

Excerpt from technical material of
the Japan Electrical Manufacturers' Association (JEMA) (March 1995)

A.1 Effect of inverters on other devices

The applicable fields in which inverters are used have been rapidly expanding. This paper describes the effect that inverters have on electronic devices already installed or on devices installed in the same system as inverters, as well as introducing noise prevention measures. (For details, refer to "A.3.3 Noise prevention examples.")

A.1.1 Effect on AM radios

Phenomenon	If an inverter operates, AM radios may pick up noise radiated from the inverter. (An inverter has almost no effect on FM radios or television sets.)
Probable cause	The noise radiated from the inverter may be received by a radio.
Measures	Inserting a noise filter on the power supply side of the inverter is effective.

A.1.2 Effect on telephones

Phenomenon	If an inverter operates, nearby telephones may pick up noise radiated from the inverter in conversation so that it may be difficult to hear.
Probable cause	A high-frequency leakage current radiated from the inverter and motors enters shielded telephone cables, causing noise.
Measures	It is effective to commonly connect the grounding terminals of the motors and return the common grounding line to the grounding terminal of the inverter.

A.1.3 Effect on pressure sensors

Phenomenon	If an inverter operates, pressure sensors may malfunction.
Probable cause	Noise may penetrate through a grounding wire into the signal line.
Measures	It is effective to install a noise filter on the power supply side of the inverter or to change the wiring.

A.1.4 Effect on position detectors (pulse encoders)

Phenomenon	If an inverter operates, pulse encoders may produce erroneous pulses that shift the stop position of a machine.
Probable cause	Erroneous pulses are liable to occur when the signal lines of the PG and power lines are bundled together.
Measures	The influence of induction noise and radiated noise can be reduced by separating the PG signal lines and power lines. Providing noise filters at the input and output terminals is also an effective measure.

A.1.5 Effect on proximity switches

Phenomenon	If an inverter operates, proximity switches (capacitance-type) may malfunction.
Probable cause	The capacitance-type proximity switches may provide inferior noise immunity.
Measures	It is effective to connect a filter to the input terminals of the inverter or to the 0V side of the power supply of the proximity switches using a condenser. The proximity switches can be replaced with superior noise immunity types such as magnetic types.

A.2 Noise

This section gives a summary of noises generated in inverters and their effects on devices subject to noise.

A.2.1 Inverter operating principles and noise

Fig. A.2-1 shows an Outline of inverter configuration. The inverter converts AC to DC (rectification) in a converter unit and converts DC to AC (inversion) with 3-phase variable voltage and variable frequency. The conversion (inversion) is performed by PWM implemented by switching six transistors (IGBT: Insulated Gate Bipolar Transistor, etc.), and is used for variable speed motor control.

Switching noise is generated by high-speed on/off switching of the six transistors. Noise current (i) is emitted and at each high-speed on/off switching, the noise current flows through stray capacitance (C) of the inverter, cable, and motor to the ground. The amount of the noise current is expressed as follows:

$$i = C \cdot dv/dt$$

It is related to the stray capacitance (C) and dv/dt (switching speed of the transistors). Further, this noise current is related to the carrier frequency since the noise current flows each time the transistors are switched ON or OFF.

Noise is generated by the DC/DC power supply converter for the control circuit during transistor switching.

These noise frequency bands extend across several tens of MHz and may interfere with communication devices such as AM radios, factory wireless networks, and telephones.

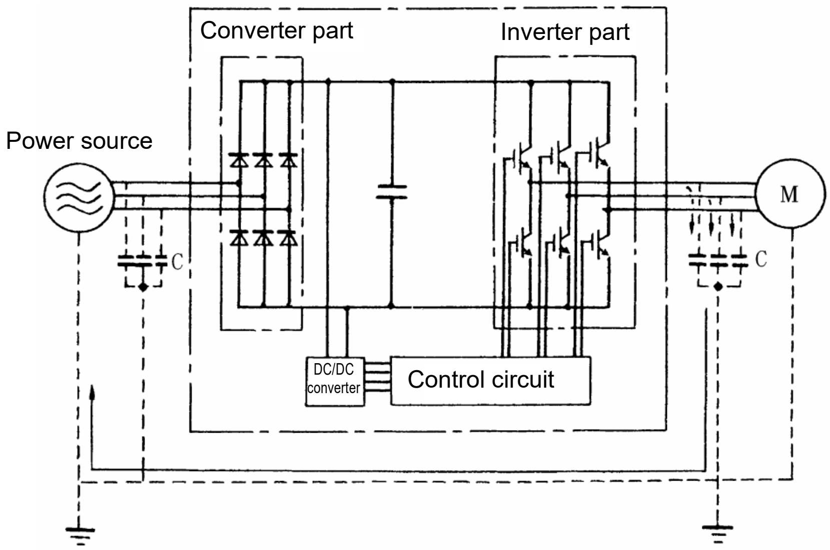


Fig. A.2-1 Outline of inverter configuration

A.2.2 Types of noise

Noise generated in an inverter is propagated through the main circuit wiring to the power supply and the motor so as to affect a wide range of applications from the power supply transformer to the motor. The various propagation routes are shown in Fig. A.2-2. According to those routes, noises are roughly classified into three types:

(1) to (3) are conducted noise, (4) is induction noise, and (5) is radiated noise. Details are given below.

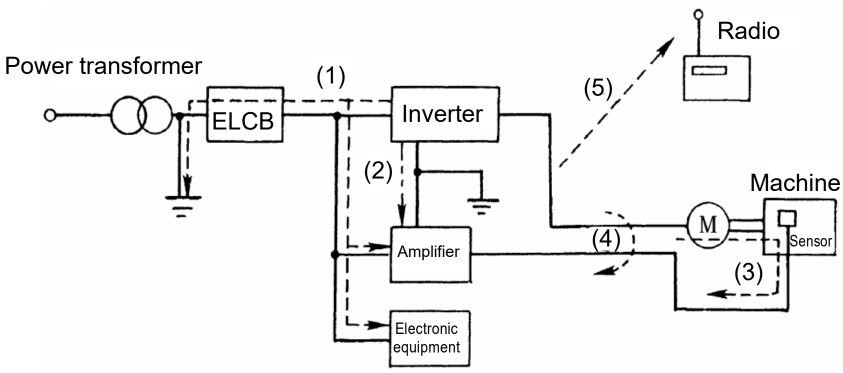


Fig. A.2-2 Noise propagation routes

(1) Conducted noise

The noise that has occurred in the inverter and propagates through a conductor to influence peripheral equipment is called conducted noise. Some conducted noise will propagate through the main circuit (1). If the ground wires are connected to a common ground, conducted noise will propagate through route (2). As shown in route (3), some conducted noise will propagate through signal lines or shielded wires.

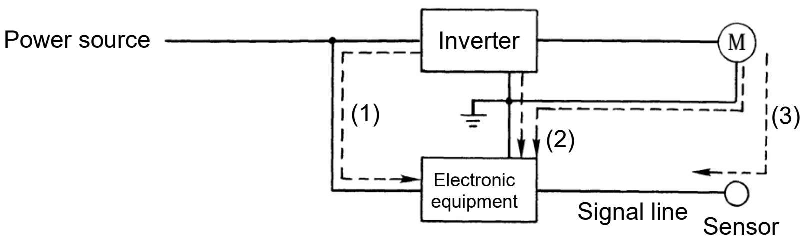


Fig. A.2-3 Conducted noise

(2) Induction noise

When wires or signal lines of peripheral devices are brought close to the wires on the input and output sides of the inverter through which noise current is flowing, noise will be induced into those wires and signal lines of the devices by electromagnetic induction (Fig. A.2-4) or electrostatic induction (Fig. A.2-5). This is called “induction noise” (4).

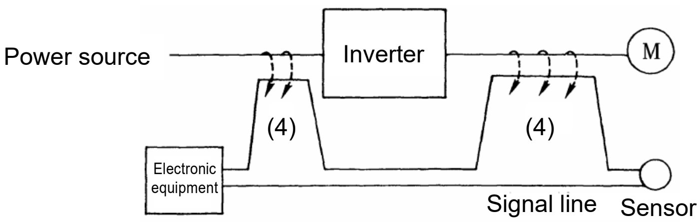


Fig. A.2-4 Electromagnetic induction noise

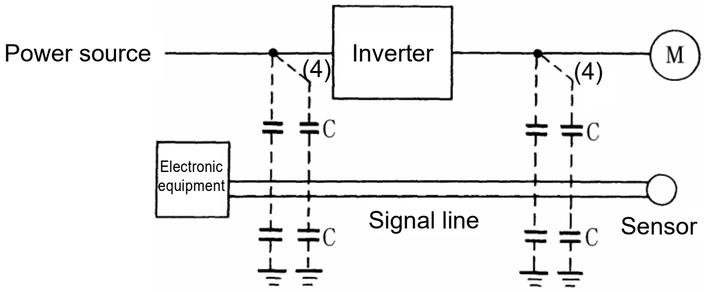


Fig. A.2-5 Electrostatic induction noise

(3) Radiated noise

Noise generated in an inverter radiates through the air with input side and output side main circuit wires, and ground wires acting as antennas; this affects peripheral devices, as well as broadcast and wireless communication. This noise is called “radiated noise,” shown below as (5). Not only wires but motor frames or control system panels containing inverters may also act as antennas.

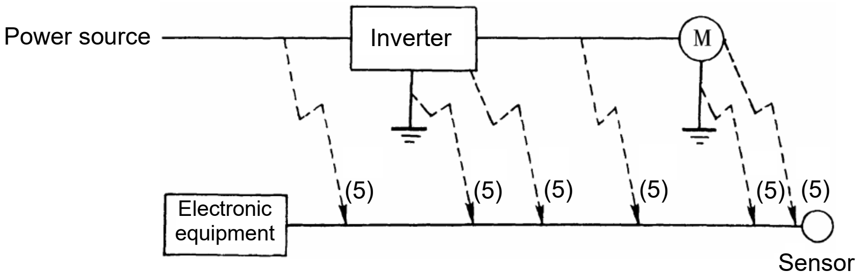


Fig. A.2-6 Radiated noise

A.3 Measures

As the noise prevention is strengthened, the more effective it is. However, with the use of appropriate measures, noise problems may be resolved easily. It is necessary to implement economical noise prevention according to the noise level and the equipment conditions.

A.3.1 Noise prevention prior to installation

Before installing an inverter in your control panel or installing inverter paneling, you need to consider noise prevention. Once noise problems occur, it will cost additional materials and time for solving them.

Noise prevention prior to installation includes:

(1) Separate the main circuit from the control circuit.

(2) Accommodate the main circuit wiring in a metal pipe (conduit pipe).

(3) Use shielded wire or twisted shielded wire in the control circuit.

(4) Perform reliable grounding work and wiring.

These noise prevention measures can avoid most noise problems.

A.3.2 Implementation of noise prevention measures

There are two types of noise prevention measures--one for noise propagation routes and the other for noise receiving sides (that are affected by noise).

The basic measures for reducing the effect of noise at the receiving side include:

(1) Separating the main circuit wiring from the control circuit wiring, avoiding noise effect.
Measures on the noise-affected side are:

(2) Lower the noise level, for example by installing a noise filter.

(3) Suppress the noise level, for example by using a metal wiring pipe or metal control panel.

(4) Block the noise propagation route, for example by using an insulation transformer for power source.

Table A.3-1 lists the Noise prevention measures, their goals, and propagation routes.

Table A.3-1 Noise prevention measures

Noise prevention method		Goal of noise prevention measures: Make it more difficult to receive noise	Goal of noise prevention measures: Cutoff noise propagation	Goal of noise prevention measures: Contain noise	Goal of noise prevention measures: Reduce noise level	Propagation route: Conducted noise	Propagation route: Induction noise	Propagation route: Radiated noise
Wiring and installation	Separate main circuit from control circuit	Y					Y	
	Minimize wiring length	Y			Y		Y	Y
	Avoid parallel and bundled wiring	Y					Y	
	Use appropriate grounding	Y			Y		Y	Y
	Use shielded wire and twisted shielded wire	Y					Y	Y
	Use shielded cable in main circuit			Y				Y
	Use metal conduit pipe			Y			Y	Y
Control panel	Appropriate arrangement of devices in panel	Y					Y	Y
	Metal control panel			Y			Y	Y
Anti-noise devices	Line filter	Y			Y	Y		Y
	Insulation transformer		Y			Y		Y
Measures taken on noise-affected side	Use a decoupling capacitor for control circuit	Y					Y	Y
	Use ferrite core for control circuit	Y					Y	Y
	Line filter	Y				Y		
Other IMs	Separate power supply systems	Y	Y			Y		
	Lower the carrier frequency				Y	Y	Y	Y

In the table, a column marked with Y shows a measure expected to produce an effect depending on the conditions. An empty column shows an ineffective measure.

What follows are noise prevention measures for the inverter drive configuration.

(1) Wiring and grounding

As shown in Fig. A.3-1, separate the main circuit wiring from the control circuit wiring as far as possible regardless of whether they are located inside or outside the system control panel containing an inverter. For the control circuit wiring, use shielded wires and twisted shielded wires that will block out extraneous noises, and minimize the wiring distance. Also avoid bundled wiring of the main circuit and control circuit or parallel wiring.

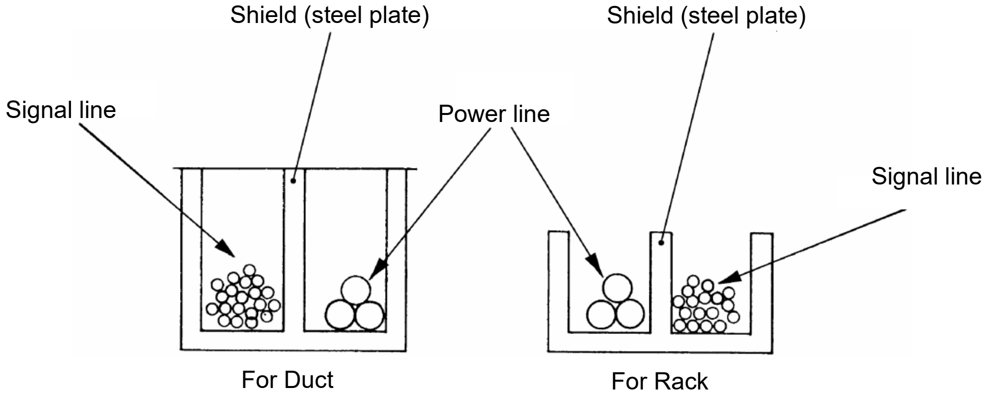


Fig. A.3-1 Separate wiring

For the main circuit wiring, use a metal conduit pipe and connect its wires to the ground to prevent noise propagation (refer to Fig. A.3-2).

The shield (braided wire) of a shielded wire should be securely connected to the base (common) side of the signal line at only one point to avoid the loop formation resulting from a multi-point connection (refer to Fig. A.3-3).

The grounding is effective not only to reduce the risk of electrical shocks due to leakage current, but also to block noise penetration and radiation. Corresponding to the main circuit voltage, the grounding work should be Class D (300 VAC or less) and Class C (300 to 600 VAC). Each ground wire is to be provided with its own ground or separately wired to a grounding point.

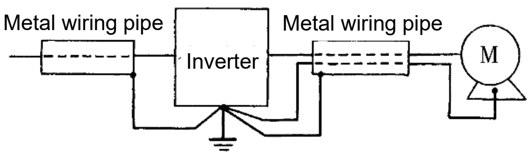


Fig. A.3-2 Grounding of metal conduit pipe

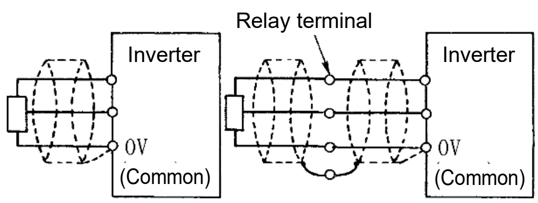


Fig. A.3-3 Treatment of braided wire of shielded wire

(2) Control panel

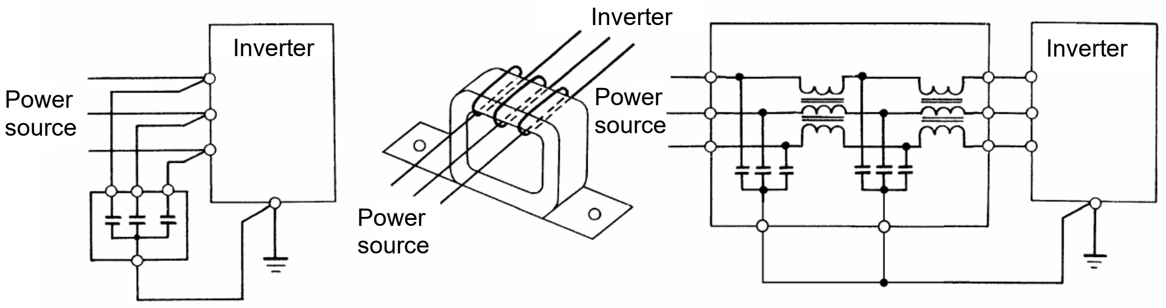
The system control panel containing an inverter is generally made of metal, which can shield noise radiated from the inverter itself.

When installing other electronic devices such as a programmable logic controller in the same control panel, be careful with the layout of each device. If necessary, arrange shield plates between the inverter and peripheral devices.

(3) Anti-noise devices

To reduce the noise propagated through the electrical circuits and the noise radiated from the main circuit wiring to the air, a line filter and power supply transformer should be used (refer to Fig. A.3-4).

Line filters are classified into simple-type filters (including capacitive filters to be connected in parallel to a power line, and inductive filters to be connected in series to a power line) and authentic filters (LC filters) to address radio noise restrictions. They are used selectively to create the target noise reduction effect. Power transformers include general-use insulation transformers, shield transformers and noise-cut transformers, which have different effects to block propagation of noise.



(a) Capacitive filter (b) Inductive filter (zero-phase reactor) (c) LC filter

Fig. A.3-4 Various filters and their connection

(4) Noise prevention measures on the receiving side

It is important to strengthen the noise immunity of those electronic devices installed in the same control panel as the inverter or located near an inverter. Line filters and shielded or twisted shielded wires are used to block the penetration of noise in the signal lines of these devices. The following treatments are also implemented.

