INSTRUCTION MANUAL

SINGLE-PHASE APR-D TYPE

RPDE2020－□　RPDE2060－□
RPDE2045－□　RPDE2100－□

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Note: Please make sure that this instruction manual will be handed over to the final user who is responsible for the maintenance of this instrument.

Fuji Electric Co., Ltd.　　INR－MK31058fE

Safety design of equipment (request)

Please take the following into consideration in designing and manufacturing equipment using the AC power regulator (hereafter called APR).

1. Scope of application of product

The APR described in this manual is designed as a general-purpose product for general industry. The application of APR is off the subject in the following usage. The nuclear power, the aerospace, the medical treatment, a traffic equipment, the passenger car, and systems of special application that may considerably affect the human life and property.

2. Failure of product

The APR uses electronic parts that center on the semiconductor for a main circuit and the control circuit. These electronic parts break down at a certain probability. Please do the safe designs of a redundant design, fire spread preventive design, erratic operation preventive design, etc. where an accident resulting in injury or death, a fire accident, and social damage, etc. are not caused as a result of the breakdown of the device that uses APR.

3. Malfunctions of main circuit semiconductors

Thyristors are used in the main circuit of the instrument. As their failure, a short-circuit may rarely occur. Although some models of the series have a function of detecting the said failure, safety design must be respected as in 2 above so that any malfunction will not entail serious damages.

About the latest information

If system designing including the APR is in progress based on the contents of our general APR brochure, general D&C brochure, and related technical documents, we recommend you to obtain the latest information from our website at the following URL.

If maintenance is to be performed for the first time in a long time since the purchase of this instrument, various pieces of information is also available at the website.

http://www.fujielectric.co.jp/technica/products/ac-power-regulators/index.html

https://felib.fujielectric.co.jp/download/index.htm
Search word : RPDE

"Attention in the use"

At the time of factory shipment, APR-D becomes "the automatic setting". When you use APR-D on the following condition, please change "setting" of APR-D. But make APR-D "factory shipment" as much as possible about other function codes.

1. When you use a manual setter (Input/ control terminal "4 C (3) - 5 V (2) - M0 (1)" are used), change function code 6o.06 (Selection of auto/ manual terminal function) to "n-m_".

2. When you use a setting indicator (Aod) , change function code 6o.06 (Selection of auto/ manual terminal function) to " r-Am". APR-D outputs by setting function code 1b.01 (Digital manual setting) as 0-100%.

INTRODUCTION

Thank you very much for purchasing Fuji's single-phase APR-D. Please be sure to read this manual carefully to ensure safety in handling the instrument, maintain intended functions and performance of the instrument, and operate the instrument properly.

This instrument should be handled (installed, wired, operated, and maintained/inspected) only by experts who have sufficient knowledge on this instrument.

1. SAFETY PRECAUTIONS

Be sure to read this instruction manual carefully before performing installation, wiring, operation, and maintenance/inspection.
Operate the instrument properly after obtaining knowledge on the devices, information on safety, and all the other precautions on this instrument.
This instruction manual classifies the level of safety precautions into "**WARNING**" and "**CAUTION**."

Warning sign	Meaning
⚠ WARNING	Improper handling may result in dangerous situations involving death or serious injury.
⚠ CAUTION	Improper handling may result in dangerous situations involving medium or minor injury or property damage.

Even notes of CAUTIONS may involve a serious accident depending on situations. You must follow all of them because they contain very important information.

Application

⚠ WARNING
• This instrument is not intended for use on devices or systems involving human lives. If you intend to use the instrument for special applications such as nuclear power control, aviation and space applications, medical treatment, or traffic control and their systems, contact our sales representative. If you use the instrument for a system that may, if fails, expose human lives to danger or cause considerable loss, be sure to install a safety device. **····· A fire or accident may result.**

Installation

⚠ WARNING

- Install the instrument to an incombustible object such as metal.
- Do not install the instrument near combustible objects.
  ⋯⋯⋯ A fire may result.

⚠ CAUTION

- Do not transport the instrument by holding the plastic cover.
  ⋯⋯⋯ The instrument may fall, thus resulting in injury.
- Prevent foreign matter such as lint, paper, wood chips, and scrap metal from entering the APR. After the installation, check that objects such as screws and tools are not left within the instrument.
  ⋯⋯⋯ A fire or accident may result.
- Install the instrument in the orientation shown by the dimensional outline drawing.
- Install the instrument in a place that satisfies the environmental conditions for installation (temperature, humidity, dust, installation gap, vibration, etc.).
- Do not transport or install the instrument with the screws and the cover kept removed to prevent deformation or break.
- Install the instrument in a place that endures the weight of the instrument, using specified screws and at specified torque.
- Do not install or operate the APR that has damaged or missing parts.
- Install the instrument within a panel that is not accessible to people.
  ⋯⋯⋯ A fire, accident, or injury may result.
- Do not step on the package of the instrument.
  ⋯⋯⋯ Injury may result.

Wiring

⚠ WARNING

- Wiring should be performed by qualified wiring experts.
- Before carrying out wiring, check that the power for the main circuit and the control power are turned off.
- Be sure to install this instrument first and then carry out wiring.
  ⋯⋯⋯ Electric shock or injury may result.
- To ensure safety, be sure to earthing the instrument to the earthing terminal.
- Install the APR main unit first, and then carry out wiring and fasten the screws of the main circuit. Check that the screws are fastened securely.
- Use the power wire and load wire that satisfy the operating conditions.
- Connect the instrument to the main circuit power supply and control power supply via a circuit breaker for circuit protection and a ground fault interrupter.
  ⋯⋯⋯ Electric shock or fire may result.

⚠ CAUTION

- Check that the rated input voltage of the product and the power supply voltage coincide.
- Pay attention not to reverse the input and output terminals.
- Check carefully that the wiring of the control circuit has been carried out properly.
- Fasten screws at the designated torque.
- The APR and wires generate electrical noise, thus causing sensors and other devices installed nearby to malfunction. To prevent this, take appropriate measures against electrical noise.
  ⋯⋯⋯ A fire, accident or injury may result.

Operation

⚠ WARNING

- Check the installation and wiring carefully for improper wiring and poor connections.
- Be sure to mount the cover of the terminal block first, and then set the power to ON. Do not remove the cover in energized state.
- Do not operate switches with wet hand. Do not splash liquid such as water over the instrument.
- If an alarm is issued, or any abnormality such as emission of abnormal odor is found, turn off the input power, and then perform inspection. If the alarm or abnormal state recurs and the cause cannot be found, be sure to contact your dealer and never leave the problem unsolved.
- Do not touch the APR terminals while energized even if the instrument is suspended.
  (When function code 6o.04 (Selection of standby state) are **on** (Standby state), they may be all LED putting out lights.)
  ⋯⋯⋯ Electric shock or fire may result.
- If function code data setting is made improperly, or it is made without understanding the contents of the instruction manual, voltage exceeding permissible value of the load may be output.
  ⋯⋯⋯ An accident may result.

⚠ CAUTION

- Do not touch the heat sink because it becomes hot.
  ⋯⋯⋯ Injury or burns may result.

Maintenance and inspection

⚠ WARNING

- Before performing inspections, turn off the power and wait for 5 minutes or longer. Check using a tester that there is no electric potential between the main circuit terminals L1 and U, and power supply terminals L and N. Before performing inspections, check the voltage between terminals as well as a terminal and the earthing with a tester, taking the entry of voltage from the output side into consideration.
- Do not perform maintenance and inspection or replace parts unless you are authorized to do so.
  ⋯⋯⋯ Electric shock or injury may result.
- Clean the cooling fin after it checks.

Disposal

⚠ CAUTION

- Dispose of the APR-D as an industrial waste.

Others

⚠ WARNING

- Never modify the instrument.
  ⋯⋯⋯ Electric shock or injury may result.

General precautions

The illustrations in this instruction manual may show the state of the instrument with the cover or safety shield removed in order to show details clearly. Before operating the instrument, be sure to mount the cover and protective shield back to the original position, and operate it according to the descriptions of the instruction manual.

Measures against harmonics

All of the APRs (auxiliary power regulator) of any type (in the case of phase control system) used by specific customers are subject to “the guideline for measures against harmonics to be taken by customers that receive high voltage or special high voltage power.” Such customers must calculate equivalent capacity and harmonic leakage current, and if the calculated value exceeds the limit specified by the contract, they must take appropriate measures.

See “JEAG 9702-2018 Technical guideline of measures against harmonics” for details.

Reference: Japan Electric Association

Conformance to RoHS directive

The RoHS directive is a regulation on toxic substances. The directive regulates the use of toxic substances for electric and electronic devices. The substances contained in such devices regulated by the directive are the following ten: lead (Pb), cadmium (Cd), hexavalent chromium (Cr6+), mercury (Hg), polybrominated biphenyls (PBBs), polybrominated diphenyl ethers (PBDEs), Di-2-ethylhexyl phthalate(DEHPs), Butyl benzyl phthalate(BBPs), Dibutyl phthalate(DBP) and Diisobutyl Phthalate (DIBP). This APR conforms to the RoHS directive.

Conformance to European standard

The APR-D conforms to the European standard directive on condition that it is installed according to the following descriptions.

⚠ CAUTION

[1] Conforming directives are RoHS directive (2011/65/EU+(EU) 2015/863), low voltage directive (2012/A11:2014 (EN62477-1)) and EMC directive (2014/30/EU (IEC60947-4-3:2014)).

[2] This product bears the CE mark on condition that it satisfies specific conditions. Since various other devices are used for mechanical equipment in addition to our product, the machine manufacturer should arrange so the product satisfies specific conditions.

[3] Install the APR under the conditions of overvoltage category Ⅱ and pollution degree of 2 or clearer specified by EN62477-1. To use it in the degree of contamination of 2 or clearer, install the instrument within a control panel that does not allow water, oil, carbon, and dust to come in (IP54 or higher).

[4] For the 400V system power supply, use a TN or TT power distribution system with the neutral point grounded.

[5] Only authorized persons (experts) should operate the control panel.

[6] The enclosure of the control panel should be opened or closed with a key or using a tool. Or ensure that the power can be turned on only when the enclosure is closed.

[7] Be sure to ground the earthing terminal of the APR, and do not attempt to protect operators from electric shock only with a ground fault interrupter. Use a crimp contact plated with tin or an equivalent material for the earthing lead, and performs single wiring with a wire of the size larger than that of the main circuit. (Do not install two or more wires together.)

[8] To protect the instrument from short circuit and overload, use a circuit breaker for circuit protection, ground fault interrupter, or electromagnetic contactor (conforming to the EN or IEC standard) on the input side of the main circuit and that of the control power.

[9] Use a wire of diameter and wire type specified in the attachment C of EN60204 for the main circuit terminal of the APR.

[10] Connect the measures parts such as input EMI filter to the exterior of the input side of the main circuit power and the control power of the APR (or the primary side of the operating transformer) to maintain the specifications of the entire instrument within the limit specified by EN61000-6-4 and EN61000-6-2. (On condition that the instrument is not used in a residential, commercial, or light industrial environment.) The following are the major precautions in handling the filter.

- Use a filter of the specifications higher than the phase, rated voltage, and rated current of the APR, and that has damping property falling within the several 100 kHz to several MHz range.
- Use a filter for each of the APR, if two or more APRs are to be used.
- To improve the earthing resistance between the filter and the panel, peel off the coating around the mounting hole to expose the metal surface, thus ensuring sufficient contact between the metal surface and the mounting surface of the filter.
- Connect the input power to the input terminal (IN) of the filter, and the earthing terminal to the earthing stud. Then connect the output terminal (OUT) of the filter to the main power of the APR and the control power input, using as short wire as possible.
- Do not allow the input and output wire to come close to each other.

[11] If the control circuit terminal is to be placed around a high-voltage live part such as a main circuit terminal, add a tube, or use double-insulated wire.