1) Lower the circuit impedance by connecting capacitors or resistors to the input and output terminals of the signal circuit in parallel.
2) Increase the circuit impedance for noise by inserting choke coils in series in the signal circuit or passing signal lines through ferrite core beads.

It is also effective to widen the signal base lines (0 V line) or grounding lines.

(5) Other IMs

The level of generating/propagating noise will change with the carrier frequency of the inverter. The higher the carrier frequency, the higher the noise level.

In an inverter whose carrier frequency can be changed, lowering the carrier frequency can reduce the generation of electrical noise and result in a good balance with the audible noise of the motor under driving conditions.

APPENDIX

A.3.3 Noise prevention examples

Table A.3-2 lists examples of the measures to prevent noise generated by a running inverter.

Table A.3-2 Examples of noise prevention measures

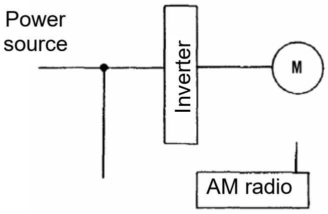
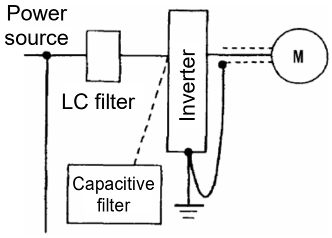
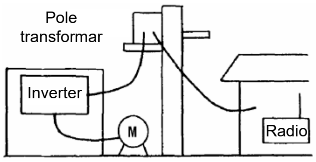
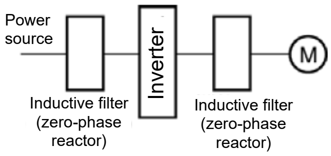
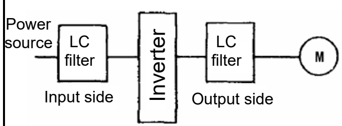
<table>
<tr><th>No.</th><th>Target device</th><th>Phenomenon</th><th>Measure</th><th>Notes</th></tr>
<tr>
<td>1</td>
<td>AM radio</td>
<td>Noise enters the AM radio broadcast (500 to 1500 kHz) when the inverter is operated.

<Possible cause>
Radiated noise from the power source and output wiring of inverter was received by the AM radio.</td>
<td>1) Install an LC filter on the power supply side of the inverter. (In some cases, a capacitive filter may be used as a simple method.)
2) Install a metal conduit wiring between the motor and inverter. Or use shielded wiring.

Note:
Minimize the distance between the LC filter and the inverter (within 1 m).</td>
<td>1) The radiated noise of the wiring can be reduced.
2) Reduce the conducted noise to the power source or apply shielded wiring. Or use shielded wiring.
Note:
Sufficient improvement may not be expected in narrow regions such as between mountains.</td>
</tr>
<tr>
<td>2</td>
<td>AM radio</td>
<td>Noise enters the AM radio broadcast (500 to 1500 kHz) when the inverter is operated.

<Possible cause>
Radiated noise from the power line of inverter's power source was received by the AM radio.</td>
<td>1) Install inductive filters at the input and output sides of the inverter.

The number of turns of the zero-phase reactor (or ferrite ring) should be as large as possible. Minimize the distance between the inverter and the inductive filter (within 1 m).
2) When further improvement is necessary, install LC filters.
</td>
<td>1) The radiated noise of the wiring can be reduced.</td>
</tr>
</table>

Table A.3-2 Examples of noise prevention measures (cont'd)

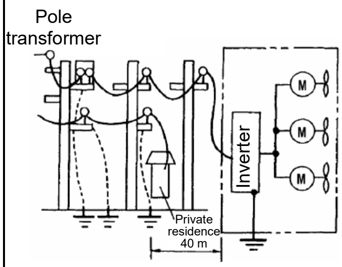
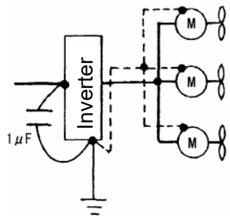
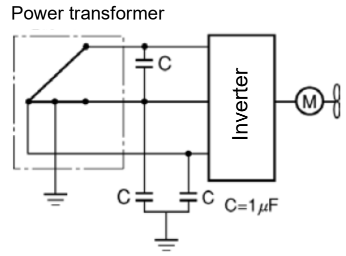
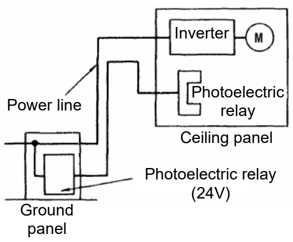
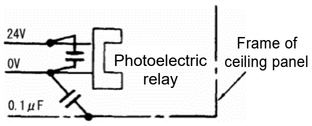
No.	Target device	Phenomenon	Measure	Notes
3	Telephone (in a common private residence at a distance of 40 m)	When driving a ventilation fan with an inverter, noise enters a telephone in a private residence at a distance of 40 m.  <Possible cause> High-frequency leak current of the inverter and motor flows into the shielded ground of the telephone cable on the way back via the ground of the pole transformer to cause noise by electrostatic induction.	1) Connect the ground terminals of the motors in a common connection. Return to the inverter panel and insert a 1 μF capacitor between the input terminal of the inverter and ground.   	1) The effect of the inductive filter and LC filter may not be as expected because of sound frequency components. 2) In the case of a V-connection power supply transformer in a 200 V system, it is necessary to connect capacitors as shown in the following figure, because of different potentials to ground.
4	Photoelectric relay	A photoelectric relay malfunctioned when the inverter runs the motor. (The inverter and motor are installed in the same place (for overhead traveling)).  <Possible cause> Input power line of the inverter and wiring of the photoelectric relay run parallel for 30 to 40 m with a spacing of about 25 mm, which invites induction noise. Due to conditions of the installation, these lines cannot be separated.	1) As a temporary measure, Insert a 0.1 μF capacitor between the 0 V terminal of the power supply circuit in the detection unit of the overhead photoelectric relay and a frame of the overhead panel.  2) As a permanent measure, move the 24 V power supply from the ground to the overhead unit so that signals are sent to the ground side with relay contacts in the ceiling part.	1) Separate the wiring (30 cm or more) 2) When separation is impossible, signals can be received and sent with dry contacts etc. 3) Do not wire low-current signal lines and power lines in parallel.

Table A.3-2 Examples of noise prevention measures (continued)

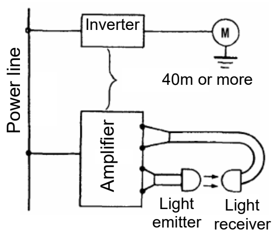
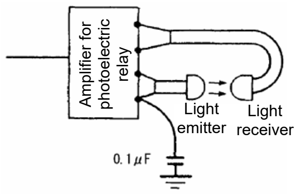
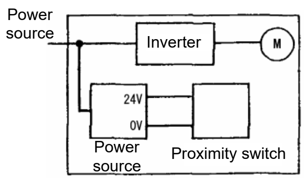
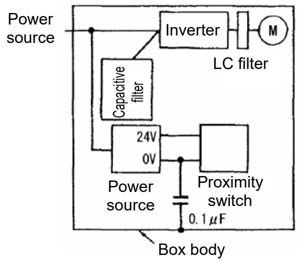
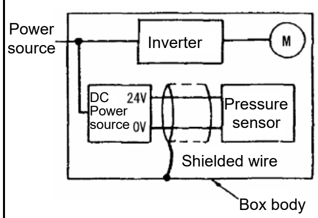
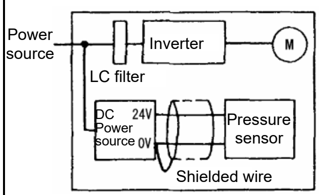
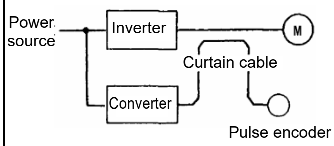
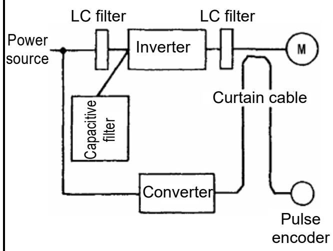
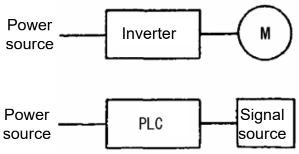
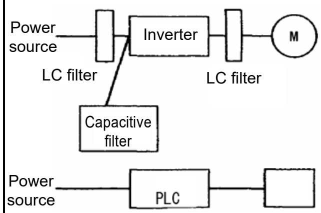
No.	Target device	Phenomenon	Measure	Notes
5	Photoelectric relay	A photoelectric relay malfunctioned when the inverter runs the motor.  <Possible cause> While the inverter is sufficiently away from the photoelectric relay, the power source is connected in common. Conducted noise has entered from the power source line.	1) Insert a 0.1 μF capacitor between the output common terminal of the amplifier of the photoelectric relay and the frame.  	1) If a low-current circuit at the malfunctioning side is observed, the measures may be simple and economical.
6	Proximity switch (capacitance type)	A proximity switch malfunctioned.  <Possible cause> The electrostatic capacitive proximity switch has a low noise immunity, and is vulnerable to circuit conducted noise and radiated noise.	1) Install an LC filter at the output side of the inverter. 2) Install a capacitive filter at the input side of the inverter. 3) Ground the 0 V (common) line of the DC power supply of the proximity switch through a capacitor to the box body of the machine.  	1) Noise generated in the inverter can be reduced. 2) The switch is superseded by a proximity switch of superior noise immunity (such as a magnetic type).
7	Pressure sensor	A pressure sensor malfunctioned.  <Possible cause> Noise enters from the box body via the shielded wire to cause malfunctioning of the pressure sensor.	1) Install an LC filter on the input side of the inverter. 2) Connect the shield of the shielded wire of the pressure sensor to the 0 V line (common) of the pressure sensor, changing the original connection.  	1) The shielded parts of shield wires for sensor signals are connected to a common point in the system. 2) Conductive noise from the inverter can be reduced.

Table A.3-2 Examples of noise prevention measures (cont'd)

No.	Target device	Phenomenon	Measure	Notes
8	Position detector (pulse encoder)	Erroneous-pulse outputs from a pulse converter caused a shift in the stop position of a crane.  <Possible cause> The motor power line and the signal line for the encoder are wired together in a bundle. This produces mis-pulses due to induction noise.	1) Install an LC filter and a capacitive filter on the input side of the inverter. 2) Install an LC filter on the output side of the inverter. 	1) This is an example of a measure where the power line and signal line cannot be separated. 2) Induction noise and radiated noise on the output side of the inverter can be reduced.
9	Programmable logic controller (PLC)	The PLC program sometimes malfunctions.  <Possible cause> Power sources of the inverter and PLC are in the same system so that noise enters PLC via the power source.	1) Install a capacitive filter and an LC filter on the input side of the inverter. 2) Install an LC filter on the output side of the inverter. 3) Lower the carrier frequency of the inverter. 	1) Total conducted noise and induction noise in the electric line can be reduced.

APPENDIX

Appendix B Effect on Insulation of General-purpose Motors Driven with 400 V Class Inverters

Excerpt from technical material of
the Japan Electrical Manufacturers' Association (JEMA) (March 1995)

Preface

When an inverter drives a motor, surge voltages generated by switching the inverter elements are superimposed on the inverter output voltage and applied to the motor terminals. If the surge voltages are too high, they may have an effect on the motor insulation and some cases have resulted in damage.

For preventing such cases this document describes the generating mechanism of the surge voltages and countermeasures against them.

For details of the principles of inverter operation, refer to "A.2.1 Inverter operating principles and noise."

B.1 Generating mechanism of surge voltages

As the inverter rectifies a commercial power source voltage and smoothes into a DC voltage, the magnitude E of the DC voltage becomes about √2 times that of the source voltage (about 620 V in case of an input voltage of 440 VAC). The peak value of the output voltage is usually close to this DC voltage value.

However, as there exists inductance (L) and stray capacitance (C) in wiring between the inverter and the motor, the voltage variation due to switching the inverter elements causes a surge voltage originating in LC resonance and results in the addition of high voltage to the motor terminals. (Refer to Fig. B.1-1)

This voltage sometimes reaches up to about twice that of the inverter DC voltage (620 V x 2 = approximately 1,200 V) depending on a switching speed of the inverter elements and wiring conditions.

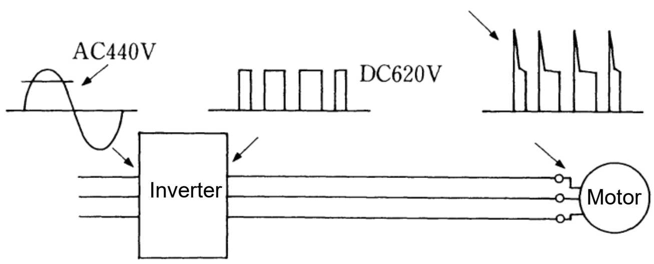
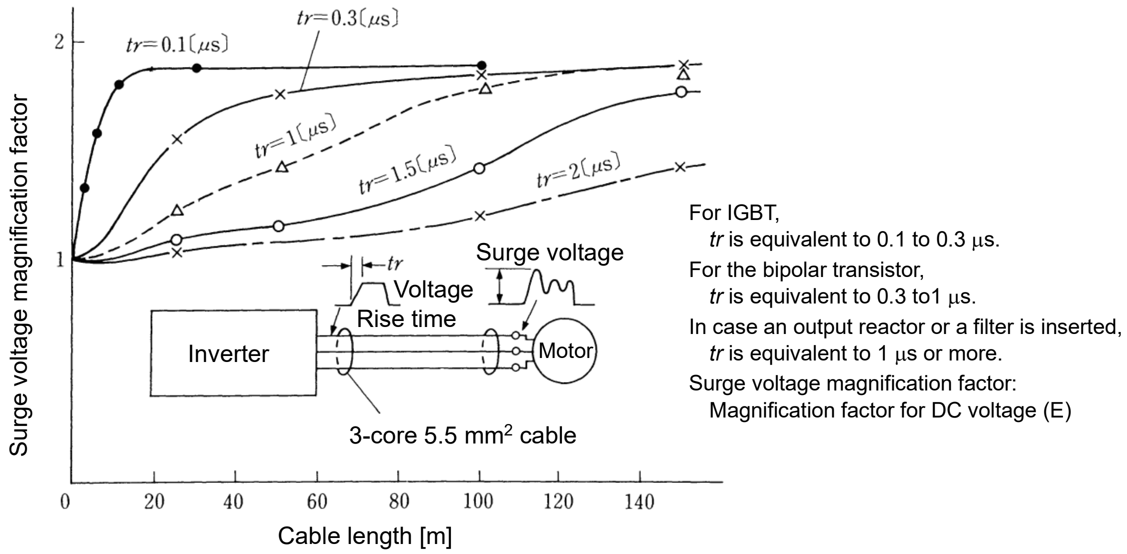


Fig. B.1-1 Voltage waveform of individual portions

A measured example in Fig. B.1-2 illustrates the relation of the peak value of the motor terminal voltage with the wiring length between the inverter and the motor.

From this it can be confirmed that the peak value of the motor terminal voltage ascends as the wiring length increases and becomes saturated at about twice the inverter DC voltage.

The shorter a pulse rise time becomes, the higher the motor terminal surge voltage rises even in the case of a short wiring length.



Excerpt from Journal of IEEJ, No. 7, vol. 107, 1987

Fig. B.1-2 Measured example of wiring length and peak value of motor terminal voltage

B.2 Effect of surge voltages

The surge voltages originated in LC resonance of wiring may be applied to the motor terminals, and, depending on their magnitude, sometimes cause damage to the motor insulation.

When the motor is driven with a 200 V-series inverter, the dielectric strength of the insulation is no problem even when the peak value of the motor terminal voltage doubles due to the surge voltages (the DC voltage is only about 300 V).

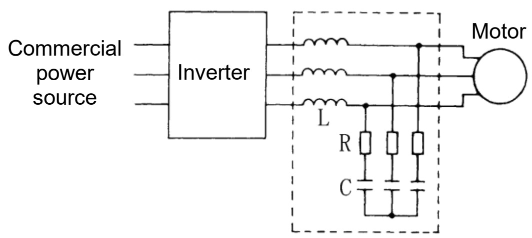
But in case of a 400 V-series inverter, the DC voltage is approximately 600 V, and, depending on the wiring length, the surge voltages may greatly increase and sometimes result in damage to the insulation.

B.3 Countermeasures against surge voltages

When driving a motor with a 400 V-series inverter, the following are countermeasures against damage to the motor insulation by the surge voltages.

B.3.1 Suppressing surge voltages

To suppress surge voltage, install a filter on the output side of the inverter that allows the peak value of the motor terminal voltage to be reduced. (Refer to Fig. B.3-1 Method to suppress surge voltage)



Output filter

Fig. B.3-1 Method to suppress surge voltage

APPENDIX

B.3.2 Using motors with enhanced insulation

Enhanced insulation of a motor’s winding allows its surge withstanding to be improved.

B.4 Regarding existing equipment

B.4.1 In case of a motor being driven with 400 V-series inverter

A survey over the last five years on motor insulation damage due to the surge voltages originating from switching of inverter elements shows that the damage incidence is 0.013% under the surge voltage condition of over 1,100 V, and most of the damage occurs within several months after commissioning the inverter. Therefore, there seems to be little probability of occurrence of motor insulation damage after a lapse of several months after commissioning.

B.4.2 In case of an existing motor driven using a newly-installed 400 V-series inverter

Contact the motor manufacturer to confirm that it can be driven using the inverter.

Appendix C Inverter Generating Loss

The table below lists the inverter generating loss.

Table C-1

Power system	Inverter type	Carrier frequency (Function code: F26)					
		ND specification	HD specification	HND specification		HHD specification	
		Factory default	Factory default	Factory default	Maximum set value	Factory default	Maximum set value
Three-phase 200 V	FRN0001E3△-2G	-	-	19	22	17	20
	FRN0002E3△-2G	-	-	29	34	23	27
	FRN0004E3△-2G	-	-	47	51	35	39
	FRN0006E3△-2G	-	-	66	71	54	58
	FRN0010E3△-2G	-	-	94	115	74	95
	FRN0012E3△-2G	-	-	115(*1)	145(*1)	98	125
	FRN0020E3△-2G	-	-	210	285	165	230
	FRN0030E3△-2G	-	-	280	360	170	230
	FRN0040E3△-2G	-	-	440	540	280	360
	FRN0056E3△-2G	-	-	520	700	440	540
	FRN0069E3△-2G	-	-	640	810	520	700
	FRN0088E3△-2G	-	-	770	970	660	860
	FRN0115E3△-2G	-	-	1120	1250	790	1040
Three-phase 400 V	FRN0002E3□-4G	33	32	32	56	30	52
	FRN0004E3□-4G	57	50	50	93	40	72
	FRN0006E3□-4G	73	69	69	120	57	100
	FRN0007E3□-4G	98	95	95	170	79	145
	FRN0012E3□-4G	155	150	150	265	130	215
	FRN0022E3□-4G	260	190	190	370	170	320
	FRN0029E3□-4G	380	290	290	510	220	390
	FRN0037E3□-4G	460	390	390	630	300	490
	FRN0044E3□-4G	470	410	410	750	340	600
	FRN0059E3□-4G	710	510	510	870	440	770
	FRN0072E3□-4G	900	710	710	1000	510	900
Single-phase 200 V	FRN0001E3□-7G	-	-	19	21	17	20
	FRN0002E3□-7G	-	-	29	31	23	27
	FRN0004E3△-7G FRN0003E3E-7G	-	-	47	50	36	40
	FRN0006E3△-7G FRN0005E3E-7G	-	-	66	69	55	59
	FRN0010E3△-7G FRN0008E3E-7G	-	-	94	110	78	100
	FRN0012E3△-7G FRN0011E3E-7G	-	-	115	140	100	130

APPENDIX

Note 1) The maximum set value (max. carrier) differs depending on specifications. For details, refer to Chapter 5 “5.3.1 F codes (Fundamental functions)/FUNCTION CODE F26.”

Note 2: When HD/ND specification units are operated at maximum carrier, perform derating of the output current while referring to Chapter 10 “10.4.2 Guidelines for selecting inverter drive mode and capacity.”
At that setting, generated losses will be at same level as the factory shipment value.

Note 3) A box (□) in the above table replaces S (Basic type) or N (Ethernet built-in type) or E (EMC filter built-in type) depending on the enclosure.

A box (△) in the above table replaces S (Basic type) or N (Ethernet built-in type) depending on the enclosure.

(*1) ND spec.

(*2)FRN____E3E-7G is only HHD spec.

Appendix D Conversion to Non-SI Units

All expressions given in Chapter 10 “SELECTING OPTIMAL MOTOR AND INVERTER CAPACITIES” are based on SI units (The International System of Units). This section explains how to convert expressions to other units.

D.1 Conversion of units

(1) Force

- 1 [kgf] ≈ 9.8 [N]
- 1 [N] ≈ 0.102 [kgf]

(2) Torque

- 1 [kgf·m] ≈ 9.8 [N•m]
- 1 [N•m] ≈ 0.102 [kgf•m]

(3) Power (energy)

- 1 [kgf•m] ≈ 9.8 [N•m] = 9.8 [J] = 9.8 [W•s]

(4) Power

- 1 [kgf•m/s] ≈ 9.8 [N•m/s] = 9.8 [J/s] = 9.8 [W]
- 1 [N•m/s] ≈ 1 [J/s] = 1 [W] ≈ 0.102 [kgf•m/s]

(5) Motor speed

- 1 [min^{-1}] = $\frac{2\pi}{60}$ [rad/s] ≈ 0.1047 [rad/s]
- 1 [rad/s] = $\frac{60}{2\pi}$ [min^{-1}] ≈ 9.549 [min^{-1}]

(6) Inertia constant

J [kg•m^2]: moment of inertia
GD^2 [kg·m^2]: flywheel effect

- $GD^2 = 4J$
- $J = \frac{GD^2}{4}$

(7) Pressure, stress

- 1 [mmAq] ≈ 9.8 [Pa] ≈ 9.8 [N/m^2]
- 1 [Pa] ≈ 1 [N/m^2] ≈ 0.102 [mmAq]
- 1 [bar] ≈ 100000 [Pa] ≈ 1.02 [kg•cm^2]
- 1 [kg•cm^2] ≈ 98000 [Pa] ≈ 980 [mbar]
- 1 barometric pressure
  = 1013 [mbar] = 760 [mmHg]
  = 101300 [Pa] ≈ 1.033 [kg/cm^2]

APPENDIX

D.2 Calculation formulas

(1) Torque, power, rotation speed

- $P[W] \approx \dfrac{2\pi}{60} \cdot N[min^{-1}] \cdot \tau\,[N \cdot m]$
- $P\,[W] \approx 1.026 \cdot N\,[min^{-1}] \cdot T\,[kgf \cdot m]$
- $\tau\,[N \cdot m] \approx 9.55 \cdot \dfrac{P\,[W]}{N\,[min^{-1}]}$
- $T\,[kgf \cdot m] \approx 0.974 \cdot \dfrac{P\,[W]}{N\,[min^{-1}]}$

(2) Kinetic energy

- $E\,[J] \approx \dfrac{1}{182.4} \cdot J\,[kg \cdot m^2] \cdot N^2\,[(min^{-1})^2]$
- $E\,[J] \approx \dfrac{1}{730} \cdot GD^2\,[kg \cdot m^2] \cdot N^2\,[(min^{-1})^2]$

(3) Linear motion load torque

[Driving mode]

- $\tau\,[N \cdot m] \approx 0.159 \dfrac{V\,[m/min]}{N_M\,[min^{-1}] \cdot \eta_G} \cdot F\,[N]$
- $T\,[kgf \cdot m] \approx 0.159 \dfrac{V\,[m/min]}{N_M\,[min^{-1}] \cdot \eta_G} \cdot F\,[kgf]$

[Braking mode]

- $\tau\,[N \cdot m] \approx 0.159 \dfrac{V\,[m/min]}{N_M\,[min^{-1}] / \eta_G} \cdot F\,[N]$
- $T\,[kgf \cdot m] \approx 0.159 \dfrac{V\,[m/min]}{N_M\,[min^{-1}] / \eta_G} \cdot F\,[kgf]$

(4) Acceleration torque

[Driving mode]

- $\tau\,[N \cdot m] \approx \dfrac{J\,[kg \cdot m^2]}{9.55} \cdot \dfrac{\Delta N\,[min^{-1}]}{\Delta t\,[s] \cdot \eta_G}$
- $T\,[kgf \cdot m] \approx \dfrac{GD^2\,[kg \cdot m^2]}{375} \cdot \dfrac{\Delta N\,[min^{-1}]}{\Delta t\,[s] \cdot \eta_G}$

[Braking mode]

- $\tau\,[N \cdot m] \approx \dfrac{J\,[kg \cdot m^2]}{9.55} \cdot \dfrac{\Delta N\,[min^{-1}] \cdot \eta_G}{\Delta t\,[s]}$
- $T\,[kgf \cdot m] \approx \dfrac{GD^2\,[kg \cdot m^2]}{375} \cdot \dfrac{\Delta N\,[min^{-1}] \cdot \eta_G}{\Delta t\,[s]}$

(5) Acceleration time

- $t_{ACC}\,[s] \approx \dfrac{J_1 + J_2/\eta_G\,[kg \cdot m^2]}{\tau_M - \tau_L/\eta_G\,[N \cdot m]} \cdot \dfrac{\Delta N\,[min^{-1}]}{9.55}$
- $t_{ACC}\,[s] \approx \dfrac{GD_1^2 + GD_2^2/\eta_G\,[kg \cdot m^2]}{T_M - T_L/\eta_G\,[kgf \cdot m]} \cdot \dfrac{\Delta N\,[min^{-1}]}{375}$

(6) Deceleration time

- $t_{DEC}[s] \fallingdotseq \dfrac{J_1+J_2 \cdot \eta_G[kg \cdot m^2]}{\tau_M-\tau_L \cdot \eta_G[N \cdot m]} \cdot \dfrac{\Delta N[min^{-1}]}{9.55}$
- $t_{DEC}[s] \fallingdotseq \dfrac{GD_1^2+GD_2^2 \cdot \eta_G[kg \cdot m^2]}{T_M-T_L \cdot \eta_G\,[kgf \cdot m]} \cdot \dfrac{\Delta N[min^{-1}]}{375}$

Appendix E Permissible Current of Insulated Wires

The tables below list the permissible current of IV wires, HIV wires, and 600 V cross-linked polyethylene insulated wires.

■ IV wire (maximum permissible temperature: 60°C (140°F))

Table E-1 (a) Permissible current of insulated wires

Wire size (mm^2)	Permissible current Threshold value (30°C or less) Io (A)	Aerial wiring					Wire duct wiring (3 wires or less in same duct)			
		35°C (95°F) (Io×0.91) (A)	40°C (104°F) (Io×0.82) (A)	45°C (113°F) (Io×0.71) (A)	50°C (122°F) (Io×0.58) (A)	55°C (131°F) (Io×0.41) (A)	35°C (95°F) (Io×0.64) (A)	40°C (104°F) (Io×0.57) (A)	45°C (113°F) (Io×0.49) (A)	50°C (122°F) (Io×0.40) (A)
2.0	27	24	22	19	15	11	17	15	13	10
3.5	37	33	30	26	21	15	23	21	18	14
5.5	49	44	40	34	28	20	31	28	24	19
8.0	61	55	49	43	35	24	38	34	30	24
14	88	80	71	62	50	35	56	50	43	35
22	115	104	93	81	66	46	73	65	56	46
38	162	147	132	114	93	66	103	92	80	65
60	217	198	177	153	125	88	138	124	107	87
100	298	272	243	210	172	121	190	170	147	120
150	395	360	322	279	228	161	252	225	195	159
200	469	428	382	331	270	191	299	268	232	189
250	556	507	453	393	321	226	355	317	275	224
325	650	593	530	459	375	265	415	371	321	262
400	745	680	608	526	430	304	476	425	368	301
500	842	768	687	595	486	343	538	481	416	340
2 x 100	497	453	405	351	286	202	317	284	246	200
2 x 150	658	600	537	465	379	268	420	376	325	265
2 x 200	782	713	638	552	451	319	499	446	387	316
2 x 250	927	846	756	655	535	378	592	529	458	374
2 x 325	1083	988	884	765	625	442	692	618	536	437
2 x 400	1242	1133	1014	878	717	507	793	709	614	501
2 x 500	1403	1280	1145	992	810	572	896	801	694	567

■ HIV wire (maximum permissible temperature: 75°C (167°F))

Table E-1 (b) Permissible current of insulated wires

Wire size (mm²)	Permissible current Threshold value (30°C or less) Io (A)	Aerial wiring					Wire duct wiring (3 wires or less in same duct)			
		35°C (95°F) (Io×0.94) (A)	40°C (104°F) (Io×0.88) (A)	45°C (113°F) (Io×0.81) (A)	50°C (122°F) (Io×0.74) (A)	55°C (131°F) (Io×0.66) (A)	35°C (95°F) (Io×0.65) (A)	40°C (104°F) (Io×0.61) (A)	45°C (113°F) (Io×0.57) (A)	50°C (122°F) (Io×0.52) (A)
2.0	33	31	29	26	24	21	21	20	18	17
3.5	45	42	39	36	33	29	29	27	25	23
5.5	60	56	52	48	44	39	39	36	34	31
8.0	74	69	65	59	54	48	48	45	42	38
14	107	100	94	86	79	70	69	65	60	55
22	140	131	123	113	103	92	91	85	79	72
38	198	186	174	160	146	130	128	120	112	102
60	265	249	233	214	196	174	172	161	151	137
100	364	342	320	294	269	240	236	222	207	189
150	483	454	425	391	357	318	313	294	275	251
200	574	539	505	464	424	378	373	350	327	298
250	680	639	598	550	503	448	442	414	387	353
325	796	748	700	644	589	525	517	485	453	413
400	912	857	802	738	674	601	592	556	519	474
500	1,031	969	907	835	762	680	670	628	587	536
2 x 100	608	571	535	492	449	401	395	370	346	316
2 x 150	805	756	708	652	595	531	523	491	458	418
2 x 200	957	899	842	775	708	631	622	583	545	497
2 x 250	1,135	1066	998	919	839	749	737	692	646	590
2 x 325	1,326	1246	1,166	1,074	981	875	861	808	755	689
2 x 400	1,521	1429	1,338	1,232	1,125	1,003	988	927	866	790
2 x 500	1,718	1614	1,511	1,391	1,271	1,133	1,116	1,047	979	893

■ 600 V crosslinked polyethylene insulated wire (maximum permissible temperature: 90°C (194°F))

Table E-3 (c) Permissible current of insulated wires

Wire size	Permissible current	Aerial wiring					Wire duct wiring (3 wires or less in same duct)			
(mm^2)	Threshold value (30°C or less) Io (A)	35°C (95°F) (Io×0.95) (A)	40°C (104°F) (Io×0.91) (A)	45°C (113°F) (Io×0.86) (A)	50°C (122°F) (Io×0.81) (A)	55°C (131°F) (Io×0.76) (A)	35°C (95°F) (Io×0.67) (A)	40°C (104°F) (Io×0.63) (A)	45°C (113°F) (Io×0.60) (A)	50°C (122°F) (Io×0.57) (A)
2.0	38	36	34	32	30	28	25	23	22	21
3.5	52	49	47	44	42	39	34	32	31	29
5.5	69	65	62	59	55	52	46	43	41	39
8.0	86	81	78	73	69	65	57	54	51	49
14	124	117	112	106	100	94	83	78	74	70
22	162	153	147	139	131	123	108	102	97	92
38	229	217	208	196	185	174	153	144	137	130
60	306	290	278	263	247	232	205	192	183	174
100	421	399	383	362	341	319	282	265	252	239
150	558	530	507	479	451	424	373	351	334	318
200	663	629	603	570	537	503	444	417	397	377
250	786	746	715	675	636	597	526	495	471	448
325	919	873	836	790	744	698	615	578	551	523
400	1,053	1,000	958	905	852	800	705	663	631	600
500	1,190	1,130	1,082	1,023	963	904	797	749	714	678
2 x 100	702	666	638	603	568	533	470	442	421	400
2 x 150	930	883	846	799	753	706	623	585	558	530
2 x 200	1,105	1,049	1,005	950	895	839	740	696	663	629
2 x 250	1,310	1,244	1,192	1,126	1,061	995	877	825	786	746
2 x 325	1,531	1,454	1,393	1,316	1,240	1,163	1,025	964	918	872
2 x 400	1,756	1,668	1,597	1,510	1,422	1,334	1,176	1,106	1,053	1,000
2 x 500	1,984	1,884	1,805	1,706	1,607	1,507	1,329	1,249	1,190	1,130

Appendix F Conformity with Standards

F.1 Compliance with European standards (CE)

The CE marking on Fuji products indicates that they comply with the essential requirements of the Electromagnetic Compatibility (EMC) Directive, Low Voltage Directive, and Machinery Directive issued by the Council of the European Communities.

Note: Keep the ambient temperature to 50°C (122°F) or less to comply with European standards.
Products with no standards indicated do not comply with European Standards.

Table F.1-1 Compliance standards

EMC Directive	EN61800-3 Immunity : Second environment (Industrial) Emission When optional EMC filter is attached: Category C2 FRN0002E3E-4G to FRN0012E3E-4G: Category C2 FRN0001E3E-7G to FRN0011E3E-7G: Category C2 Other EMC filter built-in types: Category C3
Low Voltage Directive	Adjustable speed electrical power drive systems. Part 5-1: Safety requirements. Electrical, thermal and energy EN61800-5-1
Machine Directives	EN ISO 13849-1 : Cat.3 / PL:e EN 60204-1 : Stop Category 0 EN 61800-5-2 : SIL3 (Functional Safety: STO) EN 62061 : SIL3

* A basic type inverter that does not have a built-in EMC filter complies with the EMC Directive by combining it with an dedicated Fuji external filter.

Warning

Category C2: In a domestic environment this product may cause radio interference in which case supplementary mitigation measures may be required.

Category C3: This product is not intended to be used on a low-voltage public network which supplies domestic premises; radio frequency interference is expected if used on such a network.

Category C2 and C3:

It has a risk about other equipment malfunction or breakdown by radiated electric field strength out of frequency range that is defined in EN 61800-3: 2004 + A1: 2012 2nd Environment and EN/IEC 61800-3: 2018 2nd Environment.

F.1.1 Compliance with EMC standards

The CE marking on inverters does not ensure that the entire equipment including our CE-marked products is compliant with the EMC Directive. Therefore, CE marking for the equipment shall be the responsibility of the equipment manufacturer. The reason for this is that Fuji's CE mark is indicated under the condition that the product shall be used in a way that meets all requirements for the relevant Directives.

Generally, machinery or equipment includes not only our products but other devices as well. Manufacturers, therefore, shall design the whole system to be compliant with the relevant Directives.

■ List of EMC-compliant filters

To comply with standards, either use an inverter with built-in EMC filter, or use an inverter with no built-in EMC filter in combination with a dedicated Fuji external filter (option). No matter what the application, please install noise filters using the following recommended installation method. It is recommended that noise filters be installed inside metal cabinets to ensure more reliable compliance with standards.

Tip Our EMC compliance test is performed under the following conditions. Wiring length (of the shielded cable) between the inverter (EMC filter built-in type) and motor: 10 m.

Note To use Fuji inverters in combination with a PWM converter, the basic type of inverters having no built-in EMC filter should be used. Use of an EMC filter built-in type may increase the heat of the capacitors in the inverter, resulting in damage. In addition, the effect of the EMC filter will be lost.