[12] Use crimp contacts with insolated coating for wiring to the “L(R1), N(T1)” terminals of the control circuit.

[13] If a variable resistor is to be mounted externally for manual setting or gradient setting, take appropriate measures against rotation of the main unit of the resistor.

2. CHECKING THE PRODUCT

Check the following before installing the instrument.

(1) Is the delivered instrument of specifications you ordered? Are all the accessories supplied?
(Check the type, voltage, current, outside dimensions, and accessories specified, if any.)

(2) Is the instrument damaged due to an accident during transportation?
If you notice anything wrong, contact your dealer or our sales representative nearest to you.

(3) A rating plate is attached to the main unit at the position in Fig.2-2. Check that the delivered item is the one you ordered.

1-Phase AC Power Regulator
Type RPDE 2020-T
Rating SOURCE 100-240V 50/60Hz
INPUT 100-240V 20A
Ser. No. 7X1234 M
Fuji Electric Co., Ltd. JAPAN
11-2, Tokyo, 141-0032, JAPAN

Fig.2-1 Rating plate

TYPE : APR type (Refer to "3 CODE SYMBOLS".)
Rating SOURCE : Control power supply input voltage, frequency
INPUT : Main circuit power voltage, current
Serial No. : Serial No.

7 X 12345 M

- 7: Year of production (The last digit of the year of production)
- X: Month of production
  - 1 – 9 (Jan. to Sep.)
  - X (Oct.)
  - Y (Nov.)
  - Z (Dec.)
- 12345: Production lot serial No.
- M: Production control symbol

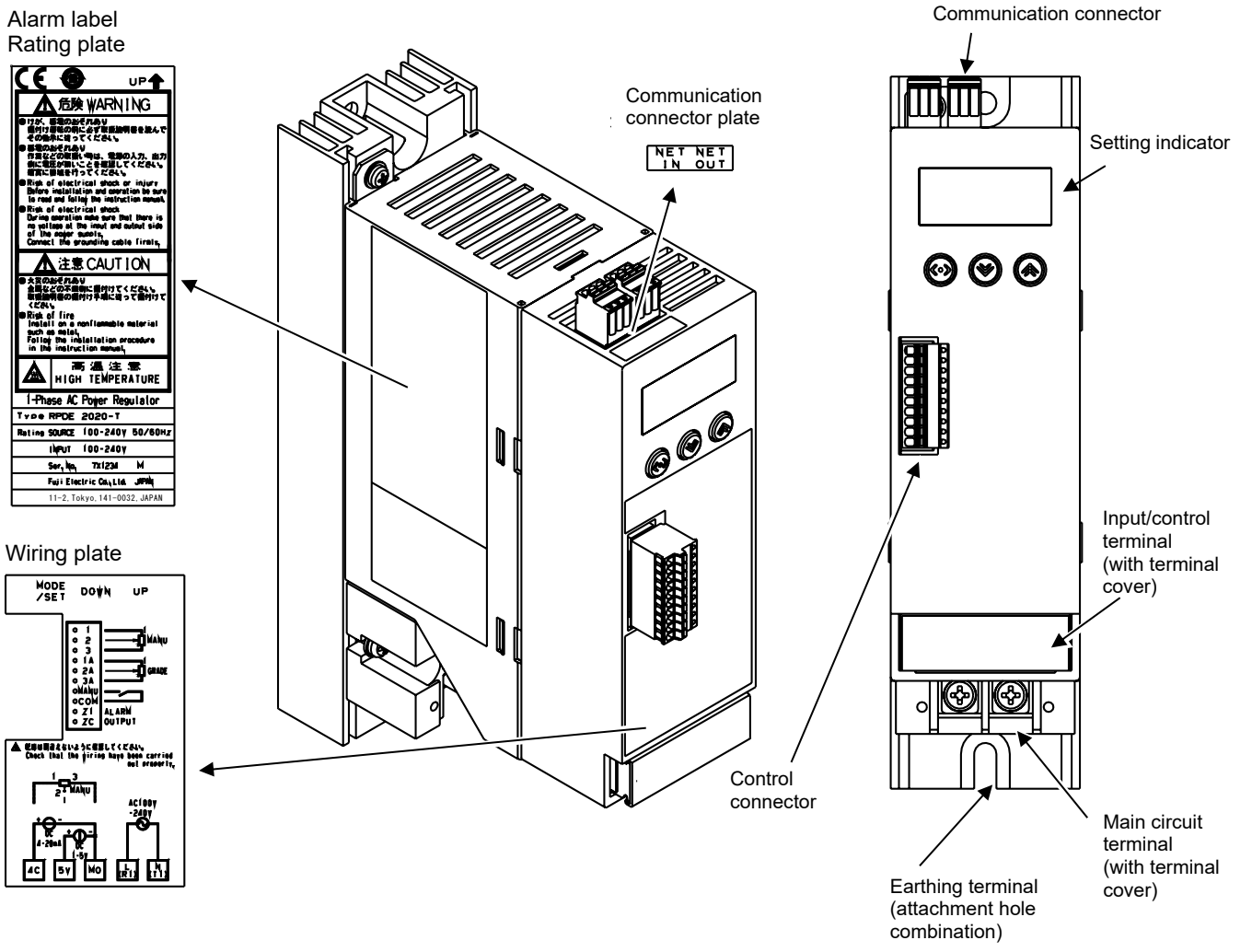


Fig.2-2 Appearance of the product
（TYPE：RPDE2020-□■-ZAM）

3. CODE SYMBOLS

RPD E 2 □□□−□ ■−■■■ (Note1)

Series

Series	Code
APR-D	RPD

Number of phase

Number of phase	Code
Single	E

Input voltage

Input voltage	Code
100 – 240V	2

Rated current

Rated current	Code
20A	020
45A	045
60A	060
100A	100

Control system

Control system	Code
Without feedback function	T
AC CLR	A
AC ACR + AC CLR	B

Specifications

Specifications	Code
Standard	Blank
Main unit optional item	Z**(Note3)

Setter (Note2)

Setter	Code
None	Blank
1 set	1
2 set	2
3 set	3

CLR: Current Limit Regulator
ACR: Automatic Current Regulator

Note1: Please stuff including "-" when the order code is a blank.
Note2: A set of setter consists of variable resistor, nameplate, knob, and sheet to be attached.
Optional order format is "RPD001", which is not displayed in the code symbol of the main unit.
Note3: Optional items of the main unit (Example)

Name of optional specifications	Description	Code symbol
Communication board: Parallel operation	Communication board mounted for master/slave system parallel operation. (Note4)	RPDE2□□□-□■-ZAP
Communication board: Modbus RTU	Communication board mounted for Modbus RTU system network communications.	RPDE2□□□-□■-ZAM
Valid for soft start after main circuit power supply is turning on	After the main circuit power supply is turned on, it is possible to soft start. (Note5)	RPDE2□□□-□■-Z45

Note4: Parallel operation by this communication board communicates only APR-D series.
Note5: When APR is connected with the second side of the transformer (Fig.7-4), this optional type cannot be applied.

4. SPECIFICATIONS

Item			Specification			
Type(Product code)			RPDE2020-☐	RPDE2045-☐	RPDE2060-☐	RPDE2100-☐
Input	Number of phases		Single phase			
	Main/ Controller	Rated Input	100-240V 50 / 60Hz (Self check)			
		Supply Voltage	Rated Input Voltage ±10% (Performance guarantee) (Note1) Rated Input Voltage ±15% (Working guarantee) (Note1)			
		Supply Frequency	50Hz / 60Hz ±2.5Hz			
	Controller Input capacity		15VA less			
Output	Output Current (at Ta=40℃)		20A	45A	60A	100A
	Cooling system		Self-cooled			
	Applicable Load		Resistance Load/ Inductive Load/ Transformer Primary Control/ Rectifier Primary Control (only resistance load(alloy) at Burst firing)			
	Minimum Output Current		0.5A (at 100% output)			
	Dissipation		30W	55W	70W	110W
Control	Firing Modes		Phase control/ Burst firing / Phase angle			
	Output Voltage Regulation Range		0 to 100% of the power voltage of the main circuit (actual value) (excluding voltage drop of thyristor)			
	Output characteristics		Linear characteristics of actual value, Linearity ±3%FS less(Phase control) Linearity ±5%FS less(Burst firing) (At resistance load and setting signal 10-90%)			
	Setting signal	Manual	Digital setting: set by front key Externally mounted variable resistor: 1kohm (B characteristics 1/2W more) HIGH-LOW (Two-position control) contact signal: External wiring or front key			
		Auto	Current signal : 4-20mA$_{DC}$ (Zin =100ohm) Voltage signal : 0-5V$_{DC}$(SSC signal:0/12V$_{DC}$), 1-5V$_{DC}$ (Zin = 11kohm) (Changeover by front key)			
	Gradient setting	Setting range	0 - 100% of output voltage			
		Setter	Digital setting: set by front key Externally mounted variable resistor: 1kohm (B characteristics 1/2W more) Control Terminal "5V-M0" Voltage signal: 1-5V$_{DC}$			
	Base load setting	Setting range	0 - 100% of output voltage			
		Setter	Digital setting: set by front key			
	Soft start and soft up/down (Note2)	Setting range	0-100sec. (control type A) 0.5-100sec. (control type B)			
		Setter	Digital setting: set by front key			
	Feedback control type (phase control and phase angle system only)		AC CLR: (Control type A) AC ACR+AC CLR: (Control type B)			
Alarm	CPU memory error		Memory error is detected when CPU is started, disabling output.			
	Power supply abnormal		Control power frequency that does not fall within the 45 to 65 Hz range is detected.			
	Auto setting input disconnection (Note3)		No signal of current/voltage setting signal is detected. (at Auto setting)			
	Manual setting input disconnection		No signal of Manual setting signal is detected. (at manual setting by externally mounted variable resistor)			
	Gradient setting input disconnection		No signal of Gradient setting signal is detected. (at gradient setting by externally mounted variable resistor or 1-5V$_{DC}$)			
	Antiphase detection		Antiphase of main and controller is detected. (Only option type: Z45)			
	Data read/write error		EEPROM Read/Write check errors are detected.			
	Thyristor error (Note4)		Thyristor short circuit is detected with integrated CT			
	Communication error		Communication error is detected. (Only option type: ZAP, ZAM)			
	CLR detection (Note4)		Load current exceeding the CLR setting is detected and the value is reduced to fall within the permissible CLR setting range by changeover phase angle.			
	Heater disconnection (Note4, 5)		APR output current value that falls below the disconnection judgment value is detected with integrated CT.			
	Output		Open-collector 24V$_{DC}$/0.1A 1circuit			
Environment	Surrounding Air Temperature		-10°C to +55°C (If the ambient temperature exceeds +40°C and less than +55°C, the load current is reduced against the rated current.)			
	Storage temperature		-20°C to +60°C			
	Ambient humidity		+5 to +95%Rh (No condensation allowed.)			
	Others		"Corrosive gas", "dust", "vibration", and "a material and act to promote insulation deterioration" are not allowed. Indoor use at altitude of 1000 m or less.			
Insulation	Withstand voltage (between main circuit and earthing terminal)		2kVac 1min.			
	Insulation resistance (to earthing terminal)		10 Mohm or more with a 500V DC megger			

Note1: Performance guarantee means APR works meeting the specification.
Working guarantee means APR works without damage of parts.
Note2: Soft start and soft up/down time in feedback control type B is invalid even if it sets it at time that is shorter than the response speed of PI control. It is because of the priority of PI control more than the soft start time.
Note3: It doesn't operate for voltage signal 0-5V_{DC} setting and SSC signal: 0/12V_{DC}.
Note4: Only feedback control type A, B.
Note5: The load open detection functions for the Burst firing.

5. INSTALLATION

⚠ WARNING

- Install the instrument to an incombustible object such as metal.
- Do not install the instrument near combustible objects.
  ····· A fire may result.