Table F.1-2 EMC-compliant filters

<table>
<tr><th rowspan="2">Power system</th><th rowspan="2">Inverter type</th><th colspan="4">Filter type</th></tr>
<tr><th>ND mode</th><th>HD mode</th><th>HND mode</th><th>HHD mode</th></tr>
<tr><td rowspan="13">Three-phase 200 V</td><td>FRN0001E3□-2G</td><td>-</td><td>-</td><td rowspan="4">B84243A8008W000</td><td rowspan="4">B84243A8008W000</td></tr>
<tr><td>FRN0002E3□-2G</td><td>-</td><td>-</td></tr>
<tr><td>FRN0004E3□-2G</td><td>-</td><td>-</td></tr>
<tr><td>FRN0006E3□-2G</td><td>-</td><td>-</td></tr>
<tr><td>FRN0010E3□-2G</td><td>-</td><td>-</td><td rowspan="3">B84243A8033W000</td><td rowspan="3">B84243A8033W000</td></tr>
<tr><td>FRN0012E3□-2G</td><td>-</td><td>-</td></tr>
<tr><td>FRN0020E3□-2G</td><td>-</td><td>-</td></tr>
<tr><td>FRN0030E3□-2G</td><td>-</td><td>-</td><td>FN3258T-75-34</td><td>FN3258T-75-34</td></tr>
<tr><td>FRN0040E3□-2G</td><td>-</td><td>-</td><td rowspan="3">FN3258T-100-35</td><td>FN3258T-75-34</td></tr>
<tr><td>FRN0056E3□-2G</td><td>-</td><td>-</td><td rowspan="2">FN3258T-100-35</td></tr>
<tr><td>FRN0069E3□-2G</td><td>-</td><td>-</td></tr>
<tr><td>FRN0088E3□-2G</td><td>-</td><td>-</td><td>EFL-22SP-2 (*1)</td><td rowspan="2">EFL-22SP-2 (*1)</td></tr>
<tr><td>FRN0115E3□-2G</td><td>-</td><td>-</td><td>FS5536-180-40</td></tr>
<tr><td rowspan="12">Three-phase 400 V</td><td>FRN0002E3□-4G</td><td rowspan="5">B84243A8017W221</td><td rowspan="5">B84243A8017W221</td><td rowspan="5">B84243A8017W221</td><td rowspan="5">B84243A8017W221</td></tr>
<tr><td>FRN0004E3□-4G</td></tr>
<tr><td>FRN0006E3□-4G</td></tr>
<tr><td>FRN0007E3□-4G</td></tr>
<tr><td>FRN0012E3□-4G</td></tr>
<tr><td>FRN0022E3□-4G</td><td rowspan="2">FS21312-44-07</td><td>FS21559-24-07-1</td><td>FS21559-24-07-1</td><td rowspan="2">FS21559-24-07-1</td></tr>
<tr><td>FRN0029E3□-4G</td><td rowspan="2">FS21312-44-07</td><td rowspan="2">FS21312-44-07</td></tr>
<tr><td>FRN0037E3□-4G</td><td rowspan="2">FS5536-72-07</td><td rowspan="2">FS21312-44-07</td></tr>
<tr><td>FRN0044E3□-4G</td><td rowspan="2">FS5536-72-07</td><td rowspan="2">FS5536-72-07</td></tr>
<tr><td>FRN0059E3□-4G</td><td>FS21312-78-07</td><td rowspan="2">FS5536-72-07</td></tr>
<tr><td>FRN0072E3□-4G</td><td>FS5536-100-35 (*1)</td><td>FS21312-78-07</td><td>FS21312-78-07</td></tr>
<tr><td rowspan="6">Single-phase 200 V</td><td>FRN0001E3□-7G</td><td>-</td><td>-</td><td rowspan="3">FS34916-10-07</td><td rowspan="4">FS34916-10-07</td></tr>
<tr><td>FRN0002E3□-7G</td><td>-</td><td>-</td></tr>
<tr><td>FRN0004E3□-7G</td><td>-</td><td>-</td></tr>
<tr><td>FRN0006E3□-7G</td><td>-</td><td>-</td><td>FS34916-17-07</td></tr>
<tr><td>FRN0010E3□-7G</td><td>-</td><td>-</td><td>FS34916-25-07</td><td>FS34916-17-07</td></tr>
<tr><td>FRN0012E3□-7G</td><td>-</td><td>-</td><td>FN2410-60-34</td><td>FS34916-25-07</td></tr>
</table>

*1) If a ferrite core (ACL-40C or ACL-74C) is added for input power wires and grounding wire (1 turns), conforms category C2 for radiated emission of IEC61800-3.

Note: A box (□) in the above table replaces S (Basic type) or N (Ethernet built-in type) depending on the enclosure.

■ Recommended installation method

To make the machinery or equipment fully compliant with the EMC Directive, certified technicians should install and wire the motor and inverter in strict accordance with the procedure described below.

EMC-compliant filter (option) installation method

1) Mount the inverter and the filter on a grounded panel or metal plate. Use shielded wires for the motor cable and route the cable as short as possible. Firmly clamp the shields to the metal plate to ground them. Furthermore, connect shields and motor grounding terminals electrically. Use a wiring guide, etc., and try as best as possible to keep input wires and output wires separate from one another.
2) For connection to inverter's control terminals and for connection of the RS-485 communication signal cable, use shielded wires. As with the motor connections, clamp the shields firmly to a grounded panel.
3) If noise from the inverter exceeds the permissible level, enclose the inverter and its peripherals within a metal panel as shown in Fig. F.1-1.

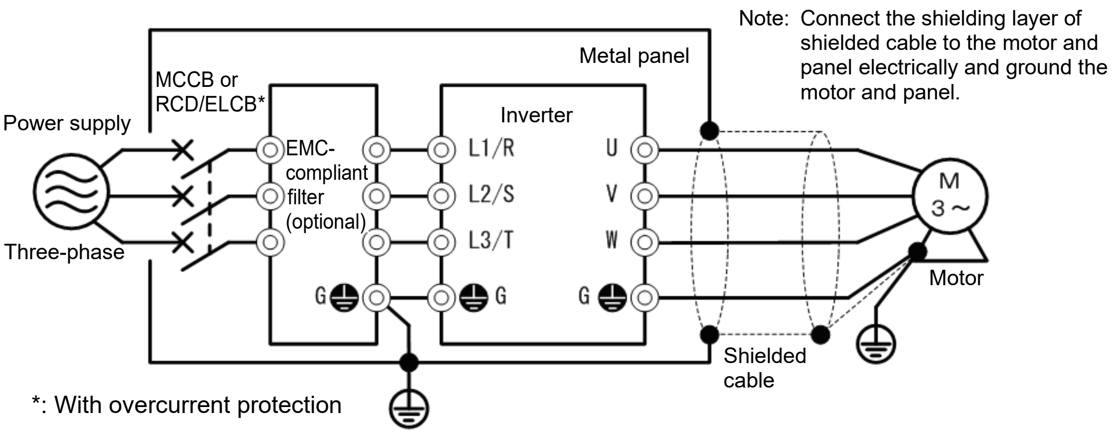


Fig. F.1-1 EMC-compliant filter (option) installation method

In case of EMC filter built-in type inverter

1) Mount the inverter on a grounded panel or metal plate. Use shielded wires for the motor cable and route the cable as short as possible. Firmly clamp the shields to the metal plate to ground them. Further, connect the shielding layers electrically to the grounding terminal of the motor. Use a wiring guide, etc., and try as best as possible to keep input wires and output wires separate from one another.
2) For connection to inverter's control terminals and for connection of the RS-485 communication signal cable, use shielded wires. As with the motor connections, clamp the shields firmly to a grounded panel.
3) If noise from the inverter exceeds the permissible level, enclose the inverter and its peripherals within a metal panel as shown in Fig. F.1-2.

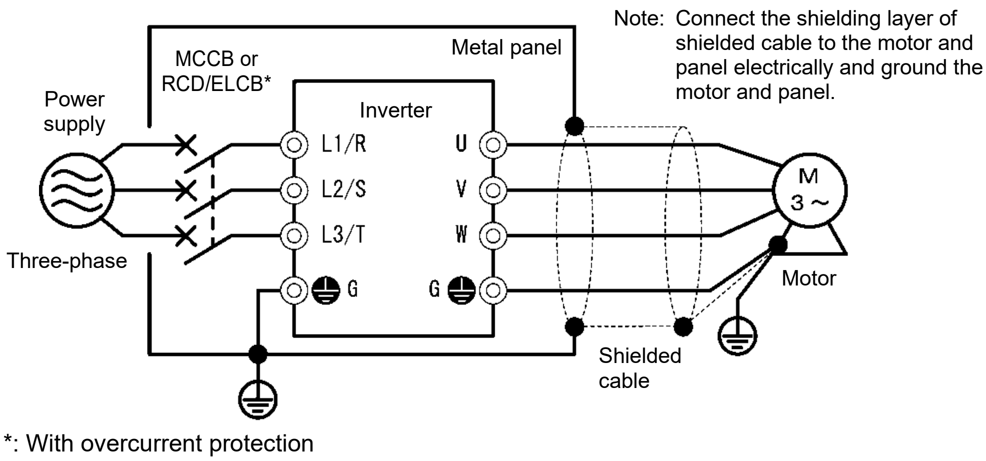


Fig. F.1-2 Installation method for built-in type EMC-compliant filter

For inverters with a capacity of FRN0059E3E-4 to FRN0072E3E-4 with carrier frequency above 8 kHz, add a core ACL-74C 2 turns at input cable

■ Leakage current of EMC-filter built-in type inverters

An EMC filter uses grounding capacitors for noise suppression. The use of grounding capacitors leads to an increase in leakage current, and therefore a check should be carried out to ensure that the power supply system has not been affected.

CAUTION

As the touch current (leakage current) of EMC filter built-in type inverters is relatively high, it is of essential importance to always assure a reliable connection to Protective Earth (PE). In Table F.1-3, for the inverter types whose leakage currents are equal to or exceed the critical value of 3.5 mA AC or 10 mA DC (IEC 61800-5-1), the minimum cross-sectional area of the PE-conductor should be:

- 10 mm^2 (Cu-conductors)
- 16 mm^2 (Al-conductors)

Failure to observe this could result in electric shock.

Table F.1-3 Leakage Current of EMC Filter Built-in Type of Inverters

Power supply voltage	Inverter type	Leakage current (mA)
Three-phase 400V *1)	FRN0002E3E-4G	2.3
	FRN0004E3E-4G	
	FRN0006E3E-4G	5.5
	FRN0007E3E-4G	
	FRN0012E3E-4G	
	FRN0022E3E-4G	11.7
	FRN0029E3E-4G	
	FRN0037E3E-4G	22.3
	FRN0044E3E-4G	
	FRN0059E3E-4G	5
	FRN0072E3E-4G	

Power supply voltage	Inverter type	Leakage current (mA)
Single-phase 200V *2)	FRN0001E3E-7G	8.7
	FRN0002E3E-7G	
	FRN0003E3E-7G	
	FRN0005E3E-7G	
	FRN0008E3E-7G	7.8
	FRN0011E3E-7G	

*1) Calculated based on these measuring conditions: 480 V/ 60 Hz, neutral grounding in Y-connection, interphase voltage unbalance ratio 2%.

*2) Calculated based on these measuring conditions: 240 V/ 60 Hz.

F.1.2 Compliance with European Low Voltage Directive

General-purpose inverters are subject to compliance with the European Low Voltage Directive. The CE marking on inverters represents a self-declaration that the product complies with the Low Voltage Directive.

■ Note

If using as a European Low Voltage Directive-compatible product, compatibility with Low Voltage Directive 2014/35/EU is achieved by installing the product as follows.

Compliance with European standards

Adjustable speed electrical power drive systems.

Part 5-1: Safety requirements. Electrical, thermal and energy EN61800-5-1

Compliance with European Low Voltage Directive

⚠WARNING⚠

1. Always ground the grounding terminal [⊕G], and do not attempt to provide electric shock protection simply with an earth leakage circuit breaker* (RCD (Residual-current-operated protective) or ELCB (Earth Leakage Circuit Breaker).
   *With overcurrent protection function
2. This offers protection against the risk of high voltage or accidents that may result in inverter damage, and therefore a fuse of the specifications indicated in the following table must be installed on the power supply side.
   •Breaking capacity of 10 kA or higher, rated voltage of 500 V or lower

<table>
<tr><th>Power system</th><th>Standard applicable motor (kW)</th><th>Inverter type</th><th>Specification</th><th>Fuse rating (A)</th></tr>
<tr><td rowspan="26">Three-phase 200 V</td><td>0.1</td><td rowspan="2">FRN0001E3□-2G</td><td>HHD</td><td rowspan="2">50(IEC 60269-4)</td></tr>
<tr><td rowspan="2">0.2</td><td>HND</td></tr>
<tr><td rowspan="2">FRN0002E3□-2G</td><td>HHD</td><td rowspan="2">50(IEC 60269-4)</td></tr>
<tr><td rowspan="2">0.4</td><td>HND</td></tr>
<tr><td rowspan="2">FRN0004E3□-2G</td><td>HHD</td><td rowspan="2">50(IEC 60269-4)</td></tr>
<tr><td rowspan="2">0.75</td><td>HND</td></tr>
<tr><td rowspan="2">FRN0006E3□-2G</td><td>HHD</td><td rowspan="2">50(IEC 60269-4)</td></tr>
<tr><td>1.1</td><td>HND</td></tr>
<tr><td>1.5</td><td rowspan="2">FRN0010E3□-2G</td><td>HHD</td><td rowspan="2">80(IEC 60269-4)</td></tr>
<tr><td rowspan="2">2.2</td><td>HND</td></tr>
<tr><td rowspan="2">FRN0012E3□-2G</td><td>HHD</td><td rowspan="2">125(IEC 60269-4)</td></tr>
<tr><td>3.0</td><td>HND</td></tr>
<tr><td>3.7</td><td rowspan="2">FRN0020E3□-2G</td><td>HHD</td><td rowspan="2">125(IEC 60269-4)</td></tr>
<tr><td rowspan="2">5.5</td><td>HND</td></tr>
<tr><td rowspan="2">FRN0030E3□-2G</td><td>HHD</td><td rowspan="2">160(IEC 60269-4)</td></tr>
<tr><td rowspan="2">7.5</td><td>HND</td></tr>
<tr><td rowspan="2">FRN0040E3□-2G</td><td>HHD</td><td rowspan="2">200(IEC 60269-4)</td></tr>
<tr><td rowspan="2">11</td><td>HND</td></tr>
<tr><td rowspan="2">FRN0056E3□-2G</td><td>HHD</td><td rowspan="2">200(IEC 60269-4)</td></tr>
<tr><td rowspan="2">15</td><td>HND</td></tr>
<tr><td rowspan="2">FRN0069E3□-2G</td><td>HHD</td><td rowspan="2">250(IEC 60269-4)</td></tr>
<tr><td rowspan="2">18.5</td><td>HND</td></tr>
<tr><td rowspan="2">FRN0088E3□-2G</td><td>HHD</td><td rowspan="2">250(IEC 60269-4)</td></tr>
<tr><td rowspan="2">22</td><td>HND</td></tr>
<tr><td rowspan="2">FRN0115E3□-2G</td><td>HHD</td><td rowspan="2">315(IEC 60269-4)</td></tr>
<tr><td>30</td><td>HND</td></tr>
</table>

Note) The □ in the inverter type is replaced by a letter of the alphabet (S, N) indicating the type.

(cont.)

APPENDIX

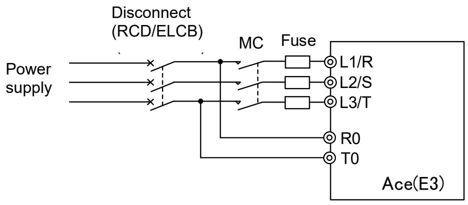
Compliance with European Low Voltage Directive (cont'd)

⚠WARNING⚠

Power system	Standard applicable motor (kW)	Inverter type	Specification	Fuse rating (A)
Three-phase 400 V	0.4	FRN0002E3□-4G	HHD	50(IEC 60269-4)
	0.75		HND	
			HD	
			ND	
		FRN0004E3□-4G	HHD	50(IEC 60269-4)
	1.1		HND	
			HD	
	1.5		ND	
		FRN0006E3□-4G	HHD	50(IEC 60269-4)
	2.2		HND	
			HD	
			ND	
		FRN0007E3□-4G	HHD	63(IEC 60269-4)
	3.0		HND	
			HD	
			ND	
	3.7	FRN0012E3□-4G	HHD	63(IEC 60269-4)
	5.5		HND	
			HD	
			ND	
		FRN0022E3□-4G	HHD	100(IEC 60269-4)
	7.5		HND	
			HD	
		FRN0029E3□-4G	HHD	125(IEC 60269-4)
	11	FRN0022E3□-4G	ND	100(IEC 60269-4)
		FRN0029E3□-4G	HND	125(IEC 60269-4)
			HD	
		FRN0037E3□-4G	HHD	125(IEC 60269-4)
	15	FRN0029E3□-4G	ND	125(IEC 60269-4)
		FRN0037E3□-4G	HND	160(IEC 60269-4)
			HD	
		FRN0044E3□-4G	HHD	160(IEC 60269-4)
	18.5	FRN0037E3□-4G	ND	125(IEC 60269-4)
		FRN0044E3□-4G	HND	160(IEC 60269-4)
			HD	
		FRN0059E3□-4G	HHD	160(IEC 60269-4)
	22	FRN0044E3□-4G	ND	160(IEC 60269-4)
		FRN0059E3□-4G	HND	160(IEC 60269-4) 160(IEC 60269-4)
			HD	
		FRN0072E3□-4G	HHD	200(IEC 60269-4)
	30	FRN0059E3□-4G	ND	160(IEC 60269-4)
		FRN0072E3□-4G	HND	200(IEC 60269-4)
			HD	
	37		ND	
Single-phase 200 V	0.1	FRN0001E3□-7G	HHD	50(IEC 60269-4)
	0.2	FRN0001E3■-7G	HND	
		FRN0002E3□-7G	HHD	50(IEC 60269-4)
	0.4	FRN0002E3■-7G	HND	
		FRN0004E3■-7G FRN0003E3E-7G	HHD	50(IEC 60269-4)
	0.55	FRN0004E3■-7G	HND	
	0.75	FRN0006E3■-7G FRN0005E3E-7G	HHD	80(IEC 60269-4)
	1.1	FRN0006E3■-7G	HND	
	1.5	FRN0010E3□-7G FRN0008E3E-7G	HHD	125(IEC 60269-4)
	2.2	FRN0010E3■-7G	HND	
		FRN0012E3■-7G FRN0011E3E-7G	HHD	125(IEC 60269-4)
	3.0	FRN0012E3■-7G	HND	

⚠WARNING⚠

Note) The ☐ in the inverter type is replaced by a letter of the alphabet (S, E, N) indicating the type.
Note) The ■ in the inverter type is replaced by a letter of the alphabet (S, N) indicating the type.