⚠ CAUTION

- Do not transport the instrument by holding the plastic cover.
  ····· The instrument may fall, thus resulting in injury.
- Prevent foreign matter such as lint, paper, wood chips, and scrap metal from entering the APR. After the installation, check that objects such as screws and tools are not left within the instrument.
  ····· A fire or accident may result.
- Install the instrument in the orientation shown by the dimensional outline drawing.
- Install the instrument in a place that satisfies the environmental conditions for installation (temperature, humidity, dust, installation gap, vibration, etc.).
- Install the instrument in a place that endures the weight of the instrument, using specified screws and at specified torque.
  ····· A fire, accident, or injury may result.

Pay attention to the following when installing the instrument.

(1) Install the instrument in a place not subject to dust and having high cooling effect.
To discharge the heat of the APR, install it on a metallic object on the vertical surface, observing the orientation shown by Fig. 5-1 and allowing sufficient space on the left, right, top, and bottom of the instrument.

(2) The temperature within the panel increases due to the heating of the APR. Take appropriate cooling/ventilating measures, taking the increase of temperature into consideration. (The maximum allowable temperature within the panel is 55°C.)
Rated current is the value specified on condition that the ambient temperature is 40°C. If the temperature exceeds 40°C, decrease the load current according to Fig. 5-2.

(3) Allow sufficient space from adjacent objects for wiring of each terminal using tools.

(4) Take care of falling objects, since there are open parts at upper of APR.

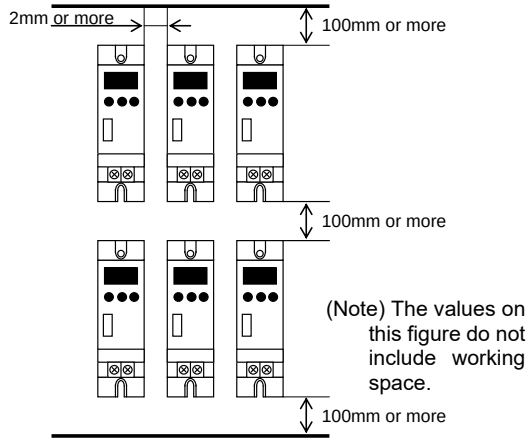


Fig.5-1 Installation interval

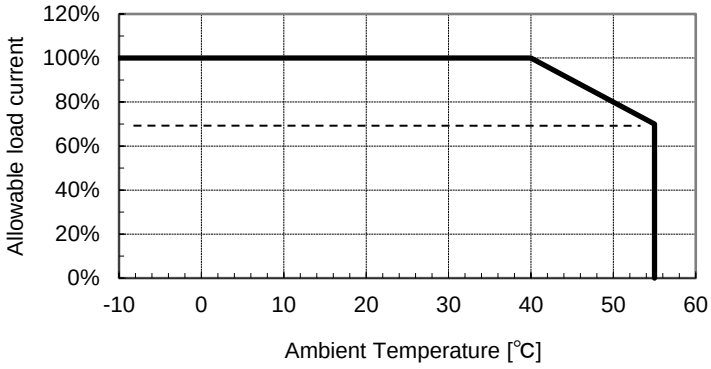


Fig.5-2 Ambient temperature − Allowable load current characteristic

6. OUTLINE

(1) 20A outline

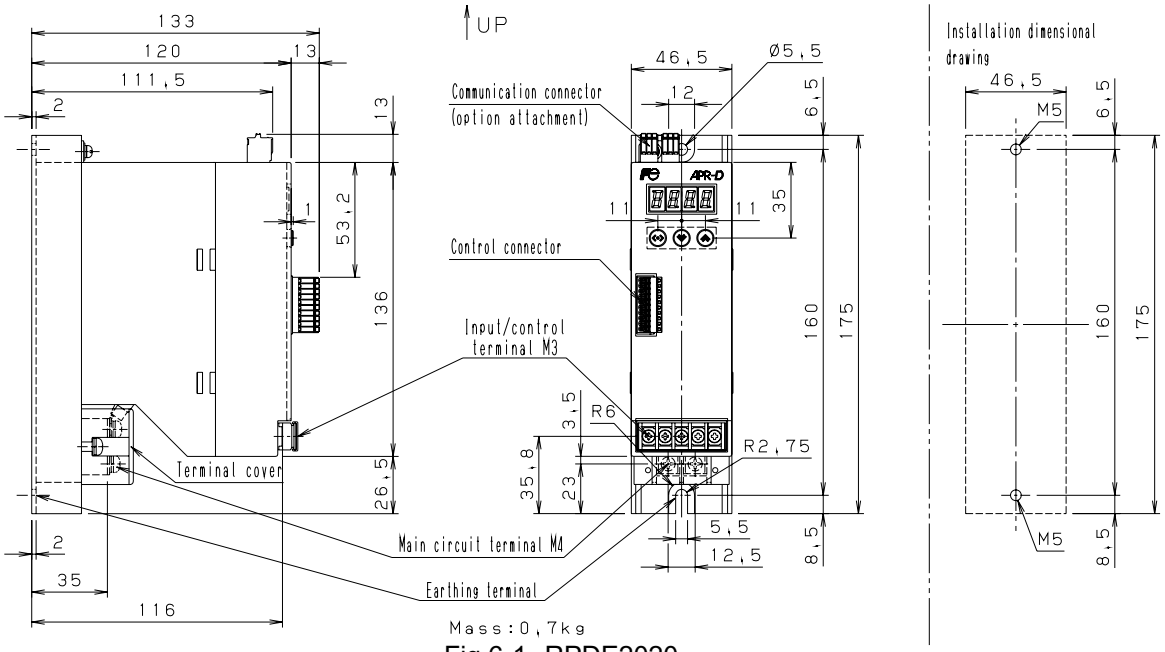


Fig.6-1 RPDE2020

(2) 45/60A outline

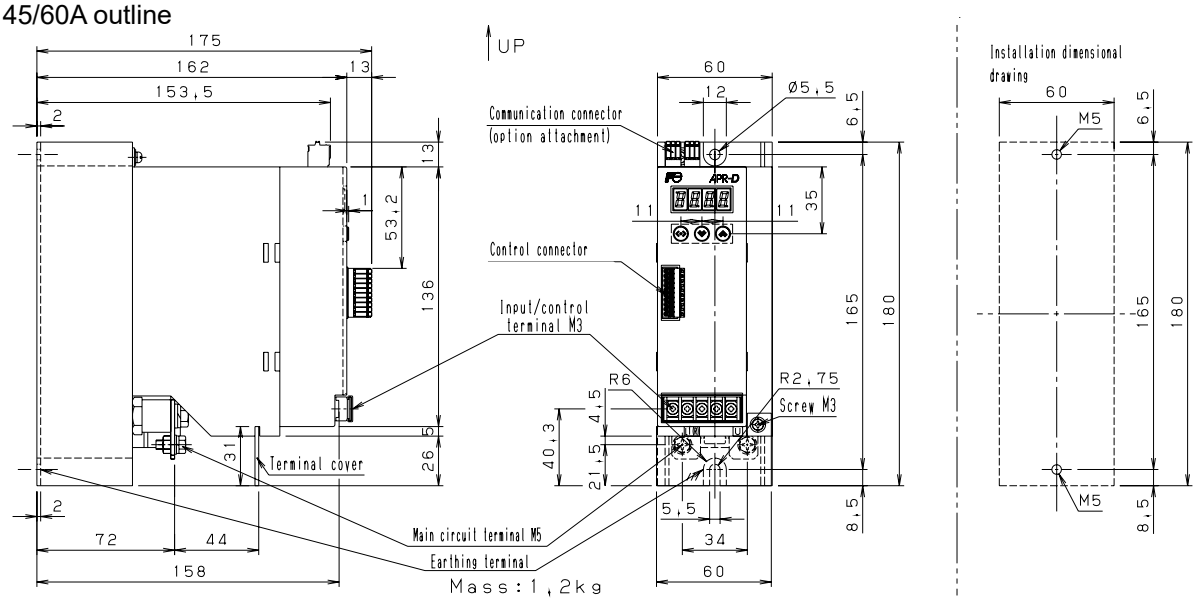


Fig.6-2 RPDE2045/RPDE2060

(3) 100A outline

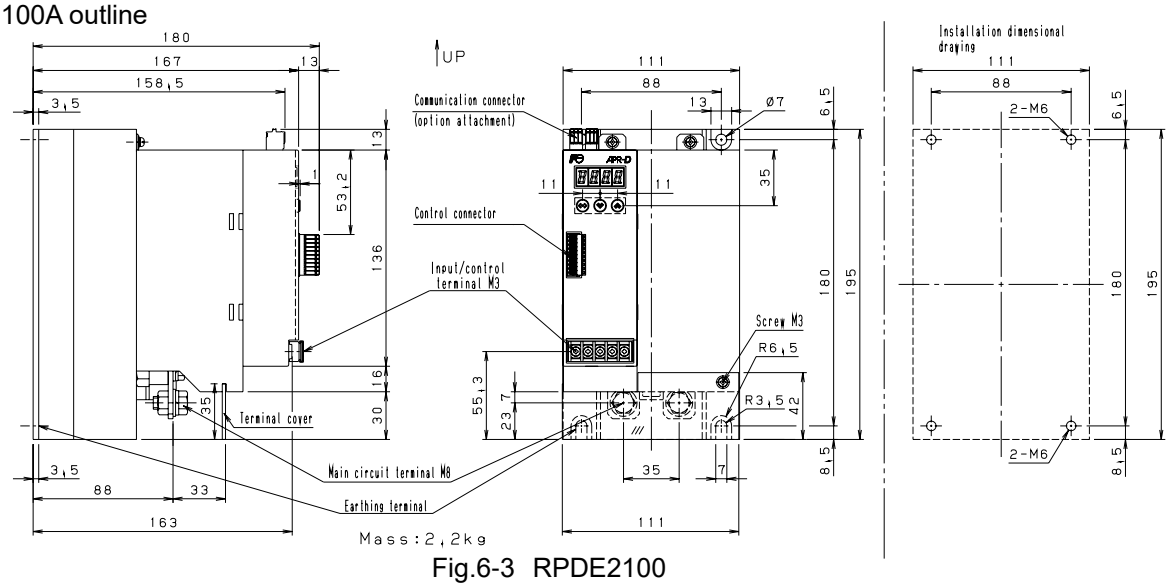


Fig.6-3 RPDE2100

7. WIRING

Observe the following during wiring.

⚠ WARNING

- Before carrying out wiring, check that the power for the main circuit and the control power are turned off.
- To ensure safety, be sure to earthing the instrument to the earthing terminal.
- Install the APR main unit first, and then carry out wiring and fasten the screws of the main circuit. Check that the screws are fastened securely.
- Use the power wire and load wire that satisfy the operating conditions.
- Connect the instrument to the main circuit power supply and control power supply via a circuit breaker for circuit protection and a ground fault interrupter.

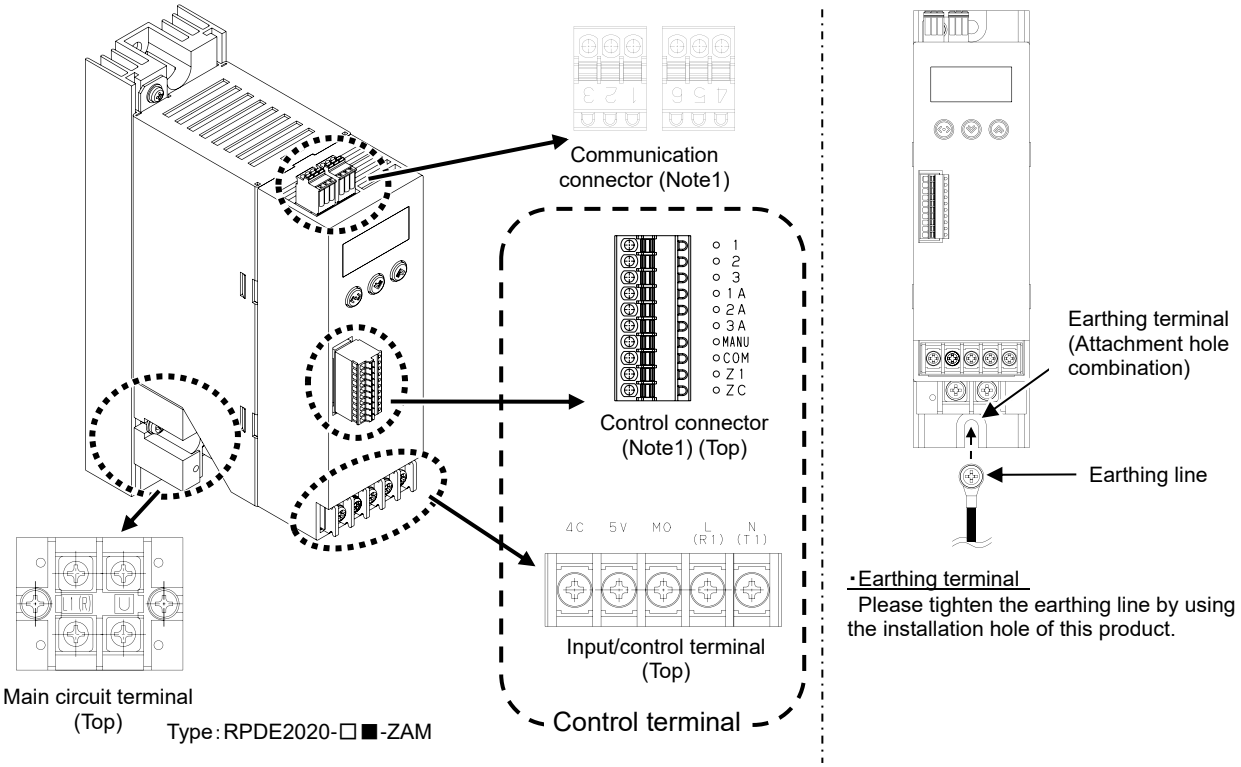
····· Electric shock or fire may result.

⚠ CAUTION

- Check that the rated input voltage of the product and the power supply voltage coincide.
- Pay attention not to reverse the input and output terminals.
- Check carefully that the wiring of the control circuit has been carried out properly.
- Fasten screws at the designated torque.

····· A fire, accident or injury may result.

7.1. Terminals and function



Terminal		Size	Torque [Nm]±10%
Main circuit terminal	L1(R),U	20A M4	1.8（18kgf・cm）
		45A, 60A M5	2.7（27kgf・cm）
		100A M8	12.0（120kgf・cm）
Input /control terminal	L(R1), N(T1), 4C, 5V, M0	M3	0.5（5kgf・cm）
Control connector	1-ZC	-	Note1
Communication connector	NET IN,NET OUT		
Mounting the main unit（Earthing line）		20 - 60A M5	3.5（35kgf・cm）
		100A M6	5.8（58kgf・cm）

Fig.7-1 Terminal and torque

Table.7-1 Terminal functions

Terminal		Pin	Symbol	Name	Description
Main circuit terminal		-	L1(R)	Main circuit terminal	L1(R) : Main power input U : Main power output(To load)
		-	U		
		-	-	Earthing terminal	Earthing Terminal for the APR
Control terminal	Input/control terminal	-	4C(3)	Auto setting input Function code: 6o.06 = **n-Am** (Default)	4C-M0: 4-20mA$_{DC}$ (Zin = 100ohm) 5V-M0: 1-5V$_{DC}$, 0-5V$_{DC}$ (SSC signal : 0/12V$_{DC}$) (Zin = 11kohm) Able to change to 1-5V$_{DC}$ of gradient setting input at 5V-M0 (Refer to "8.3. Function codes")
		-	5V(2)		
		-	M0(1)	Manual setting input Function code: 6o.06 = **n-m_**	Input of manual setting allowed by connecting a variable resistor. ※ In case of using as manual setting input, the alarm of setting input disconnected does not detect.
		-	L(R1)	Control power terminal	Control power input. Please connect at same Phase of main circuit.
		-	N(T1)		
	Control connector	1	1	Manual setting input	Input of manual setting allowed by connecting a variable resistor.
		2	2		
		3	3		
		4	1A	Gradient setting input	Input of gradient setting allowed by connecting a variable resistor.
		5	2A		
		6	3A		
		7	MANU	Auto/manual changeover input	External contact Open : Auto Close : Manual
		8	COM		
		9	Z1	Alarm output	The internal open-collector is set to ON when an alarm is issued.
		10	ZC		
Communication connector	Network	1・2	NET IN	RS-485 signal	This connector send and receive signal apply Modbus protocol on the network (Option type: ZAM)
		4・5	NET OUT		
	Parallel operation	1・2	NET IN	Parallel operation input	This connector receive parallel operation signal on the parallel operation (Option type: ZAP).
		4・5	NET OUT	Parallel operation output	This connector send parallel operation signal on the parallel operation (Option type: ZAP).

Note1: Refer to Fig.7-2 about wire assembly for control connector and communication connector.

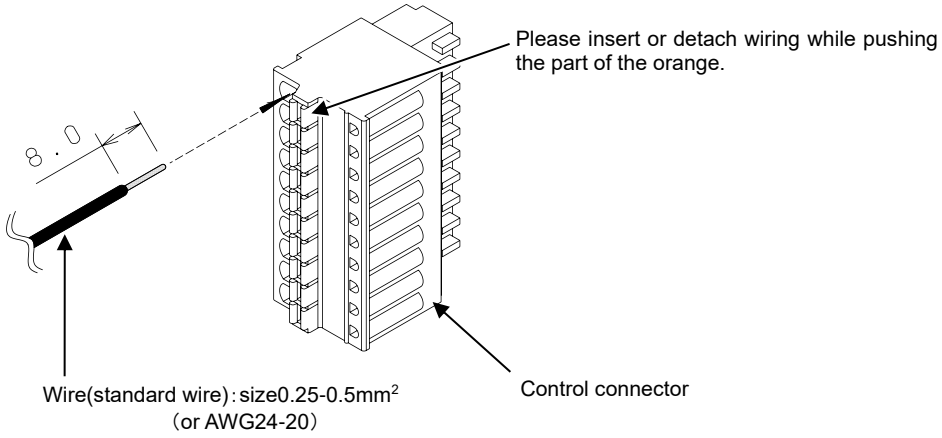


Fig.7-2 Assembly for Control connector and communication connector

7.2. Main circuit and control circuit

(1) 100 to 240V

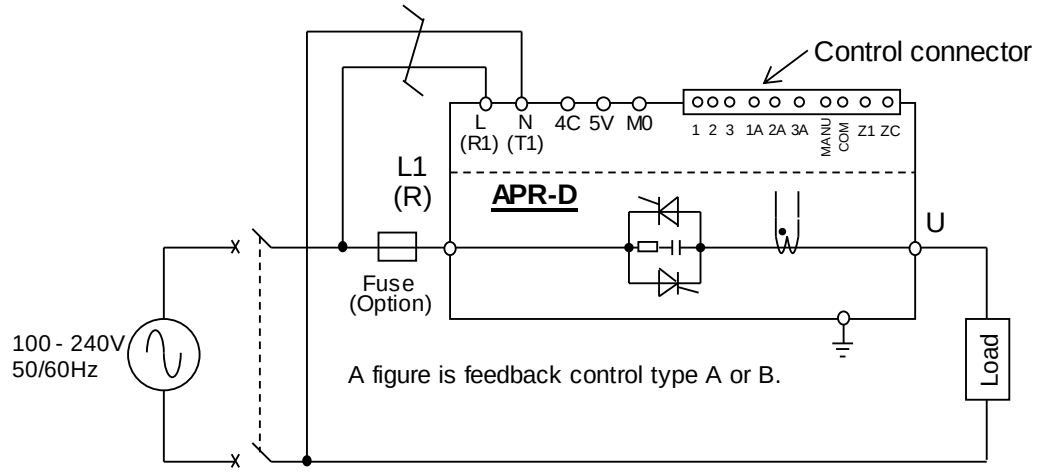


Fig.7-3 External connection diagram (100-240V)

(2) Less than 100V

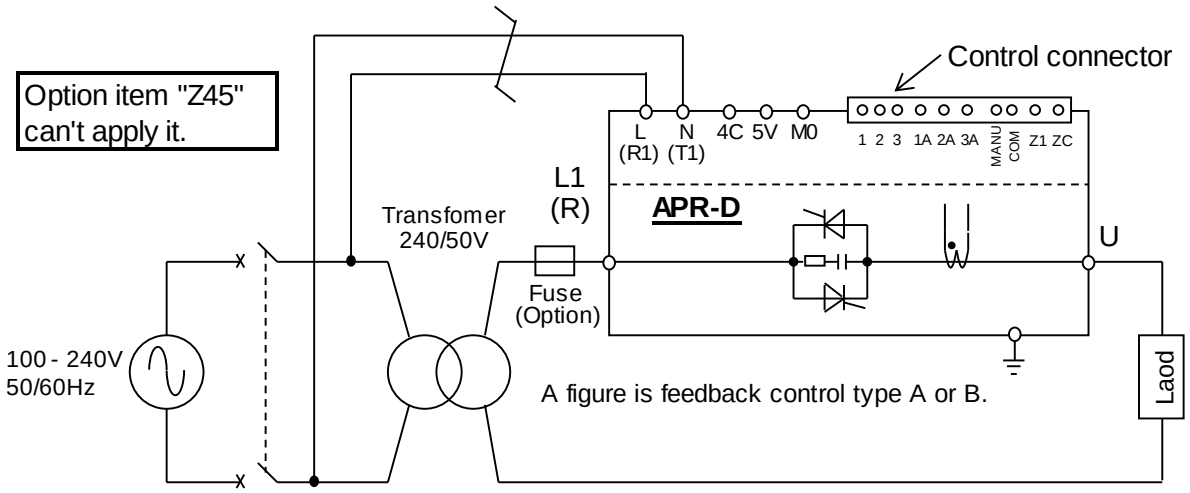


Fig.7-4 External connection diagram (Less than 100V)

Note1: Connect at same Phase of main circuit and control circuit.

Note2: The terminal only for the earth is not installed in this product.
Please tighten the earthing line by using the installation hole of this product.

Note3: The rapid fuse is needed for the load-short protection.
The rapid fuse is not built into the APR.
Please set it up on the power supply side by the customer.

Table.7-2 Rapid fuses (Recommendation)

Rate	Type	Fuse holder
20A	CR2LS-30	CM-1A (3-pole)
45A	CR2LS-75	
60A	CR2LS-100	
100A	CR2L-150	CM-2A (3-pole)

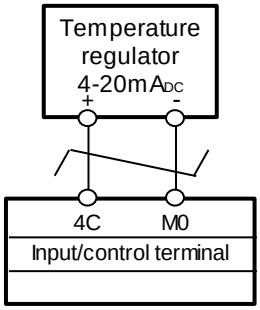
Note4: Please set input voltage for control circuit at function code 0i.01, please shut down and power on.
(It is described detail at 8.3.2. Outline of function code.)