3. When used with the inverter, a molded case circuit breaker (MCCB), residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) or magnetic contactor (MC) should conform to the EN or IEC standards.
4. When you use a residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) for protection from electric shock in direct or indirect contact power lines or nodes, be sure to install type B of RCD/ELCB on the input (primary) of the inverter.

Power system	Standard applicable motors	Inverter type	Specification	Molded case circuit breaker (MCCB) *1		Residual-current-operated device/earth leakage circuit breaker (RCD / ELCB) *1			
				Rated current		Rated current		Sensitivity current *2	Maximum fault loop impedance
				With DC reactor	Without DC reactor	With DC reactor	Without DC reactor		
Three-phase 200 V	0.1	FRN0001E3☐-2G	HHD	5	5	5	5	30mA	200Ω
	0.2		HND						
		FRN0002E3☐-2G	HHD						
	0.4		HND						
		FRN0004E3☐-2G	HHD						
	0.75		HND		10		10		
		FRN0006E3☐-2G	HHD						
	1.1		HND	10		10			
	1.5	FRN0010E3☐-2G	HHD		15		15		
	2.2		HND		20		20		
		FRN0012E3☐-2G	HHD						
	3.0		HND	20	30	20	30		
	3.7	FRN0020E3☐-2G	HHD						
	5.5		HND	30	40	30	40		
		FRN0030E3☐-2G	HHD		50		50		
	7.5		HND	40	75	40	75		
		FRN0040E3☐-2G	HHD						
	11		HND	50.	100	50	100		
		FRN0056E3☐-2G	HHD						
	15		HND	75	125	75	125		
		FRN0069E3☐-2G	HHD						
	18.5		HND	100	150	100	150		
		FRN0088E3☐-2G	HHD						
	22		HND		175		175		
		FRN0115E3☐-2G	HHD						
	30		HND	150	200	150	200		

Note) The ☐ in the inverter type is replaced by a letter of the alphabet (S, N) indicating the type.
*1 The frame size and model of the MCCB or RCD/ELCB (with overcurrent protection) will vary, depending on the power transformer capacity. Refer to the related technical documentation for details.
*2 Sensitivity current settings in the TT-system vary by country, so follow the instructions of the authorities.

(cont.)

Compliance with European Low Voltage Directive (cont'd)

⚠WARNING⚠

Power system	Standard applicable motors	Inverter type	Specification	Molded case circuit breaker (MCCB) *1 Rated current: With DC reactor	MCCB *1 Rated current: Without DC reactor	Residual-current-operated device/earth leakage circuit breaker (RCD / ELCB) *1 Rated current: With DC reactor	RCD / ELCB *1 Rated current: Without DC reactor	Sensitivity current *2	Maximum fault loop impedance
Three-phase 400 V	0.4	FRN0002E3□-4G	HHD	5	5	5	5	30mA	20Ω
	0.75		HND						
			HD						
			ND						
		FRN0004E3□-4G	HHD						
	1.1		HND						
			HD						
	1.5		ND						
		FRN0006E3□-4G	HHD		10		10		
	2.2		HND						
			HD						
			ND						
		FRN0007E3□-4G	HHD	10	15	10	15		
	3.0		HND						
			HD						
			ND						
	3.7	FRN0012E3□-4G	HHD		20		20		
	5.5		HND	15	30	15	30		
			HD						
			ND						
		FRN0022E3□-4G	HHD						
	7.5		HND	20	40	20	40		
			HD						
		FRN0029E3□-4G	HHD						
	11	FRN0022E3□-4G	ND	30	50	30	50		
		FRN0029E3□-4G	HND						
			HD						
		FRN0037E3□-4G	HHD						
	15	FRN0029E3□-4G	ND	40	60	40	60	100mA	
		FRN0037E3□-4G	HND						
			HD						
		FRN0044E3□-4G	HHD						
	18.5	FRN0037E3□-4G	ND	40	75	40	75		
		FRN0044E3□-4G	HND						
			HD						
		FRN0059E3□-4G	HHD						
	22	FRN0044E3□-4G	ND	50	100	50	100		
		FRN0059E3□-4G	HND						
			HD						
		FRN0072E3□-4G	HHD						
	30	FRN0059E3□-4G	ND	75	125	75	125		
		FRN0072E3□-4G	HND						
			HD						
	37		ND	100		100			
Single-phase 200 V	0.1	FRN0001E3□-7G	HHD	5	5	5	5	30mA	200Ω
	0.2	FRN0001E3■-7G	HND						
		FRN0002E3□-7G	HHD						
	0.4	FRN0002E3■-7G	HND		10		10		
		FRN0004E3■-7G FRN0003E3E-7G	HHD						
	0.55	FRN0004E3■-7G	HND	10		10			
	0.75	FRN0006E3■-7G FRN0005E3E-7G	HHD		15		15		
	1.1	FRN0006E3■-7G	HND	15	20	15	20		
	1.5	FRN0010E3■-7G FRN0008E3E-7G	HHD						
	2.2	FRN0010E3■-7G	HND	30	30	30	30		
		FRN0012E3■-7G FRN0011E3E-7G	HHD	20		20			
	3.0	FRN0012E3■-7G	HND	30	40	30	40		

⚠WARNING⚠

Note) The ☐ in the inverter type is replaced by a letter of the alphabet (S, E, N) indicating the type.
Note) The ■ in the inverter type is replaced by a letter of the alphabet (S, N) indicating the type.
*1 The frame size and model of the MCCB or RCD/ELCB (with overcurrent protection) will vary, depending on the power transformer capacity. Refer to the related technical documentation for details.
*2 Sensitivity current settings in the TT-system vary by country, so follow the instructions of the authorities.

5. The inverter should be used in an environment that does not exceed Pollution Degree 2 requirements. If the environment has a Pollution Degree of 3 or 4, install the inverter in an enclosure of IP54 or higher.
6. Install the inverter, AC or DC reactor, input or output filter in an enclosure with a minimum degree of protection of IP2X, to prevent the human body from directly touching live parts of the equipment. The top surface of the enclosure shall be minimum IP4X if it can be easily touched.
7. Do not connect any copper wire directly to grounding terminals. Use crimp terminals with tin or equivalent plating to connect them.
8. When you use an inverter at an altitude of more than 2000 m, you should apply basic insulation for the control circuits of the inverter. The inverter cannot be used at altitudes of more than 3000 m.
9. Use the wiring shown in IEC60364-5-52.

Power system	Standard applicable motors	Inverter type	Specification	Recommended wire size (mm^2)								
				Main terminal							Control circuit	Control power auxiliary supply R0, T0
				Main power supply input [L1/R, L2/S, L3/T]		Grounding for inverter [⏚] *2		Inverter output [U, V, W] *1	DC reactor connection [P1, P(+)] *1	Braking resistor connection [P(+), DB] *1		
				With DC reactor	Without DC reactor	With DC reactor	Without DC reactor					
Three-phase 200 V	0.1	FRN0001E3☐-2G	HHD	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.75	–
	0.2		HND	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.75	–
	0.2	FRN0002E3☐-2G	HHD	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.75	–
	0.4		HND	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.75	–
	0.4	FRN0004E3☐-2G	HHD	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.75	–
	0.75		HND	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.75	–
	0.75	FRN0006E3☐-2G	HHD	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.75	–
	1.1		HND	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.75	–
	1.5	FRN0010E3☐-2G	HHD	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.75	–
	2.2		HND	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.75	–
	2.2	FRN0012E3☐-2G	HHD	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.75	–
	3.7		HND	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.75	–
	3.7	FRN0020E3☐-2G	HHD	2.5	4	2.5	4	2.5	2.5	2.5	0.75	–
	5.5		HND	2.5	6	2.5	6	2.5	4	2.5	0.75	–
	5.5	FRN0030E3☐-2G	HHD	4	6	4	6	4	4	2.5	0.75	–
	7.5		HND	6	10	6	10	6	10	2.5	0.75	–
	7.5	FRN0040E3☐-2G	HHD	6	10	6	10	6	10	2.5	0.75	–
	11		HND	10	16	10	16	10	16	2.5	0.75	–
	11	FRN0056E3☐-2G	HHD	10	16	10	16	10	16	2.5	0.75	–
	15		HND	16	25	16	16	16	25	2.5	0.75	–
	15	FRN0069E3☐-2G	HHD	16	25	16	16	16	25	2.5	0.75	–
	18.5		HND	25	35	16	16	25	35	2.5	0.75	–
	18.5	FRN0088E3☐-2G	HHD	25	35	16	16	25	35	2.5	0.75	2.5
	22		HND	35	50	16	25	35	35	2.5	0.75	2.5
	22	FRN0115E3☐-2G	HHD	35	50	16	25	35	35	2.5	0.75	2.5
	30		HND	50	70	25	35	50	70	2.5	0.75	2.5

Note) The ☐ in the inverter type is replaced by a letter of the alphabet (S, N) indicating the type.
*1 The recommended wire sizes for the main circuit terminals are shown for an ambient temperature of 40°C (104°F) using 70°C (158°F), 600 V PVC wire.
*2 Only one wire with a recommended size can be connected to a ground terminal.

(cont.)

APPENDIX

Compliance with European Low Voltage Directive (cont'd)

⚠WARNING⚠

Power system	Standard applicable motors	Inverter type	Specification	Recommended wire size (mm^2)								
				Main terminal *1							Control circuit	Control power auxiliary supply
				Main power supply input [L1/R, L2/S, L3/T]		Grounding for inverter [⏚] *2		Inverter output [U, V, W]	DC reactor connection [P1, P(+)]	Braking resistor connection [P(+), DB]		
				With DC reactor	Without DC reactor	With DC reactor	Without DC reactor					
Three-phase 400 V	0.4	FRN0002E3□-4G	HHD	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.75	–
	0.75		HND/HD/ND									
		FRN0004E3□-4G	HHD									
	1.1		HND/HD									
	1.5		ND									
		FRN0006E3□-4G	HHD									
	2.2		HND/HD/ND									
		FRN0007E3□-4G	HHD									
	3.0		HND/HD/ND									
	3.7	FRN0012E3□-4G	HHD									
	5.5		HND/HD/ND									
		FRN0022E3□-4G	HHD									
	7.5		HND/HD		4		4					
	11		ND	4	6	4	6	4	4			
	7.5	FRN0029E3□-4G	HHD	2.5	4	2.5	4	2.5	2.5			
	11		HND/HD	4	6	4	6	4	4			
	15		ND	6	10	6	10	6	10			
		FRN0029E3E-4G			6		6					
	11	FRN0037E3□-4G	HHD	4		4		4	4			
	15		HND/HD	6	10	6	10	6	10			
	18.5		ND	10	16	10	16	10				
		FRN0037E3E-4G			10		10					
	15	FRN0044E3□-4G	HHD	6	10	6	10	6				
	18.5		HND/HD	10	16	10	16	10				
		FRN0044E3E-4G			10		10					
	22	FRN0044E3□-4G	ND		16		16		16			
		FRN0044E3E-4G										
	18.5	FRN0059E3□-4G	HHD						10			2.5
	22		HND/HD						16			
	30		ND	16	25	16	16	16	25			
	22	FRN0072E3□-4G	HHD	10	16	10	16	10	16			
	30		HND/HD	16	25	16	16	16	25			
	37		ND	25	35	25	16	25				
Single-phase 200 V	0.1	FRN0001E3□-7G	HHD	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.75	-
	0.2	FRN0001E3■-7G	HND									
		FRN0002E3□-7G	HHD									
	0.4	FRN0002E3■-7G	HND									
		FRN0004E3□-7G FRN0003E3E-7G	HHD									
	0.55	FRN0004E3■-7G	HND									
	0.75	FRN0006E3□-7G FRN0005E3E-7G	HHD									
	1.1	FRN0006E3■-7G	HND									
	1.5	FRN0010E3□-7G FRN0008E3E-7G	HHD									
	2.2	FRN0010E3■-7G	HND		4		4		4			
		FRN0012E3□-7G FRN0011E3E-7G	HHD									
	3	FRN0012E3■-7G	HND	4		4			6			

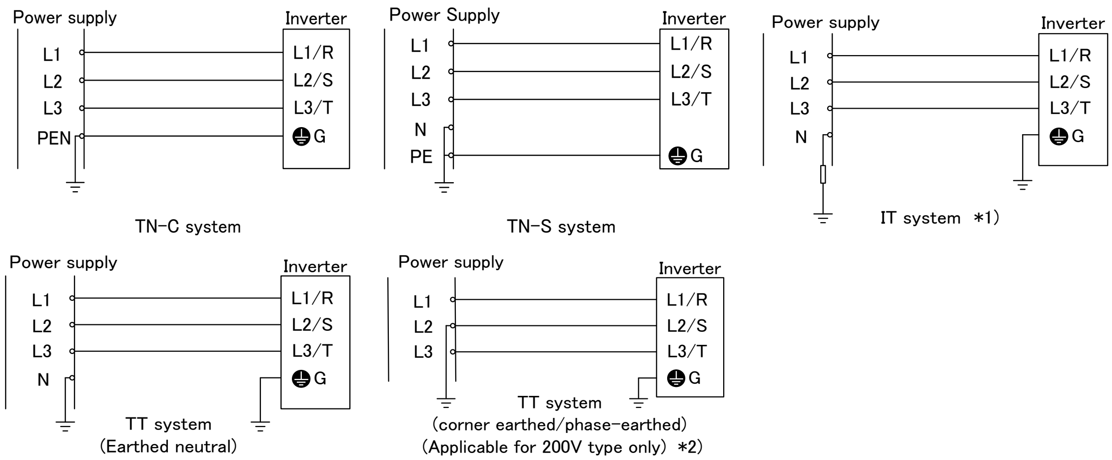
Note) The □ in the inverter type is replaced by a letter of the alphabet (S, E, N) indicating the type.
Note) The ■ in the inverter type is replaced by a letter of the alphabet (S, N) indicating the type.
*1 The recommended wire sizes for the main circuit terminals are shown for an ambient temperature of 40°C (104°F) using 70°C (158°F), 600 V PVC wire.

⚠WARNING⚠

*2 Only one wire with a recommended size can be connected to a ground terminal.
The wire size in parentheses indicates the ground wire.

10. An IEC61800-5-1 5.2.3.6.3 Short-circuit Current Test has been carried out on this inverter under the following conditions.
    Current when shorted: 10,000 A
    240 V or less (200V series)
    480 V or less (400V series)

11. Use this inverter with the following power supply systems.



*1 Use this inverter with the following IT systems.

<table>
<tr><td>Non-earthed (isolated from earth) IT system</td><td rowspan="2">Can be used.
In this case the insulation between the control interface and the main circuit of the inverter is basic insulation.
Thus, do not connect SELV circuit from external controller directly.
(Make connection using supplementary insulation.)
Use an earth fault detector able to disconnect the power within 5s after the earth fault occurs.</td></tr>
<tr><td>IT system which earthed neutral by an impedance</td></tr>
<tr><td>Corner earthed / Phase-earthed IT system by an impedance</td><td>Cannot be used.</td></tr>
</table>

*2 Cannot apply to Corner earthed / Phase-earthed TT system of 400V type

12. Motor overload protection (electronic thermal overload relay) is provided in each model. Use function codes F10 to F12 to set the protection level.

(Finished)

■ Compatibility with revised EMC and Low Voltage Directives

In the revised EMC Directive (2014/30/EU) and Low Voltage Directive (2014/35/EU), it is necessary to clearly state the name and the address of manufacturers and importers to enhance traceability. Importers shall be indicated as follows when exporting products from Fuji Electric to Europe.

(Manufacturer)
Fuji Electric Co., Ltd.
5520, Minami Tamagaki-cho, Suzuka-city, Mie 513-8633, Japan

(Importer in Europe)
Fuji Electric Europe GmbH
Goethering 58, 63067 Offenbach / Main, Germany

<Precaution when exporting to Europe>

● Not all Fuji Electric products in Europe are necessarily imported by the above importer. If any Fuji Electric products are exported to Europe via another importer, please ensure that the importer is clearly stated by the customer.

F.2 Harmonic component regulations in EU

F.2.1 General comments

When you use general-purpose industrial inverters in the EU, the harmonics emitted from the inverter to power lines are strictly regulated as stated below.

If an inverter whose rated input is 1 kW or less is connected to a public low-voltage power supply, it is regulated by the harmonics emission regulations from inverters to power lines (with the exception of industrial low-voltage power lines). (For details, refer to Fig. F.2-1.)

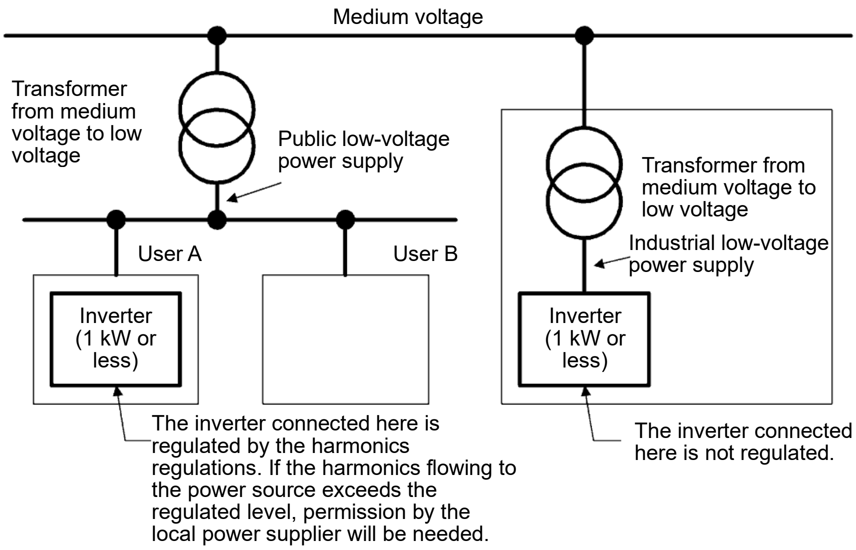


Fig. F.2-1 Power supply system

F.2.2 Compliance with harmonic component regulations

Table F.2-1 Compliance with harmonic component regulations

Power supply voltage	Inverter type	Applicable motor [kW]	ND/HD/HND/HHD	w/o DCR	w/ DCR	Applicable DC reactor type
Three-phase 200 V	FRN0001E3□-2G	0.1	HHD	Y *1	Y *1	DCR2-0.2D
		0.2	HND	Y *1	Y *1	DCR2-0.2D
	FRN0002E3□-2G	0.2	HHD	Y *1	Y *1	DCR2-0.2D
		0.4	HND	Y *1	Y *1	DCR2-0.4D
	FRN0004E3□-2G	0.4	HHD	Y *1	Y *1	DCR2-0.4D
		0.75	HND	Y *1	Y *1	DCR2-0.75D
	FRN0006E3□-2G	0.75	HHD	Y *1	Y *1	DCR2-0.75D
Three-phase 400 V	FRN0002E3□-4G	0.4	HHD	x	Y	DCR4-0.4D
		0.75	HND/HD/ND	x	Y	DCR4-0.75D
	FRN0004E3□-4G	0.75	HHD	x	Y	DCR4-0.75D
Single-phase 200 V(*1)	FRN0001E3□-7G	0.1	HHD	x	x	DCR2-0.2D
		0.2	HND	x	x	DCR2-0.4D
	FRN0002E3□-7G	0.2	HHD	x	x	DCR2-0.4D
		0.4	HND	x	x	DCR2-0.75D
	FRN0004E3△-7G FRN0003E3E-7G	0.4	HHD	x	x	DCR2-0.75D
		0.55	HND	x	x	DCR2-0.75D
	FRN0006E3△-7G FRN0005E3E-7G	0.75	HHD	x	x	DCR2-1.5D

Note 1) Evaluated by the level of harmonics flow to the 400 VAC line when three-phase 200 VAC power is supplied from the three-phase 400 VAC power supply via a step-down transformer.