7.3. Control terminal and communication connector (Note1) (Note2) (Note3)

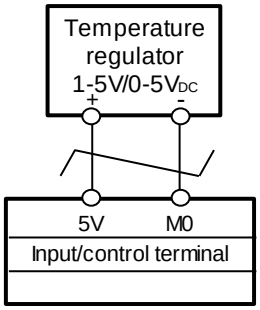
(1) In case of using Input/control terminal

Auto setting

Setting signal: Current signal(4-20mA$_{DC}$)
Gradient signal: N/C, or function code:1b.02(digital gradient setting)

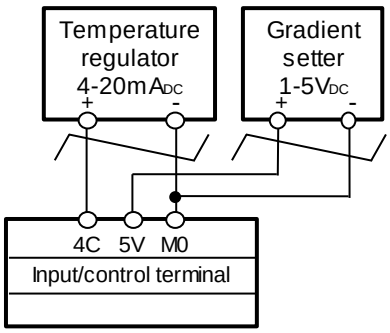


Setting signal: Voltage signal(1-5V/0-5V$_{DC}$ (SSC signal: 0/12V$_{DC}$))
Gradient signal: N/C, or function code:1b.02(digital gradient setting)



Auto setting

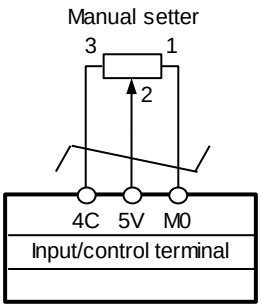
Setting signal: Current signal(4-20mA$_{DC}$)
Gradient signal: Voltage signal(1-5V$_{DC}$)



●Function code setting.
・2b.02(selection of gradient setting device): **5vm0**
(Voltage signal setting)

Manual setting

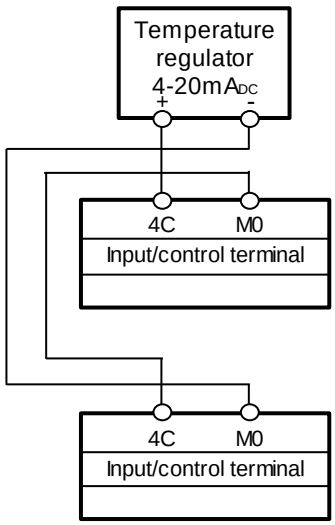
Setting signal: Manual setter
Gradient signal: N/C or function code: 1b.02(digital gradient setting)



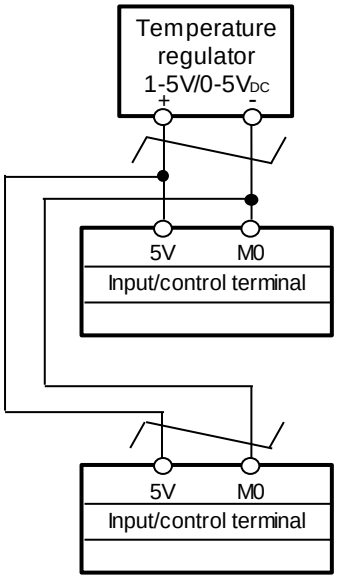
●Function code setting.
・6o.06(selection of auto/manual terminal function):**n-m_**
((MANU-COM)Normal-(4C-5V-M0)Manual-(1-2-3)invalid)

Direct parallel operation of 2 or more units

Setting signal: Current signal(4-20mA$_{DC}$)
Gradient signal: N/C or function code: 1b.02(digital gradient setting)



Setting signal: Voltage signal(1-5V/0-5V$_{DC}$ (SSC signal: 0/12V$_{DC}$))
Gradient setting: N/C or function code: 1b.02(digital gradient setting)

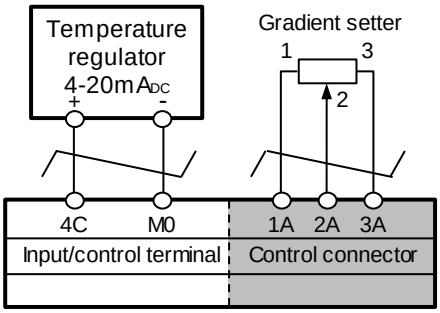


Notes:
(a) Do not connect between terminals COM of each APR.
(b) Set the number of APR so that the total of internal resistance (4C-M0:100Ω) of APR should not exceed the temperature regulator.

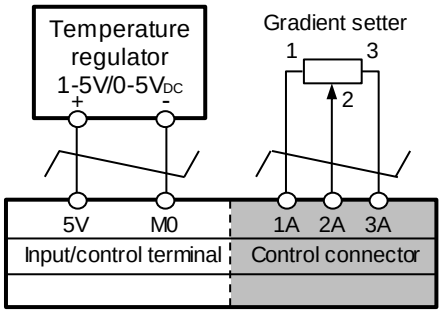
(2) In case of using Input/control terminal and control connector

Auto setting

Setting signal: Current signal(4-20mA$_{DC}$)
Gradient signal: Gradient setter



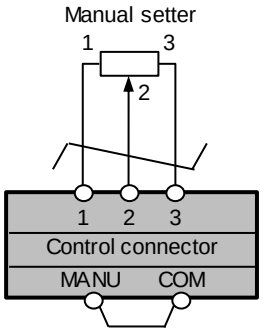
Setting signal: Voltage signal(1-5V/0-5V$_{DC}$ (SSC signal: 0/12V$_{DC}$))
Gradient signal: Gradient setter



●Function code setting.
・2b.02(selection of gradient setting device): **G-vr** (External variable resistor)

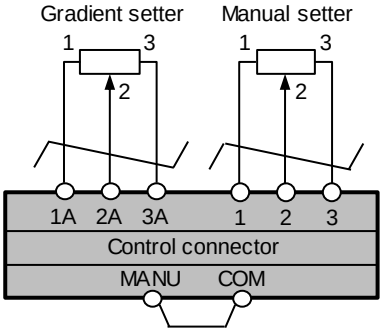
Manual setting

Setting signal: Manual setter
Gradient signal: N/C or function code: 1b.02(digital gradient setting)



●Function code setting.
・2b.01(selection of manual setting device): **m-vr** (External variable resistor)

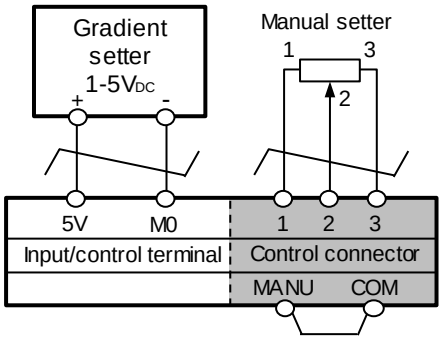
Setting signal: Manual setter
Gradient signal: Gradient setter



●Function code setting.
・2b.01(selection of manual setting device): **m-vr** (External variable resistor)
・2b.02(selection of gradient setting device): **G-vr** (External variable resistor)

Manual setting

Setting signal: Manual setter
Gradient signal: Voltage signal(1-5V$_{DC}$)

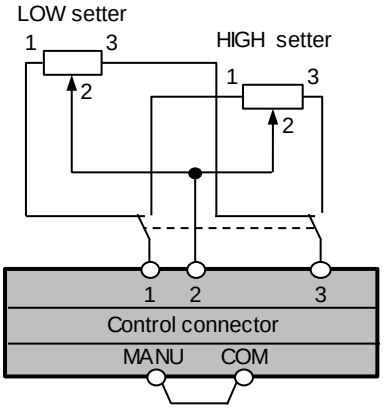


●Function code setting.
・2b.01(selection of manual setting device): **m-vr** (External variable resistor)
・2b.02(selection of gradient setting device): **5vm0** (Voltage signal setting)

HIGH-LOW setting

HIGH setting: Manual setter 1
LOW setting : Manual setter 2

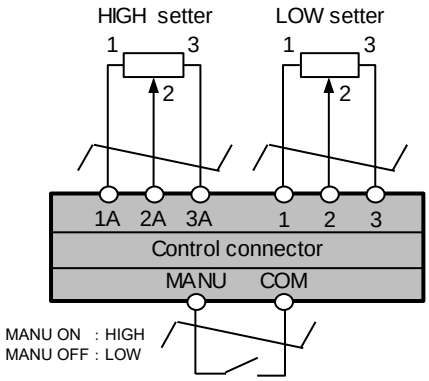
Method1: HIGH and LOW settable separately



●Function code setting.
・2b.01(selection of manual setting device): **m-vr**
(External variable resistor)

HIGH setting: Gradient setter
LOW setting: Manual setter

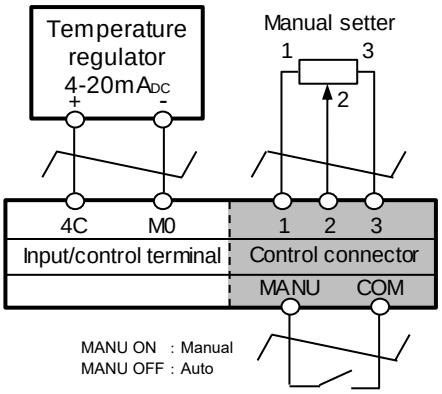
Method2：HIGH and LOW settable separately. Changeover of HIGH/LOW uses Input of Auto/Manual changeover.



●Function code setting.
・2b.06(selection of two-position control valid / switching): **mAnU**
(Auto/manual changeover input)
・2b.07(selection of two-position control high / low lay out):**Lv. Hv**
(L - Manual VR , H - Gradient VR)

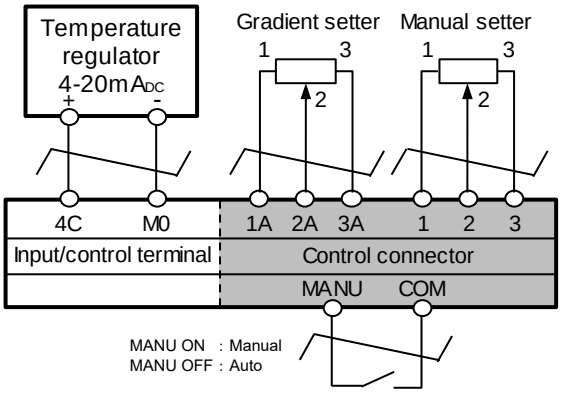
Auto/Manual setting

Setting signal: Current signal(4-20mA$_{DC}$) or manual setter
Gradient signal: N/C or function code: 1b.02(digital gradient setting)



●Function code setting.
・2b.01(selection of manual setting device): **m-vr**
(External variable resistor)

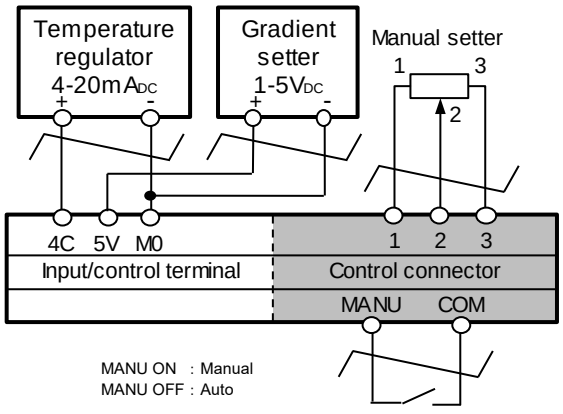
Setting signal: Current signal(4-20mA$_{DC}$) or manual setter
Gradient signal: Gradient setter



●Function code setting.
・2b.01(selection of manual setting device): **m-vr**
(External variable resistor)
・2b.02(selection of gradient setting device): **G-vr**
(External variable resistor)

Auto/Manual setting

Setting signal: Current signal(4-20mA$_{DC}$) or manual setter
Gradient signal: Voltage signal(1-5V$_{DC}$)

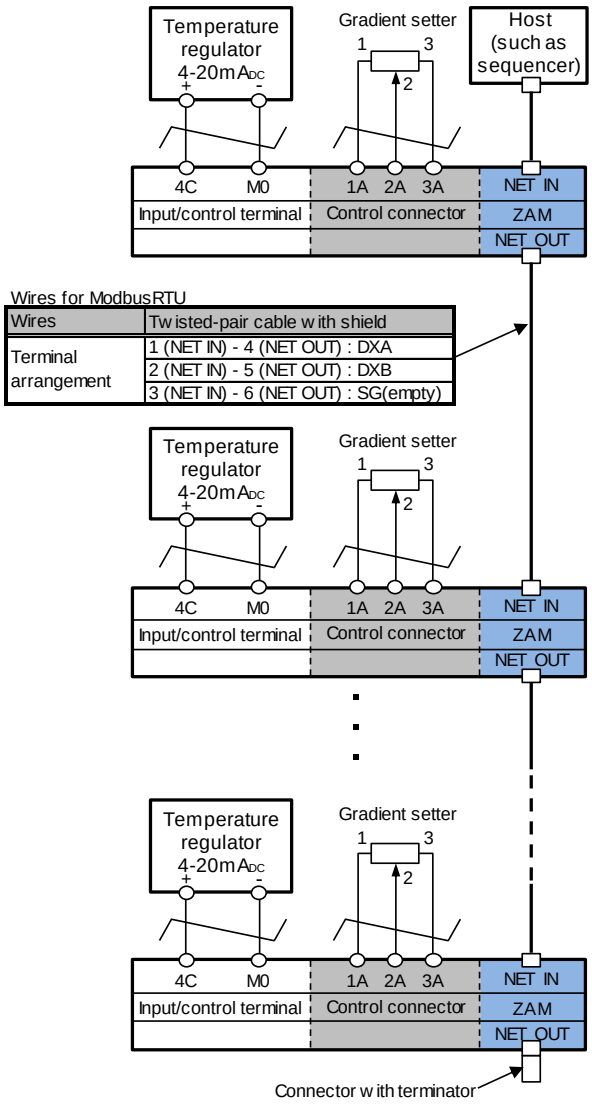


●Function code setting.
・2b.01(selection of manual setting device): **m-vr** (External variable resistor)
・2b.02(selection of gradient setting device): **5vm0** (Voltage signal setting)

(3) In case of using Input/control terminal and control connector + communication connector

Network communication（Modbus RTU）

Setting signal: Current signal(4-20mA$_{DC}$)
Gradient signal: Gradient setter

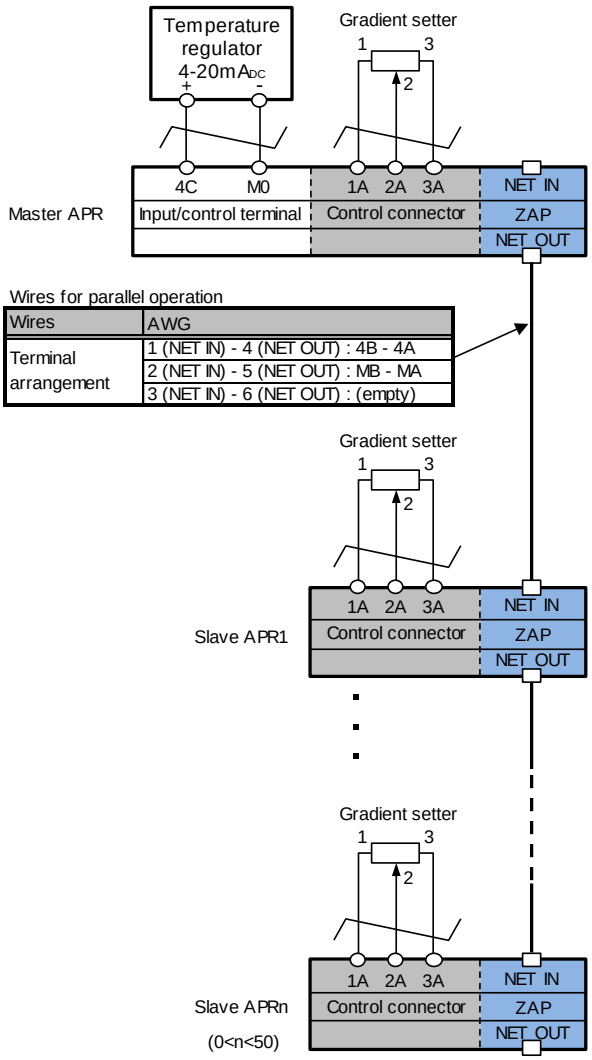


●Notice

(a) It becomes goods equipped with "For network communication board". (Main body option item. Option type: ZAM)
(b) You need to set at function code.
・2b.02(selection of gradient setting device): **G-vr** (External variable resistor)
・4n.02(unit setting): unit number set
(c) Insert the connector with the terminator of the attachment in the NET OUT terminal in end APR.
(d) Details are manuals of communication board Modbus RTU refer to (No. INR-MK31060E).

Parallel operation of 2 or more units

Setting signal: Current signal(4-20mA$_{DC}$)
Gradient signal: Gradient setter



●Notice

(a) It becomes goods equipped with "For parallel operation network communication board". (Main body option item. Option type: ZAP)
(b) You need to set at function code.
・2b.02(selection of gradient setting device): **G-vr** (External variable resistor)
(c) You need to set at function code of slave APR.
・4n.01(selection of parallel operation Master / Slave): **no.2-** (Slave)
(d) In the case of the phase control, gradient setting and base load setting function of each slave APR are valid. They are invalid in case of Burst firing.
(e) If manual setting is selected for a slave APR (by closing MANU-COM), isolated manual operation of that unit can be made. The subsequent APRs are operated in parallel by the Master APR.
(f) The order of power on.
Example 1: It is master machine, slave machine 1, 2, order of 3 successively.
Example 2: Perform power supply of all machines (MAX.50) at the same time.

Note1: Ensure 1 kohm (1/2 W or higher), B characteristics, for each variable resistor. The output increases by turning clockwise.

Note2: In case of changing voltage signal (1-5V/0-5V_{DC} (SSC signal: 0/12V_{DC})), you need to set to the following function code.
・2b.03(selection of auto setting voltage signal): **1-5v**(1-5V_{DC}), **0-5v**(0-5V_{DC} (0/12V_{DC}))

Note3: Fig.7-5 is equivalent circuit of “Auto/Manual changeover” and “Alarm output”.
Signals with or without contacts can be input at “Auto/Manual changeover”.

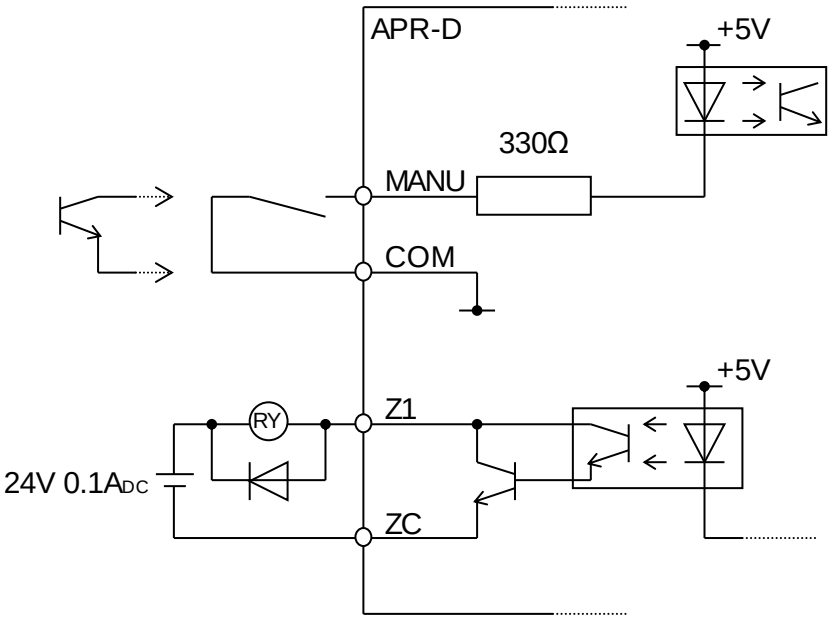


Fig.7-5 Equivalent circuit for MANU-COM, Z1-ZC

7.4. Notes

(1) Use the supplied screws (bolts) for main circuit terminals [L1(R), U]. If screws (bolts) larger than the specified size are used, insufficient insulation from surrounding parts may result. Use an insulation cap for crimp contacts.

(2) Use crimp contacts with insulation coating when performing wiring to terminals [L (R1), N (T1)], within the control circuit terminal block, and ensure sufficient insulation from adjacent terminals.

(3) To prevent noise, perform wiring to control circuit terminals [L (R1), N (T1)], allowing sufficient distance from the control power terminals [L1(R), U]. Do not place them in the same duct. If wires are to be crossed, place them so they cross at right angles. Twist wires by signal group (4 to 7 turns/10 cm). If a shielded wire is to be used, connect the shield casing to the earthing terminal, and keep the other end open.

(4) If a breaker for circuit protection is to be used on the input side of the control power, we recommend you to install it at the position shown by Figs. 7-3, and 7-4.

(5) After the wiring is completed, return the terminal block cover back to the original position to ensure safety.

(6) Voltage is generated at the output terminals through the internal snubber circuit even if output is not made from the APR. To prevent electric shock during maintenance and inspection, install a breaker or equivalent devices in the former stage of the APR.

(7) When performing primary control with a transformer (to be connected between the APR and the load), observe the following to prevent overcurrent, blowing of main fuse, and burns of the transformer due to magnetic deviation of the transformer.

a) Allow sufficient magnetic flux density of the transformer.
b) If there is a possibility that no load is applied to the transformer, connect a resistance that feeds the current of approximately 0.5 A to the primary winding in parallel.

(8) Wire the control circuit terminal in the same board. When extend to the board outside, insert signal amplifiers midway, and do noise measures.

8. MONITOR AND SETTING OPERATION

In the setting indicator, the monitor function and the control point setting can be done.

⚠ WARNING

- Be sure to mount the cover of the terminal block first, and then set the power to ON. Do not remove the cover in energized state.
- Do not operate switches with wet hand. Do not splash liquid such as water over the instrument.
- Do not touch the APR terminals while energized even if the instrument is suspended.
  (When function code 6o.04 (selection of standby state) are **on** (standby state), they may be all LED putting out lights.)
  ····· **Electric shock may result.**
- If function code data setting is made improperly, or it is made without understanding the contents of the instruction manual, voltage exceeding permissible value of the load may be output.
  ····· **An accident or injury may result.**

8.1. Part name and functional overview

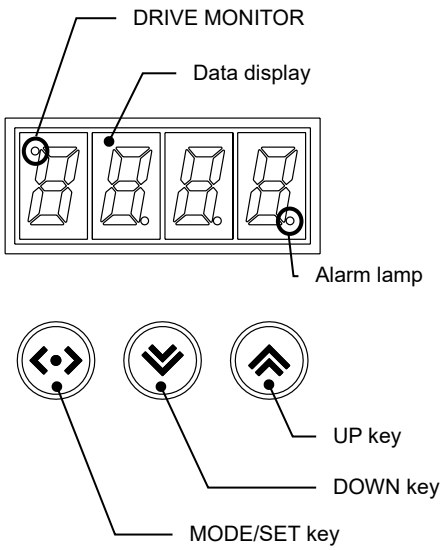
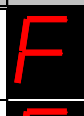
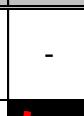
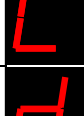
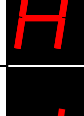
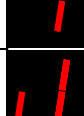
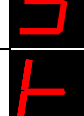
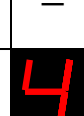
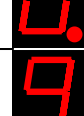


Fig.8-1-1 Setting indicator

Table 8-1-1 Overview of setting indicator

Name	Function
DRIVE MONITOR	The fourth digit in data display part DP. APR output RUN (turn on) / STOP (turn off)
Data display	7-segment LED monitors Displays the following contents depending on each operation. • Monitor mode Displays information on operation (such as output voltage, output current, and load resistance). Displays the alarm code when an alarm is issued. The fourth figure displays the item in each operation information. • Setting mode Displays function code and function code data. * Table.8-1-2 shows the alphanumeric character display.
Alarm lamp	The first digit in data display part DP Alarm Occurrence (blinks) / No alarm (turn off)
UP key Down key	Used to select setting item displayed on the LED monitor or change the function code data. * The data display is changed automatically by a long push for 1 second or more.
MODE/SET key	The operation mode is switched. • Monitor mode If it pushes and detaches, it will switch to setting mode. • Setting mode _ function code select If it pushes and detaches, it will switch to the display of function code data. The change is divided into the monitor mode for 1 second or more by a long push. • Setting mode _ function code data select Data is fixed when pushing and separating. The setting is canceled for 1 second or more by a long push, and it returns to the monitor mode.