Note 2) A box (☐) in the above table replaces S (Basic type) or N (Ethernet type) or E (EMC filter built-in type) depending on the enclosure.

A box (△) in the above table replaces S (Basic type) or N (Ethernet type) depending on the enclosure.

*1 FRN_____E3E-7G is only HHD specification.

F.3 Compliance with UL standards and Canadian standards (cUL certification)

F.3.1 General comments

UL standards (Underwriters Laboratories Inc. standards) are North American safety standards used to prevent fire and other such accidents, and offer protection to users, service technicians, and the general public.

cUL indicates that products which comply with CSA standards are certified by UL. cUL certified products are as valid as those certified as complying with CSA standards.

F.3.2 UL standards and Canadian standards (cUL certification) compatibility

Compatibility with UL standards (UL61800-5-1) and Canadian standards (cUL certification C22.2 No.274-17) is ensured by installing inverters with UL/cUL marking in accordance with the items in the following table.

UL standards and Canadian standards (cUL certification) compatibility

⚠WARNING⚠
High available fault current – damage warning: The opening of the branch-circuit protective device may be an indication that a fault current has been interrupted. To reduce the risk of fire or electric shock, current-carrying parts and other components of the controller should be examined and replaced if damaged. If burnout of the current element of an overload relay occurs, the complete overload relay must be replaced.

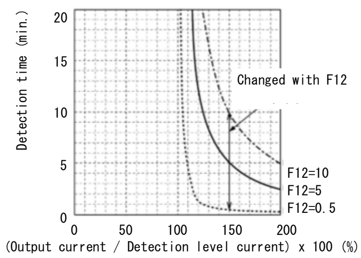
(cont.)

UL standards and Canadian standards (cUL certification) compatibility (cont'd)

⚠CAUTION

1. Motor overload protection (electronic thermal overload relay) is provided in each model.
   Use function codes F10 to F12 to set the protection level, referring to the descriptions below.

F10	Electronic thermal overload protection for motor 1 (Select motor characteristics)
	1: Enable (For a general-purpose motor with self-cooling fan) 2: Enable (For an inverter-driven motor with separately powered cooling fan)
F11	(Overload detection level)
	0.00 (disable), current value of 1 to 135% of inverter rated current (Inverter rated current dependent on F80)
F12	(Thermal time constant)
	0.5 to 75.0 min, Refer to the graph below.



2. Use Cu wire only.

3. Use R/C Appliance Wiring Material (AVLV2/8), rated min. 105˚C/600V for control circuit if the control circuit wiring can touch to the main circuit part.

4. Short circuit current rating

   200 volts class models are suitable for use on a circuit of delivering not more than 100,000 rms symmetrical amperes, 240 volts maximum when protected by appropriate protection device (refer to the below tables of 9.) having the short circuit current rating (SCCR) not less than 100,000 rms symmetrical amperes, 240 volts maximum.

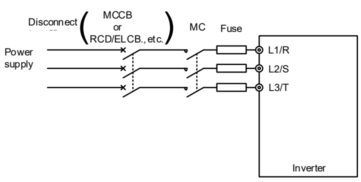
   400 volts class models are suitable for use on a circuit of delivering not more than 100,000 rms symmetrical amperes, 480 volts maximum when protected by appropriate protection device (refer to the below tables of 9.) having the short circuit current rating (SCCR) not less than 100,000 rms symmetrical amperes, 480 volts maximum.

   If the branch circuit devices with less than the short circuit current rating 100,000 A is used, the short circuit current rating will be limited to the short circuit current rating of the protection device.

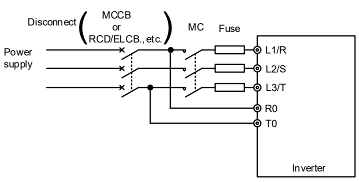
   Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code and any additional local codes.

5. Field wiring connections must be made by a UL Listed and CSA Certified closed-loop terminal connector sized for the wire gauge involved. Connector must be fixed using the crimp tool specified by the connector manufacturer.

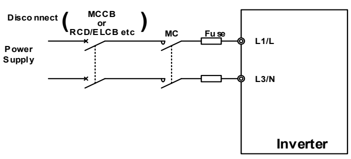
6. All circuits with terminals [L1/R], [L2/S], [L3/T], [L1/L], [L2/N], [R0], [T0] must have a common disconnect and be connected to the same pole of the disconnect if the terminals are connected to the power supply.



FRN0069E3☐-2 or below
FRN0044E3☐-4 or below



FRN0088E3☐-2 or above
FRN0059E3☐-4 or above



Connection diagram of the single-phase input type.

(cont.)

UL standards and Canadian standards (cUL certification) compatibility (cont'd)

⚠CAUTION

7. Environmental Requirements

The table below applies to FRN△△△E3□ -○G.

(△ indicates inverter capacity, □: Indicates type* ○: Indicates the series 2, 4, or 7.)

*□ : S, N, or E ■ : S or N

Type	Open type HHD °C (°F)	Open type HND °C (°F)	Enclosed type HHD °C (°F)	Enclosed type HND °C (°F)
FRN0001E3■-2G	50 (122)	50 (122)	40 (104)	40 (104)
FRN0002E3■-2G	50 (122)	50 (122)	40 (104)	40 (104)
FRN0004E3■-2G	50 (122)	50 (122)	40 (104)	40 (104)
FRN0006E3■-2G	50 (122)	50 (122)	40 (104)	40 (104)
FRN0010E3■-2G	50 (122)	50 (122)	40 (104)	40 (104)
FRN0012E3■-2G	50 (122)	40 (104)	40 (104)	30 (86)
FRN0020E3■-2G	50 (122)	40 (104)	40 (104)	30 (86)
FRN0030E3■-2G	50 (122)	50 (122)	40 (104)	40 (104)
FRN0040E3■-2G	50 (122)	50 (122)	40 (104)	40 (104)
FRN0056E3■-2G	50 (122)	50 (122)	40 (104)	40 (104)
FRN0069E3■-2G	50 (122)	50 (122)	40 (104)	40 (104)

Type	Open type HHD °C (°F)	Open type HND °C (°F)	Open type HD °C (°F)	Open type ND °C (°F)	Enclosed type* HHD °C (°F)	Enclosed type* HND °C (°F)	Enclosed type* HD °C (°F)	Enclosed type* ND °C (°F)
FRN0002E3□-4	50 (122)	50 (122)	40 (104)	40 (104)	40 (104)	40 (104)	30 (86)	30 (86)
FRN0004E3□-4	50 (122)	50 (122)	40 (104)	40 (104)	40 (104)	40 (104)	30 (86)	30 (86)
FRN0006E3□-4	50 (122)	50 (122)	40 (104)	40 (104)	40 (104)	40 (104)	30 (86)	30 (86)
FRN0007E3□-4	50 (122)	40 (104)	40 (104)	40 (104)	40 (104)	30 (86)	30 (86)	30 (86)
FRN0012E3□-4	50 (122)	40 (104)	40 (104)	40 (104)	40 (104)	30 (86)	30 (86)	30 (86)
FRN0022E3□-4	50 (122)	50 (122)	40 (104)	40 (104)	40 (104)	40 (104)	30 (86)	30 (86)
FRN0029E3□-4	50 (122)	50 (122)	40 (104)	40 (104)	40 (104)	40 (104)	30 (86)	30 (86)
FRN0037E3□-4	50 (122)	50 (122)	40 (104)	40 (104)	40 (104)	40 (104)	30 (86)	30 (86)
FRN0044E3□-4	50 (122)	50 (122)	40 (104)	40 (104)	40 (104)	40 (104)	30 (86)	30 (86)
FRN0059E3□-4	50 (122)	50 (122)	40 (104)	40 (104)	40 (104)	40 (104)	30 (86)	30 (86)
FRN0072E3□-4	50 (122)	50 (122)	40 (104)	40 (104)	40 (104)	40 (104)	30 (86)	30 (86)

Type	Open type HHD °C (°F)	Open type HND °C (°F)	Enclosed type HHD °C (°F)	Enclosed type HND °C (°F)	Type	Open type HHD °C (°F)	Open type HND °C (°F)	Enclosed type HHD °C (°F)	Enclosed type HND °C (°F)
FRN0001E3■-7G	50 (122)	50 (122)	40 (104)	40 (104)	FRN0006E3■-7	50 (122)	40 (104)	40 (104)	30 (86)
FRN0001E3E-7G	50 (122)	-	-	-	FRN0005E3E-7	50 (122)	-	-	-
FRN0002E3■-7G	50 (122)	50 (122)	40 (104)	40 (104)	FRN0010E3■-7	50 (122)	40 (104)	40 (104)	30 (86)
FRN0002E3E-7G	50 (122)	-	-	-	FRN0008E3E-7	50 (122)	-	-	-
FRN0004E3■-7G	50 (122)	40 (104)	40 (104)	30 (86)	FRN0012E3■-7	50 (122)	40 (104)	40 (104)	30 (86)
FRN0003E3E-7G	50 (122)	-	-	-	FRN0011E3E-7	50 (122)	-	-	-

・ Atmosphere: For use in pollution degree 2 environments. (for Open-type models)

* There is no Enclosed type for FRN△△△E3E-○.

8. Storage and Transport Environments

Item	Specifications	
Storage temperature	During transport: -25 to +70°C (-13 to +158°F)	Places not subjected to abrupt temperature changes or condensation or freezing
	During storage: -25 to +65°C (-13 to +153°F)	
Relative humidity	5 to 95% RH *1	
Atmosphere	The inverter must not be exposed to dust, direct sunlight, corrosive or flammable gases, oil mist, vapor, water drops or vibration. The atmosphere must contain only a low level of salt. (0.01 mg/cm² or less per year)	
Atmospheric pressure	86 to 106 kPa (during storage)	
	70 to 106 kPa (during transportation)	

*1 Even if the humidity is within the specified requirements, avoid such places where the inverter will be subjected to sudden changes in temperature that will cause condensation or freezing.

(cont.)

UL standards and Canadian standards (cUL certification) compatibility (cont'd)

⚠CAUTION

9. Install UL certified protection devices between the power supply and the inverter, referring to the table below.

Power supply voltage	Inverter type	HHD/HND mode	Short circuit current rating (SCCR) 100 kA			
			Semiconductor fuse Cat No.*1		Class CC,J,T,L fuse	Inverse time circuit breaker
			Manufacturer: Mersen	Manufacturer: Bussmann (Eaton)	Maximum Current (A)	Maximum Current (A)
Three-phase 200 V	FRN0001E3△-2G	HHD	PC30UD69V50■	170M3458	3	15
		HND				
	FRN0002E3△-2G	HHD	PC30UD69V50■	170M3458	6	15
		HND				
	FRN0004E3△-2G	HHD	PC30UD69V50■	170M3458	10	15
		HND				
	FRN0006E3△-2G	HHD	PC30UD69V50■	170M3460	15	15
		HND				
	FRN0010E3△-2G	HHD	PC30UD69V80■	170M3462	20	20
		HND				
	FRN0012E3△-2G	HHD	PC30UD69V125■	170M3462	30	30
		HND				
	FRN0020E3△-2G	HHD	PC30UD69V125■	170M3463	40	50
		HND			50	
	FRN0030E3△-2G	HHD	PC30UD69V160■	170M3464	60	80
		HND			80	
	FRN0040E3△-2G	HHD	PC30UD69V200■	170M3465	80	100
		HND			100	
	FRN0056E3△-2G	HHD	PC30UD69V200■	170M3465	100	125
		HND			150	
	FRN0069E3△-2G	HHD	PC30UD69V250■	170M3466	150	150
		HND			175	
	FRN0088E3△-2G	HHD	PC30UD69V250■	170M3466	175	175
		HND			200	
	FRN0115E3△-2G	HHD	PC30UD69V315■	170M3467	200	250
		HND			250	

(△: S, N.)

Note) ■ is replaced by a letter of the alphabet indicating the fuse type.

*1 The fuses listed are representative parts. Refer to the additional material "INR-SI47-2587□" for the alternative parts.

(cont.)

UL standards and Canadian standards (cUL certification) compatibility (cont'd)

⚠CAUTION

Power supply voltage	Inverter type	HHD/HND mode	Short circuit current rating (SCCR) 100kA			
			Semiconductor fuse Cat No.*1		Class CC,J,T,L fuse	Inverse time circuit breaker
			Manufacturer: Mersen	Manufacturer: Bussmann (Eaton)	Maximum Current (A)	Maximum Current (A)
Three-phase 400 V	FRN0002E3□-4G	HHD	PC30UD69V50■	170M3458	3	15
		HND/HD/ND			6	
	FRN0004E3□-4G	HHD	PC30UD69V50■	170M3458	6	15
		HND/HD/ND			10	
	FRN0006E3□-4G	HHD	PC30UD69V50■	170M3459	10	15
		HND/HD/ND			15	
	FRN0007E3□-4G	HHD	PC30UD69V63■	170M3460	15	20
		HND/HD/ND			20	
	FRN0012E3□-4G	HHD	PC30UD69V63■	170M3461	20	30
		HND/HD/ND			30	
	FRN0022E3□-4G	HHD	PC30UD69V100■	170M3462	30	50
		HND/HD			40	
		ND			60	
	FRN0029E3□-4G	HHD	PC30UD69V125■	170M3463	40	70
		HND/HD			60	
		ND			70	
	FRN0037E3□-4G	HHD	PC30UD69V125■	170M3464	60	80
		HND/HD			70	
		ND			90	
	FRN0044E3□-4G	HHD	PC30UD69V160■	170M3464	70	100
		HND/HD			90	
		ND			100	
	FRN0059E3□-4G	HHD	PC30UD69V160■	170M3464	90	125
		HND/HD			100	
		ND			125	
	FRN0072E3□-4G	HHD	PC30UD69V200■	170M3465	100	150
		HND/HD			125	
		ND			175	
Single-phase 200 V	FRN0001E3□-7G	HHD	PC30UD69V50■	170M3458	6	15
		HND			10	
	FRN0002E3□-7G	HHD	PC30UD69V50■	170M3458	6	15
		HND			10	
	FRN0004E3△-7G FRN0003E3E-7G	HHD	PC30UD69V50■	170M3459	10	15
	FRN0004E3△-7G	HND			15	
	FRN0006E3△-7G FRN0005E3E-7G	HHD	PC30UD69V80■	170M3462	20	30
	FRN0006E3△-7G	HND			30	
	FRN0010E3△-7G FRN0008E3E-7G	HHD	PC30UD69V125■	170M3463	30	40
	FRN0010E3△-7G	HND			40	
	FRN0012E3△-7G FRN0011E3E-7G	HHD	PC30UD69V125■	170M3463	50	40
	FRN0012E3△-7G	HND			60	

(□: S, E, N. △: S,N.)

Note) ■ is replaced by a letter of the alphabet indicating the fuse type.

*1 The fuses listed are representative parts. Refer to the additional material "INR-SI47-2587□" for the alternative parts.

(cont.)