Table.8-1-2 Alphanumeric character display

Alphanumeric character	Display	Alphanumeric character	Display	Alphanumeric character	Display	Alphanumeric character	Display	Alphanumeric character	Display	Alphanumeric character	Display
A		F		K		-		P		U		Z	
b		G		L		q		v		-	
C		H		m		r		w		_	
d		i		n		S		X		0.	
E		J		o		t		y		9.	

8.2. Outline of operation mode

The setting indicator can be operated in either of the following two modes.

- Monitor mode: The operation is monitored in real time. An alarm code is displayed when an alarm is issued.
- Setting mode: Function code data can be checked or set in this mode.

Fig.8-2-1 indicates the state of these operation modes.

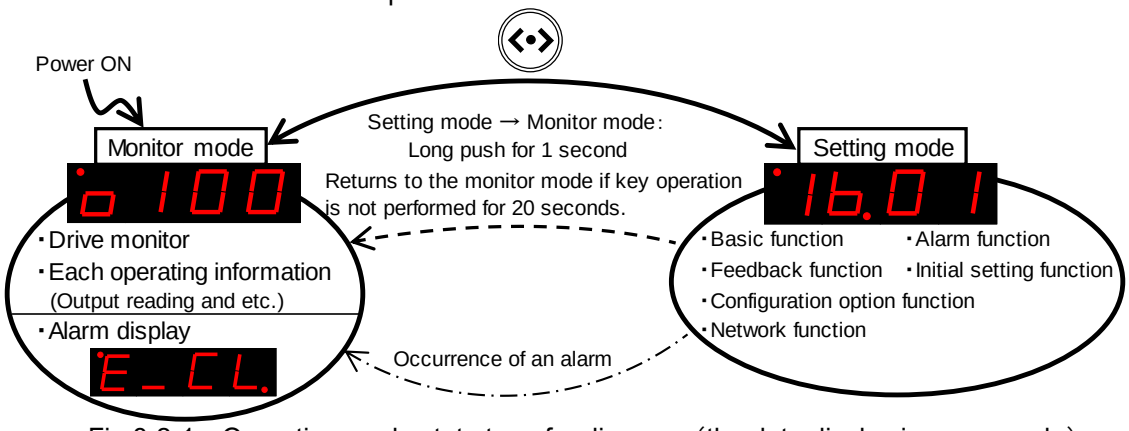


Fig.8-2-1　Operation mode state transfer diagram（the data display is an example）

8.2.1. Monitor mode

In the monitor mode, seven items shown in Table.8-2-1 can be monitored. Operate the UP･DOWN key about the switch of the monitor item. If an alarm issued, the alarm code is displayed.

Table.8-2-1　Monitor item (Note1)

No.	Monitor item	Function item display	Display	Unit	Description of reading	Monitor accuracy T	Monitor accuracy A/B
1	Output reading	o	100	%	Output reading by internal calculation of the APR	○	
2	Output current (Note2)	A	20.0	A	AC output current detection	-	○
3	Power supply frequency	H	60.0	Hz	Power supply frequency detection	○	
4	Output setting signal	r	100	%	Setting signal detection	○	
5	Gradient setting signal	G	100	%	Gradient setting detection	○	
6	Auto/manual changeover input	t	At/m1/m2	-	The state display of auto and manual change terminal At … Auto(Input/control terminal) m1…Manual(Control connector) m2…Manual(Input/control terminal)		
			Hi/Lo	-	State display of two-position control Hi … HIGH setting Lo … LOW setting		
7	Alarm code	E	_CL	-	Display when alarm is generated		

Note1: Monitor accuracy±5%FS　—:Not display
Only the resistance load when the phase control is effective.
The monitor item of the slave machine for burst firing will be "power supply frequency", "auto/manual changeover input" and "alarm code".

Note2: **on** (display) is chosen in function code 6o.07 (selection of output current display). (Factory setting: **oFF** (not display))
In inductive load, transformer primary control, and rectifier primary control, exact output current cannot be displayed.
Moreover, when **CyC** (burst firing) has been selected with function code 2b.04 (selection of firing mode), function code 6o.07 and the monitor item - output current are skipped (non-display).

Note3: It can't be shifted to setting mode during the alarm display. When indicating monitor item except for an alarm, you can shift to setting mode.

Fig.8-2-2 displays the method of operating monitor mode. Items not displayed are skipped.

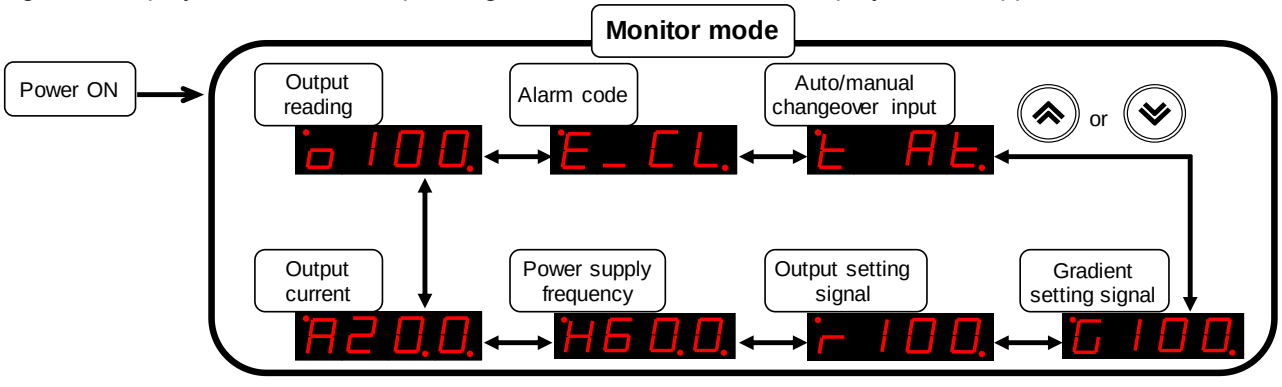
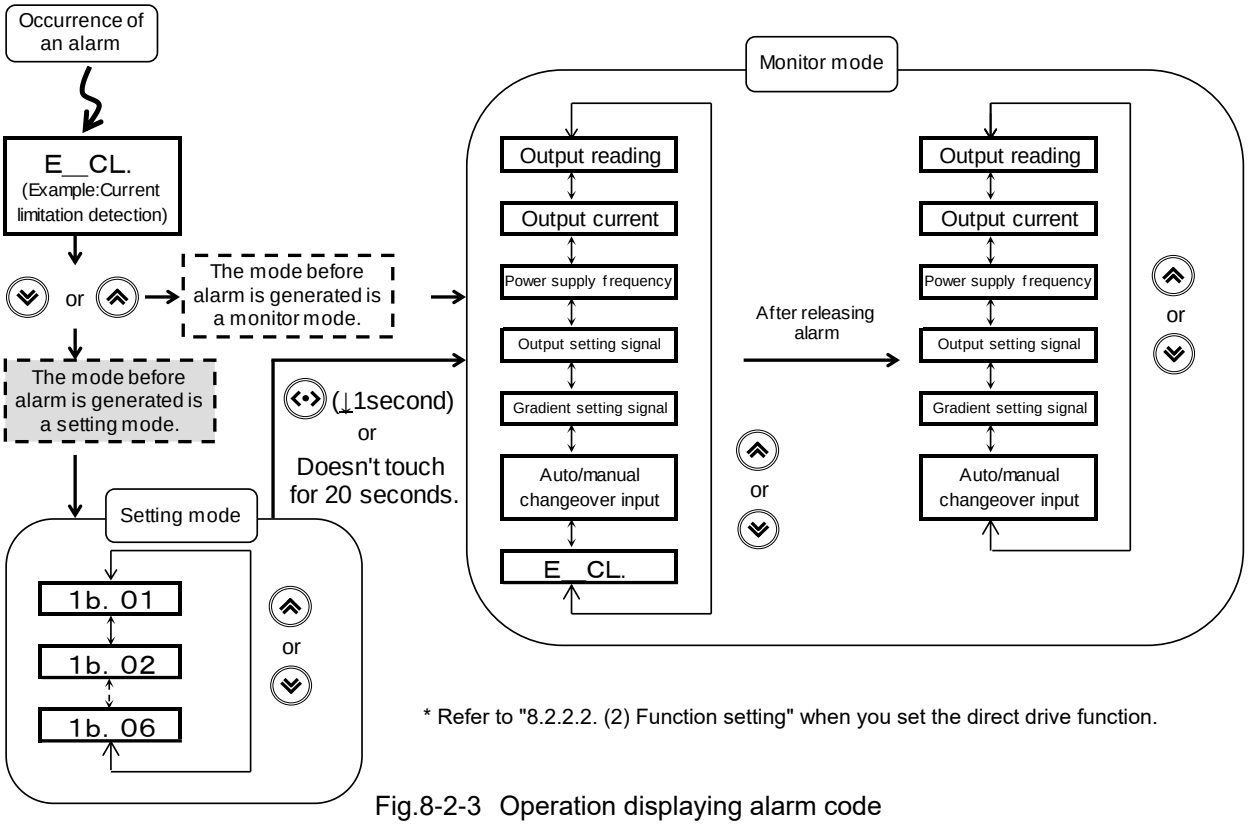


Fig.8-2-2　Method of operating monitor mode（display detecting current limitation）

8.2.1.1. Alarm code display

If the protective function is activated and an alarm is issued, the relevant alarm code is automatically displayed. Fig.8-2-3 shows the manner of operation displaying the alarm code.



* Refer to "8.2.2.2. (2) Function setting" when you set the direct drive function.

Fig.8-2-3 Operation displaying alarm code

Only one alarm code is displayed. Moreover, the display has the priority level shown in Table.8-2-2. The breakdown that occurs early is displayed for the same priority level.
Table.8-2-3 shows the alarm code list. Refer to "10. MAINTENANCE AND INSPECTION" for details of each alarm.

Table.8-2-2 Alarm code priority level

Priority level	Alarm output (Note1)	Operation after detection (Note2)
HIGH	ON	Output stop
⇕	ON	Output continued
⇕	OFF	Output stop
LOW	OFF	Output continued

Note1: Refer to "Function code 5A(alarm function)"
Note2: Refer to "Table.10-1"

Table.8-2-3 Alarm code list

Display	Name
E_tH	Thyristor error (Control system type A or B)
E_CP	CPU memory error
E_nt	Communication error (Network or Parallel operation)
E_Hb	Heater disconnection (Control system type A or B)
E_LF	Power supply abnormal
E_PH	Antiphase detection (Valid for main circuit power supply detection)
E_CL	CLR detection (Control system type A or B)
E_Sm	Manual setting input disconnected
E_SG	Gradient setting input disconnected
E_SA	Auto setting input disconnected
E_rw	Data write/read error
E_10	Password input error

8.2.1.2. DRIVE MONITOR／Alarm lamp

(1) DRIVE MONITOR
The fourth digit DP in data display part displays the DRIVE MONITOR.
The DRIVE MONITOR displays the gate pulse output of APR.
・Gate pulse ON :The 4th digit DP lights.
・Gate pulse OFF:The 4th digit DP turning off.

(2) Alarm lamp
The first digit DP in data display part displays the Alarm lamp.
The alarm lamp displays the presence of alarm.
・Alarm generation: The first digit DP is blinking.
・No alarm : The first digit DP turning off.