UL standards and Canadian standards (cUL certification) compatibility (cont'd)

⚠CAUTION

10. Refer to the table below for field wiring.

Power supply voltage	Nominal applied motor	Inverter type	HHD/HND mode	Required torque lb-in (N・m): Main terminal	Required torque lb-in (N・m): Grounding for inverter	Required torque lb-in (N・m): Aux. control power supply	Wire size AWG (mm²): Main terminal Cu Wire [L1/R], [L2/S], [L3/T] 60°C Cu Wire	[L1/R], [L2/S], [L3/T] 75°C Cu Wire	[L1/R], [L2/S], [L3/T] Remarks	[U], [V], [W] 60°C Cu Wire	[U], [V], [W] 75°C Cu Wire	[U], [V], [W] Remarks	Grounding for inverter	Aux. control power supply
Three-phase 200 V	0.1	FRN0001E3□-2G	HHD	7.1 (0.8)	10.6 (1.2)	–	14 (2.1)	14 (2.1)	*3	14 (2.1)	14 (2.1)	*3	14 (2.1)	–
Three-phase 200 V	0.2	FRN0001E3□-2G	HND	7.1 (0.8)	10.6 (1.2)	–	14 (2.1)	14 (2.1)	*3	14 (2.1)	14 (2.1)	*3	14 (2.1)	–
Three-phase 200 V	0.2	FRN0002E3□-2G	HHD	7.1 (0.8)	10.6 (1.2)	–	14 (2.1)	14 (2.1)	*3	14 (2.1)	14 (2.1)	*3	14 (2.1)	–
Three-phase 200 V	0.4	FRN0002E3□-2G	HND	7.1 (0.8)	10.6 (1.2)	–	14 (2.1)	14 (2.1)	*3	14 (2.1)	14 (2.1)	*3	14 (2.1)	–
Three-phase 200 V	0.4	FRN0004E3□-2G	HHD	7.1 (0.8)	10.6 (1.2)	–	14 (2.1)	14 (2.1)	*3	14 (2.1)	14 (2.1)	*3	14 (2.1)	–
Three-phase 200 V	0.75	FRN0004E3□-2G	HND	7.1 (0.8)	10.6 (1.2)	–	14 (2.1)	14 (2.1)	*3	14 (2.1)	14 (2.1)	*3	14 (2.1)	–
Three-phase 200 V	0.75	FRN0006E3□-2G	HHD	7.1 (0.8)	10.6 (1.2)	–	14 (2.1)	14 (2.1)	*3	14 (2.1)	14 (2.1)	*3	14 (2.1)	–
Three-phase 200 V	1.1	FRN0006E3□-2G	HND	7.1 (0.8)	10.6 (1.2)	–	14 (2.1)	14 (2.1)	*3	14 (2.1)	14 (2.1)	*3	14 (2.1)	–
Three-phase 200 V	1.5	FRN0010E3□-2G	HHD	10.6 (1.2)	15.9 (1.8)	–	14 (2.1)	14 (2.1)	*3	14 (2.1)	14 (2.1)	*3	12 (3.3)	–
Three-phase 200 V	2.2	FRN0010E3□-2G	HND	10.6 (1.2)	15.9 (1.8)	–	14 (2.1)	14 (2.1)	*3	14 (2.1)	14 (2.1)	*3	10 (5.3)	–
Three-phase 200 V	2.2	FRN0012E3□-2G	HHD	10.6 (1.2)	15.9 (1.8)	–	14 (2.1)	14 (2.1)	*3	14 (2.1)	14 (2.1)	*3	10 (5.3)	–
Three-phase 200 V	3.0	FRN0012E3□-2G	HND	10.6 (1.2)	15.9 (1.8)	–	12 (3.3)	12 (3.3)	*3	14 (2.1)	14 (2.1)	*3	10 (5.3)	–
Three-phase 200 V	3.7	FRN0020E3□-2	HHD	10.6 (1.2)	15.9 (1.8)	–	10 (5.3)	10 (5.3)	*3	12 (3.3)	12 (3.3)	*3	10 (5.3)	–
Three-phase 200 V	5.5	FRN0020E3□-2	HND	10.6 (1.2)	15.9 (1.8)	–	10 (5.3)	10 (5.3)	*3	12 (3.3)	12 (3.3)	*3	10 (5.3)	–
Three-phase 200 V	5.5	FRN0030E3□-2G	HHD	27 (3.0)	27 (3.0)	–	8 (8.4)	8 (8.4)	*3	10 (5.3)	10 (5.3)	*3	8 (8.4)	–
Three-phase 200 V	7.5	FRN0030E3□-2G	HND	27 (3.0)	27 (3.0)	–	6 (13.3)	8 (8.4)	*3	10 (5.3)	10 (5.3)	*3	8 (8.4)	–
Three-phase 200 V	7.5	FRN0040E3□-2G	HHD	27 (3.0)	27 (3.0)	–	6 (13.3)	8 (8.4)	*3	8 (8.4)	8 (8.4)	*3	6 (13.3)	–
Three-phase 200 V	11	FRN0040E3□-2G	HND	27 (3.0)	27 (3.0)	–	–	6 (13.3)	*3	8 (8.4)	8 (8.4)	*3	6 (13.3)	–
Three-phase 200 V	11	FRN0056E3□-2G	HHD	51.3 (5.8)	51.3 (5.8)	–	4 (21.2)	6 (13.3)	*3	6 (13.3)	8 (8.4)	*3	6 (13.3)	–
Three-phase 200 V	15	FRN0056E3□-2G	HND	51.3 (5.8)	51.3 (5.8)	–	3 (26.7)	4 (21.2)	*3	4 (21.2)	6 (13.3)	*3	6 (13.3)	–
Three-phase 200 V	15	FRN0069E3□-2G	HHD	51.3 (5.8)	51.3 (5.8)	–	3 (26.7)	4 (21.2)	*3	4 (21.2)	6 (13.3)	*3	6 (13.3)	–
Three-phase 200 V	18.5	FRN0069E3□-2G	HND	51.3 (5.8)	51.3 (5.8)	–	1 (42.4)	3 (26.7)	*3	4 (21.2)	4 (21.2)	*3	6 (13.3)	–
Three-phase 200 V	18.5	FRN0088E3□-2G	HHD	51.3 (5.8)	51.3 (5.8)	10.6 (1.2)	1 (42.4)	3 (26.7)	*3	3 (26.7)	4 (21.2)	*3	6 (13.3)	14 (2.1) *1 *2
Three-phase 200 V	22	FRN0088E3□-2G	HND	51.3 (5.8)	51.3 (5.8)	10.6 (1.2)	–	2 (33.6)	*2 *3	2 (33.6)	3 (26.7)	*3	6 (13.3)	14 (2.1) *1 *2
Three-phase 200 V	22	FRN0115E3□-2G	HHD	51.3 (5.8)	51.3 (5.8)	10.6 (1.2)	–	2 (33.6)	*2 *3	2 (33.6)	3 (26.7)	*3	4 (21.2)	14 (2.1) *1 *2
Three-phase 200 V	30	FRN0115E3□-2G	HND	51.3 (5.8)	51.3 (5.8)	10.6 (1.2)	–	2/0 (67.4)	*2 *3	–	2 (33.6)	*2 *3	3 (33.6)	14 (2.1) *1 *2

(□: S, E, N.)

*1 No terminal end treatment is required for connection.
*2 Use 75 °C Cu wire only.
*3 The wire size of UL Open Type and Enclosed Type are common. Please contact us if UL Open Type exclusive wire is necessary.

(cont.)

UL standards and Canadian standards (cUL certification) compatibility (cont'd)

⚠CAUTION

Power supply voltage	Nominal applied motor	Inverter type	HHD/HND mode	Required torque lb-in (N・m)			Wire size AWG (mm²)							
							Main terminal Cu Wire							
							[L1/R], [L2/S], [L3/T]			[U], [V], [W]				
				Main terminal	Grounding for inverter	Aux. control power supply	60°C Cu Wire	75°C Cu Wire	Remarks	60°C Cu Wire	75°C Cu Wire	Remarks	Grounding for inverter	Aux. control power supply
Three-phase 400 V	0.4	FRN0002E3□-4G	HHD	10.6 (1.2)	15.9 (1.8)	–	14 (2.1)	14 (2.1)	*3	14 (2.1)	14 (2.1)	*3	14 (2.1)	–
	0.75		HND/HD/ND											
		FRN0004E3□-4G	HHD											
	1.1		HND/HD											
	1.5		ND											
		FRN0006E3□-4G	HHD										12 (3.3)	
	2.2		HND/HD/ND											
		FRN0007E3□-4G	HHD											
	3		HND/HD/ND											
	3.7	FRN0012E3□-4G	HHD										10 (5.3)	
	5.5		HND/HD/ND				12 (3.3)	12 (3.3)						
		FRN0022E3□-4G	HHD	27 (3.0)	27 (3.0)									
	7.5		HND/HD				10 (5.3)	10 (5.3)		12 (3.3)	12 (3.3)			
	11		ND				8 (8.4)	8 (8.4)		10 (5.3)	10 (5.3)		8 (8.4)	
	7.5	FRN0029E3□-4G	HHD											
	11		HND/HD											
	15		ND				6 (13.3)							
	11	FRN0037E3□-4G	HHD	51.3 (5.8)	51.3 (5.8)		8 (8.4)							
	15		HND/HD				6 (13.3)			8 (8.4)	8 (8.4)			
	18.5		ND					6 (13.3)		6 (13.3)	6 (13.3)			
	15	FRN0044E3□-4G	HHD					8 (8.4)		8 (8.4)	8 (8.4)			
	18.5		HND/HD					6 (13.3)		6 (13.3)				
	22		ND				4 (21.2)				6 (13.3)		6 (13.3)	
	18.5	FRN0059E3□-4G	HHD			10.6 (1.2)	6 (13.3)							14 (2.1) *1 *2
	22		HND/HD				4 (21.2)							
	30		ND				3 (26.7)	4 (21.2)		4 (21.2)				
	22	FRN0072E3□-4G	HHD				4 (21.2)	6 (13.3)		6 (13.3)				
	30		HND/HD				3 (26.7)	4 (21.2)		4 (21.2)				
	37		ND				2 (33.6)	3 (26.7)		3 (26.7)	4 (21.2)			
Single-phase 200 V	0.1	FRN0001E3△-7G FRN0001E3E-7G	HHD	7.1 (0.8)	10.6 (1.2)	–	14 (2.1)	14 (2.1)	*3	14 (2.1)	14 (2.1)	*3	14 (2.1)	–
	0.2	FRN0001E3△-7G	HND											
		FRN0002E3△-7G FRN0002E3E-7G	HHD											
	0.4	FRN0002E3◁-G7	HND											
		FRN0004E3△-7G FRN0003E3E-7G	HHD											
	0.55	FRN0004E3◁-7G	HND										12 (3.3)	
	0.75	FRN0006E3△-7G FRN0005E3E-7G	HHD										10 (5.3)	
	1.1	FRN0006E3◁-7G	HND											
	1.5	FRN0010E3◁-7G FRN0008E3E-7G	HHD	10.6 (1.2)	15.9 (1.8)		12 (3.3)	12 (3.3)						
	2.2	FRN0010E3◁-7G	HND											
		FRN0012E3◁-7G FRN0011E3E-7G	HHD				10 (5.3)	10 (5.3)						
	3	FRN0012E3◁-7G	HND											

(□: S, E, N.)

*1 No terminal end treatment is required for connection.
*2 Use 75 °C Cu wire only.
*3 The wire size of UL Open Type and Enclosed Type are common. Please contact us if UL Open Type exclusive wire is necessary.

(Finished)

F.4 Compliance with functional safety standards

F.4.1 General comments

With FRENIC-Ace Series, the motor coasts to a stop by turning OFF (opening) the connection between terminals [EN1] - [PLC] or [EN2] - [PLC]. This is a safe shutdown function (STO) of Cat. 0 (uncontrolled stop) specified in EN 60204-1 and complies with the functional safety standards.

When constructing a safety system, a safety shut-off device was required outside the inverter, but using Safe Torque Off (STO) eliminates the need for an external safety shut-off device.

Table F.4-1 Functional safety performance

EN ISO 13849-1		
	Category	3
	Performance level	e
	Average diagnostic coverage	Medium (DCavg)
	Response time	50 ms or less (Response time)
	Mean dangerous failure time for each channel	>62 years (MTTFd)
EN 61508-1 to -7 EN 61800-5-2		
	Safety function	Safe Torque Off (STO)
	Safety integrity level	SIL3
	Hardware fault tolerance	1 (HFT)
	Safe failure fraction	90 % or more (SFF)
	Average probability of failure of a hazardous function upon request for actuation	1.58E-05 (PFDavg)
	Mean frequency of hazardous failures [h^{-1}]	2.60E-09 (PFH)
	Mission time	10 years

WARNING

- Although the specified STO is used for IEC61800-5-2 for the output breaker-off function of this inverter, it does not completely shut off the power supply and the motor electrically. Therefore, depending on the application of the inverter, for the safety of the final user, for example, a mechanically locking brake and motor terminal protection to prevent electric shock are required.
- The output breaker-off function of this inverter does not completely shut off the power supply and the motor electrically. Therefore, turn off the power supply of the inverter securely and wait at least 5 minutes before wiring or maintenance work.
- For the PMSM (permanent magnet synchronous motor), voltage is generated at the terminal during coasting with the output shut-off function. Make sure that the PMSM is stopped securely before performing maintenance, inspection, and wiring.

Failure to observe this could result in electric shock.

Enable terminals, peripheral circuits and internal circuit configuration

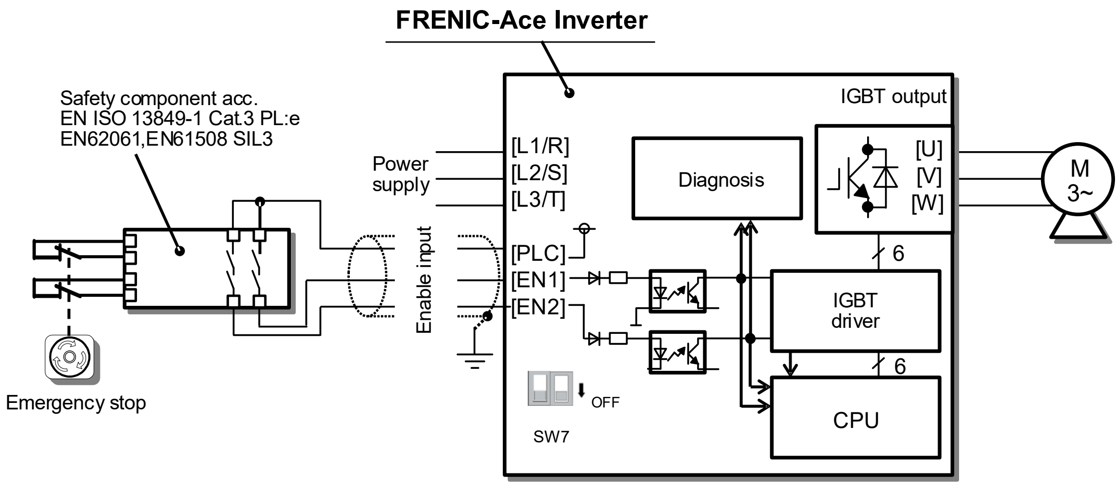


Fig. F.4-1 FRENIC-Ace

Note: When the terminals [EN1] and [EN2] are used as functional safety, turn OFF both SW9 switches on the control PCB.

Table F.4-2 Terminals [EN1], [EN2]-[PLC] and inverter status

Digital input signal		ECF alarm*	Inverter status	Remarks
[EN1]	[EN2]			
ON (short circuit)	ON (short circuit)	None	Completion of operation preparation	
		Yes	Output shutdown (STO)	Logical mismatch detection*
OFF (open circuit)	OFF (open circuit)	None	Output shutdown (STO)	
		Yes	Output shutdown (STO)	Logical mismatch detection*
ON (short circuit)	OFF (open circuit)	Yes	Output shutdown (STO)	Logical mismatch detection*
OFF (open circuit)	ON (short circuit)	Yes	Output shutdown (STO)	Logical mismatch detection*

* For details, refer to F.4.4

APPENDIX

F.4.2 Notes for compliance with functional safety standards

1) Safety requirements

All of the following requirements must be met in order to comply with functional safety.

1-1) Installation

- Turn off both SW9 switches on the control PCB.
- Install the inverter in a cabinet with a protective enclosure of IP54 or higher.
- Also comply with the European standards EN 61800-5-1 and EN 61800-3 for inverters or mechanical equipment.
- To ensure redundancy, wire the terminals [EN1] and [EN2] separately.
- For ON/OFF of terminals [EN1] and [EN2], use a safety component with EN ISO 13849-1 Cat.3 PL:e or higher.
- When using an external power supply, use a SELV power supply.

1-2) STO test

- Check that STO operates properly once every three months.

2) Notes for using STO

- When constructing a product safety system with STO, the machinery manufacturer is responsible for conducting a risk assessment of all machinery and equipment for the product safety system required by the machinery manufacturer, including other equipment, devices, and wires, as well as the external equipment and wires connected to the terminals [EN1] and [EN2], to ensure that all machinery and equipment conforms to that product safety system. Also, for preventive maintenance, be sure to perform periodic inspections to confirm that the product safety system operates properly.
- Input short pulses to terminal [EN1] and [EN2] for less than 1 ms when performing a diagnosis with the safety PLC.

  If a single fault is detected in the inverter, an alarm is output to the external device and the inverter coasts the motor to a stop even if the terminals [EN1] and [EN2] are ON. (The alarm outputting function is not guaranteed to be outputted with all single faults, but can be adapted to EN ISO 13849-1 Cat.3 PL:e.)
- The logical discrepancy due to the signal delay between the terminals [EN1] and [EN2] should be 50 ms or less. Outputs an ECF alarm when it exceeds 50 ms.

3) Wiring for terminal [EN1], [EN2]

- The terminals [EN1] and [EN2] are used to wire the safety circuitry. Since reliability is obtained by connecting each signal independently, be careful not to short-circuit the signal in the middle of wiring.

F.4.3 Inverter output status when STO is activated

A STO condition occurs in the inverter when terminals [EN1] and [EN2] are turned OFF.

Fig. F.4-2 shows the inverter output status when terminals [EN1] and [EN2] are turned OFF while the inverter is stopped.

The inverter ready status will be complete when the terminal [EN1] and [EN2] inputs turn ON.

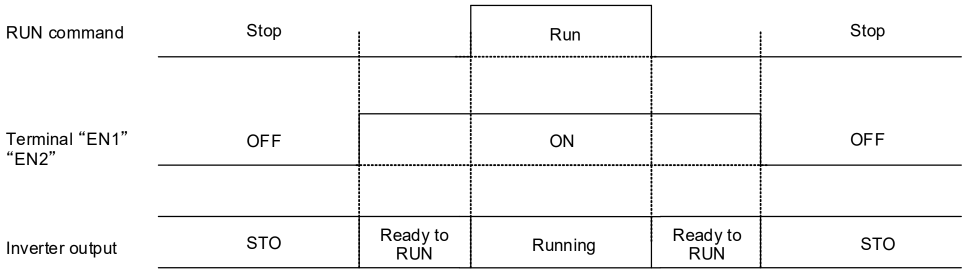


Fig. F.4-2 Inverter output status when terminals [EN1] and [EN2] are turned OFF while the inverter is stopped

Fig. F.4-3 shows the timing chart when terminals [EN1] and [EN2] are turned OFF while the inverter is running.

Input to terminals [EN1] and [EN2] turns OFF, the inverter enters the STO condition, and the motor coasts to a stop.

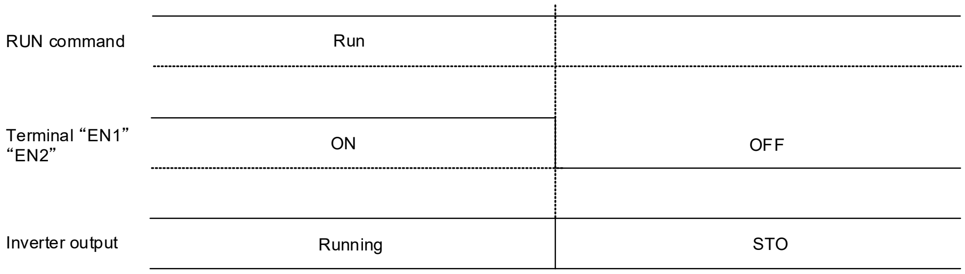


Fig. F.4-3 Inverter output status when terminals [EN1] and [EN2] are turned OFF during inverter operation

F.4.4 ECF alarm and inverter-output status

FRENIC-Ace monitors the logical discrepancy of the signal input to the terminals [EN1] and [EN2], and continuously diagnoses the failure of the safety circuit.

Fig. F.4-4 shows the timing chart for the ECF alarm following a terminal [EN1] or [EN2] input mismatch. A STO condition occurs in the inverter when terminals [EN1] and [EN2] are turned OFF. If the terminal [EN1] and [EN2] input mismatch lasts longer than 50 ms, the inverter will interpret that there is an abnormality with the safely system and output an ECF alarm.

To operate the EN terminal circuit correctly by operating the terminals [EN1] and [EN2], hold ON/OFF of [EN1] and [EN2] for 2 s or more. If they is not held for more than 2 s, an ECF alarm may occur.

In the event of an ECF alarm, it will be necessary to shut OFF the power supply or the alarm reset to cancel the safety status.

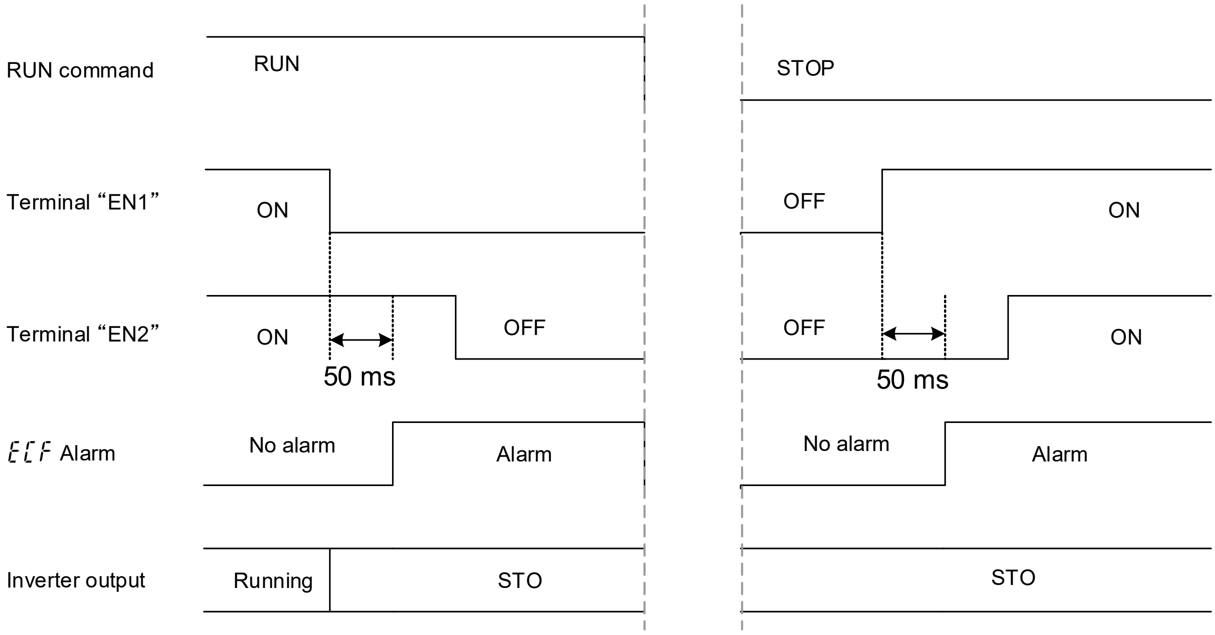


Fig. F.4-4 ECF alarm (logical mismatch) and inverter-output status

F.4.5 Precautions for releasing STO

If the terminals [EN1] and [EN2] are turned OFF during inverter operation, the inverter forcibly coasts to a stop.

After that, if [EN1] and [EN2] are turned ON with the operation command being input, the inverter restarts the output. Be careful when resetting the safety components. (Fig. F.4-5)

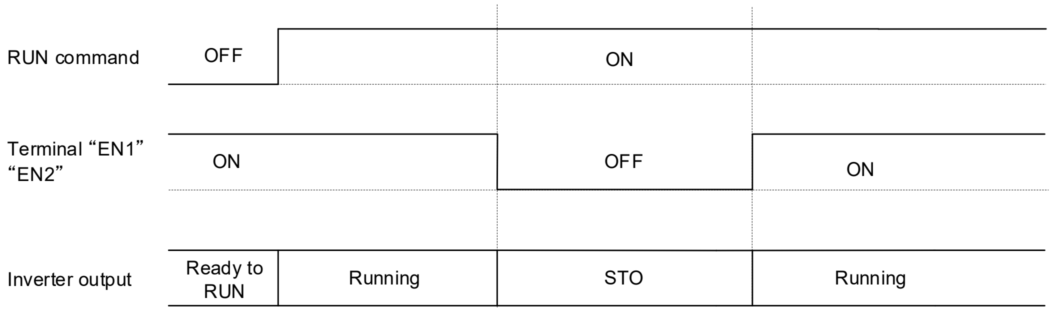


Fig. F.4-5 When STO is released

F.5 Compliance with the Radio Waves Act (South Korea)

한국 전파법 대응

사용자안내문

이 기기는 업무용 환경에서 사용할 목적으로 적합성평가를 받은 기기로서 가정 외의 지역에서 사용하는 것을 목적으로 하며 대상 형식은 다음과 같습니다.

FRN△△△E3S-□G, FRN△△△E3N-□G, FRN△△△E3E-□G

(△는 인버터용량, □는 전압시리즈를 표시하는 숫자 2 또는 4또는 7가 표기됩니다.)

(규격 표시 가 없는 제품은 적합 대상에서 제외됩니다.)

Compliance with the Radio Waves Act (South Korea)

User guidance

This product has undergone a conformity assessment for the purpose of use in a work environment, and is intended for use in areas outside the home.

The following types of the product are applicable to this certification.

Type: FRN△△△E3S-□G, FRN△△△E3N-□G, FRN△△△E3E-□G

(△: is filled with inverter output power and □: is also for what power supply voltage 2 or 4 or 7 is.)

(Products without standard indication are not applicable.)

Applicant: Fuji Electric Korea
Equipment Name: Inverter
Country of Origin: Described on the nameplate
Date of Manufacture: Described on the nameplate
Manufacturer: Fuji Electric Co., Ltd.

Appendix G Inverter Replacement Precautions (When Using PWM Converter (RHC Series))

If using the RHC series and replacing the following inverters, it is necessary to change the connection method for the inverter control power auxiliary input terminals (R0, T0). The replaced inverter may not function normally if the connection method is not changed. Be sure to change the connection method.

G.1 Applicable inverters

Table G.1-1

Applicable inverter (before change)	Replacement inverter (after change)
<FRENIC5000G11S series> • FRN30G11S-2, FRN30P11S-2 inverter or higher • FRN30G11S-4, FRN30P11S-4 inverter or higher <FRENIC-VG7S series> • FRN18.5VG7S-2, FRN18.5VG7S-4 inverter or higher	FRENIC-Ace series (FRENIC-MEGA series) (FRENIC-VG series) (FRENIC-Eco series) (FRENIC-Lift series)

G.2 Changing the connection method (inverter control power auxiliary input terminals (R0, T0))

(1) RHC series: if using ■ RHC7.5-2C to RHC90-2C, ■ RHC7.5-4C to RHC220-4C

Applicable inverter (before change) connection diagram

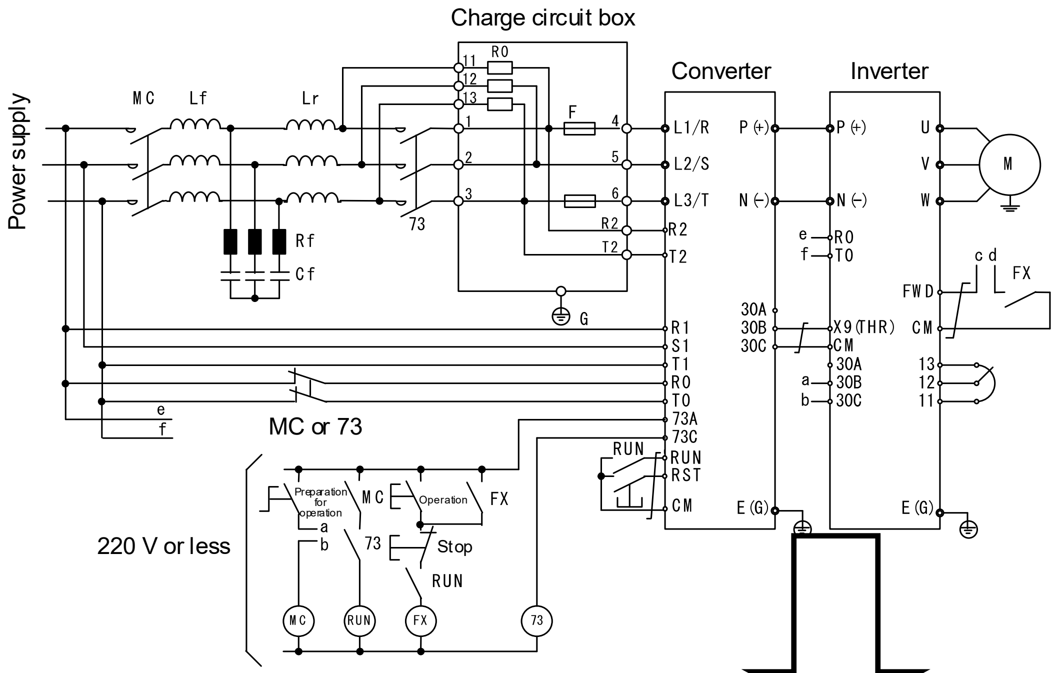


Fig. G.2-1

Replacement inverter (after change) connection diagram

Change the connections of the [dashed box] sections.

1) Inverter control power auxiliary input terminals (R0, T0)
   Be sure to connect to the main power supply via contact b on the power supply circuit electromagnetic contactor (73 or MC).
2) Fan power auxiliary input terminals (R1, T1) * Only on models equipped with R1, T1 terminals
   Be sure to connect to the main power supply without going via contact b on the power supply circuit electromagnetic contactor (73 or MC).

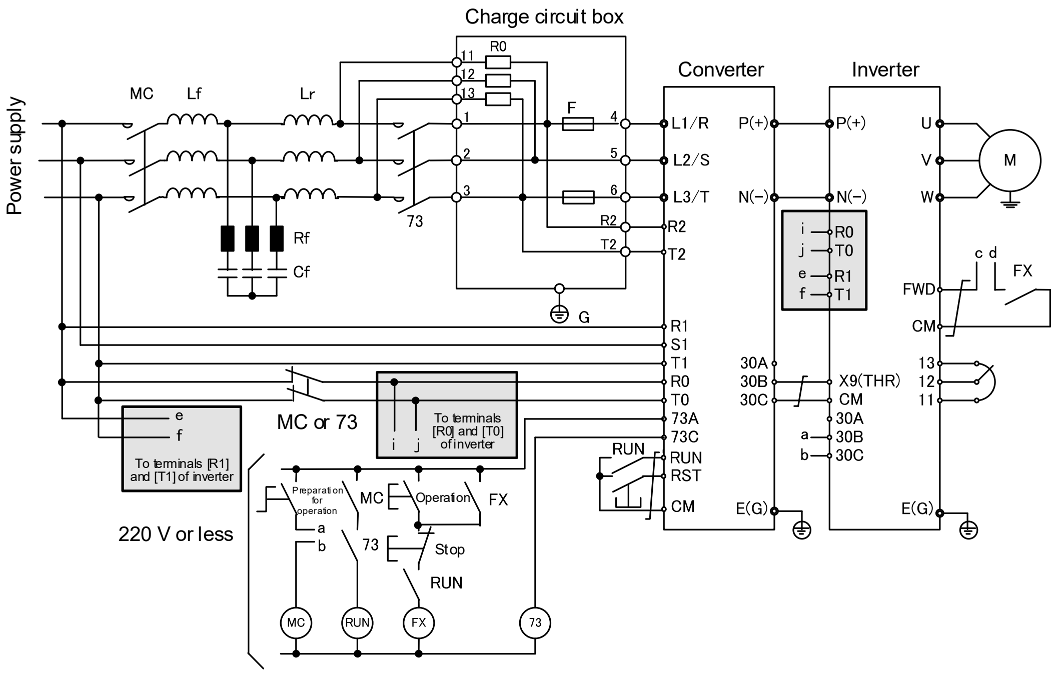


Fig. G.2-2

(2) RHC series: If using when ■ RHC280-4C to RHC630-4C, ■ RHC400-4C VT specifications apply
If using ■ RHC500B to RHC800B-4C

Applicable inverter (before change) connection diagram

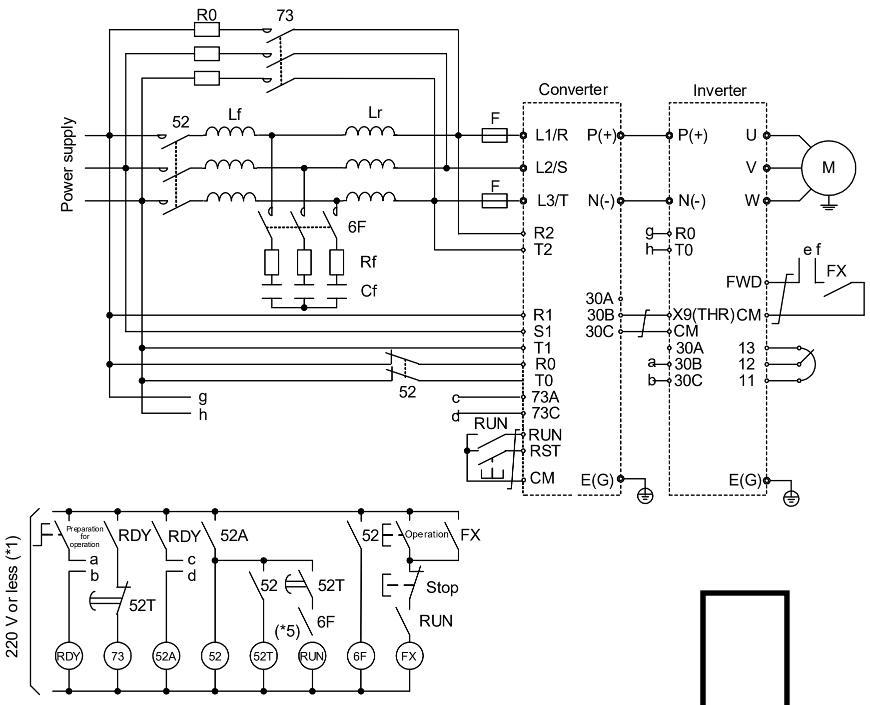


Fig. G.2-3

Replacement inverter (after change) connection diagram

Change the connections of the [dashed box] sections.

1) Inverter control power auxiliary input terminals (R0, T0)
Be sure to connect to the main power supply via contact b on the power supply circuit electromagnetic contactor (52).
2) Fan power auxiliary input terminals (R1, T1) * Only on models equipped with R1, T1 terminals
Be sure to connect to the main power supply without going via contact b on the power supply circuit electromagnetic contactor (73 or 52).

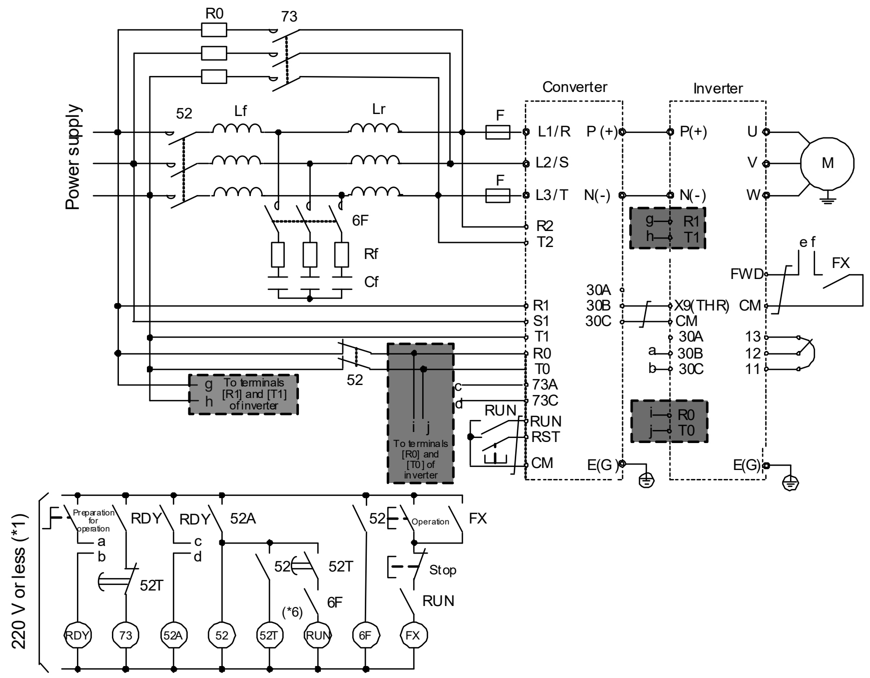


Fig. G.2-4

High-Performance Standard Inverter

FRENIC-Ace (E3) Series

User's Manual

First Edition December 2023
Second Edition January 2025

Fuji Electric Co., Ltd.

Fuji Electric Co., Ltd.

Gate City Ohsaki, East Tower, 11-2, Osaki 1-chome, Shinagawa-ku, Tokyo, 141-0032, Japan
Phone: +81 3 5435 7058　　Fax: +81 3 5435 7420
URL　www.fujielectric.com/

2025-01（A25a/L23）MS 00 FOLS