8.2.2. Setting mode

8.2.2.1. Selection of function code

Table.8-2-4 shows the kind of the function code.

The figure of the first digit in the function code shows the set item number and reflects a set content by the digit of the remainder.

When the instrument enters the setting mode for the second and subsequent times, the menu that was displayed when the previous setting mode was exited appears.

Table.8-2-4 Outline of function code

Menu	Display	Set item	Major function
Data setting	1b._ _	Basic function 1 b code (1b.01-1b.06)	Function used in basic APR operations. Alternate function of external volume.
	2b._ _	Basic function 2 b code (2b.01-2b.07)	Function used in basic APR operations. Various functions are selected.
	3F._ _	Feedback function F code (3F.01-3F.08)	The setting in conjunction with the feedback function. There are CLR setting, a heater disconnection function.
	4n._ _	Network function n code (4n.01-4n.08)	Function related to communication.
	5A._ _	Alarm function A code (5A.01-5A.09)	Setting of alarm output (control connector)
Configuration option	6o._ _	Configuration option function o code (6o.01-6o.07)	Setting of utility function.
Initial setting	0i._ _	Initial setting function i code (0i.01-0i.05)	Factory setting

The display pushes UP or the DOWN key completely and the function code of a set item is changed.

A part of function code is skipped according to the setting of the control method etc.

Moreover, a setting item can be changed for the UP key by long aggressiveness more than for 1 second.

In this case, the function code displays the head of a set item. Non-skip function code after the head is displayed for the function code that the head skips.

Fig.8-2-4 shows the method of operating the function code selection.

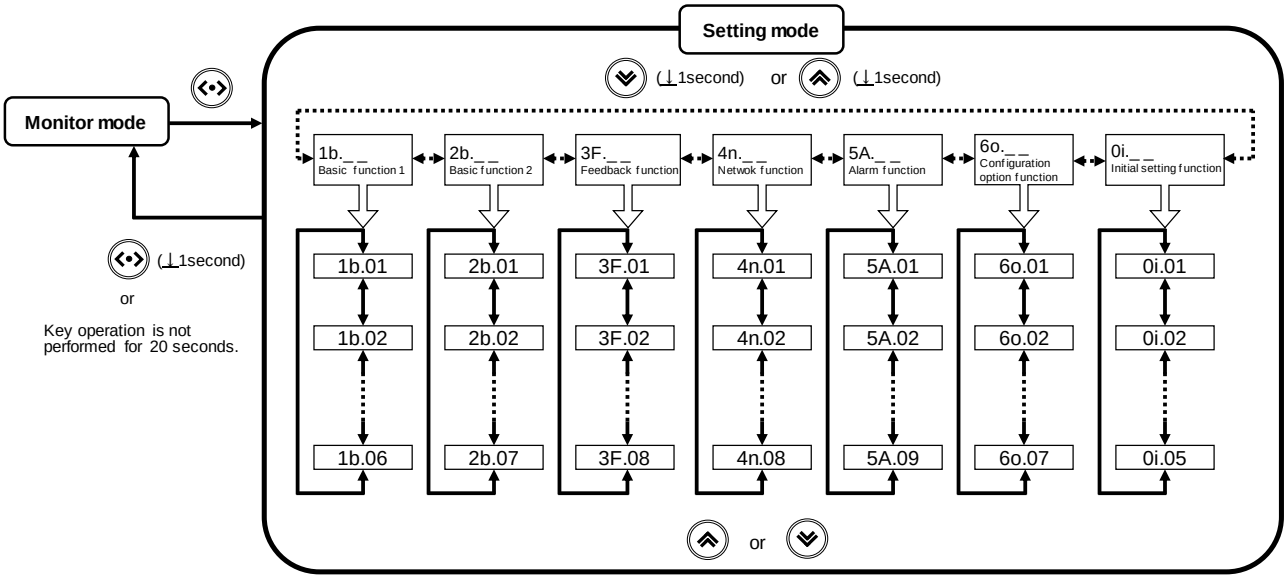


Fig.8-2-4 Method of operating the function code selection

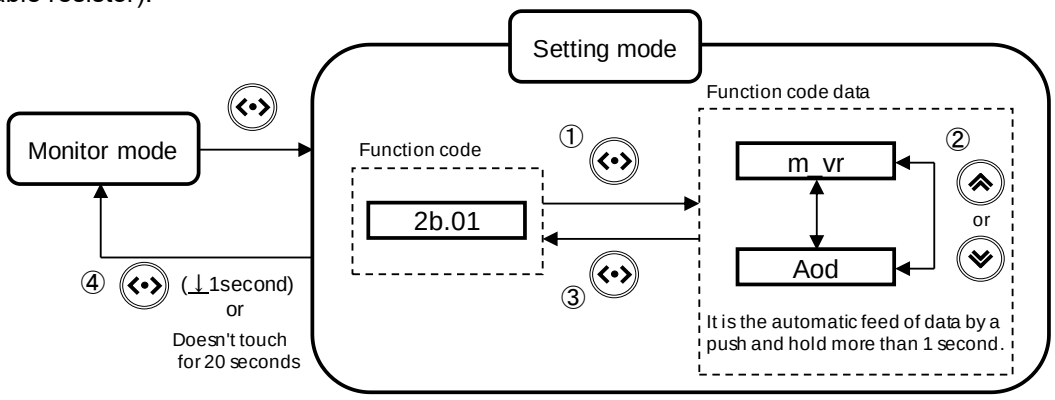
8.2.2.2. Setting of function code data

There are three methods of set operations of the function code data.

- Function select : Method of selecting parameter
- Function setting : Method of setting numerical value of 0-100%.
- Data Check & change : Method of confirming changed data (function code 6o.01)

(1) Function select

It explains the data of function code 2b.01 (selection of manual setting device) as an example of operating the function select and it explains the method of the change to **Aod** (setting indicator) from **m_vr** (external variable resistor).



Operational procedure

① When the function code is selected in a setting mode, and is pushed, the function code data is displayed.

② The function code data is selected by operating or .

③ ～ At the decision ～

The function code data is fixed when is pushed, and it returns to the display of the function code.

④ ～ At the cancellation ～

The change is canceled when there is no operation for 20 seconds or long push during 1 second and it returns to the monitor mode.

Fig.8-2-5 Method of operating function selection

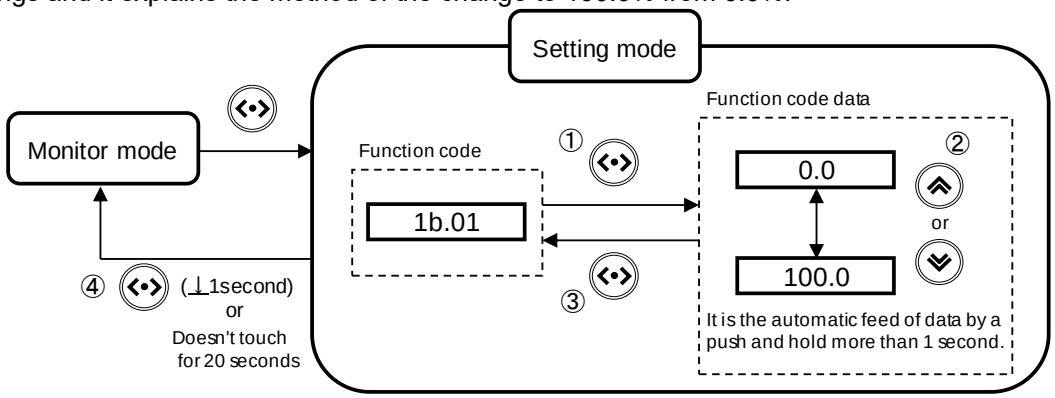
Note: About the password input

Partially of set item "Initial setting function", there is something to demand the password by fixing the function code data.

These function codes are allowed by only the monitoring. Cancel the MODE/SET key for 1 second or more in the casting when the password input is displayed.

(2) Function setting

It explains the data of function code 1b.01 (digital manual setting) as an example of operating function settings and it explains the method of the change to 100.0% from 0.0%.



Operational procedure

① When the function code is selected in a setting mode, and is pushed, the function code data is displayed.

② The function code data is selected by operating or .

③ ～ At the decision ～

The function code data is fixed when is pushed, and it returns to the display of the function code. Data is fixed without the operation for 20 seconds, and it returns to the monitor mode for the function code of a direct drive.

④ ～ At the cancellation ～

The change is canceled when there is no operation for 20 seconds or long push during 1 second and it returns to the monitor mode. Data is canceled, and it returns to the monitor mode without the operation for 20 seconds for the function codes other than a direct drive.

Fig.8-2-6 Method of operating function setting

Note: About the direct drive

A direct drive is a function that the change data is reflected in the output of APR even if it doesn't fix it. The change data is recorded in an internal memory by fixation (The MODE/SET key is pushed or do not operate key for 20 seconds.). (It is not recorded in the memory while changing data.)

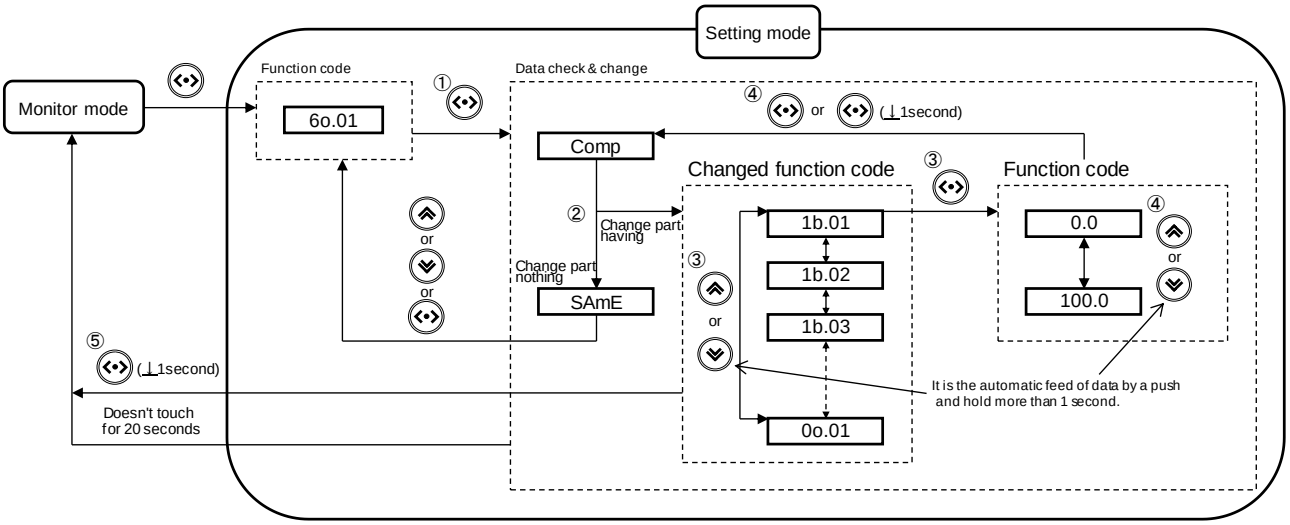
Refer to "8.3.1. Function code list "about the function code of the object.

* It returns to the data setting display to push the UP･DOWN key when the alarm code is displayed while setting the data of a direct drive. The data before the alarm code is displayed is automatically fixed.

(3) Data check & change

It explains the manner of operation of data check & change.

In this operation, function code only 6o.01 (data check & change) is an object.



Operational procedure

① Function code 6o.01 is selected in a setting mode, and ⟷ is pushed.

② After it is displayed as **ComP**, the following display is done.

･When there is no change part of the function code

It is displayed as **SAmE.** It returns to the function code display when ⟷, ∧ or ∨ is pushed.

･When there is a change part of the function code

The changed function code is displayed.

③ It switches with ∧ or ∨ when there are two or more changed function codes.

When the function code is selected, and ⟷ is pushed, the function code data is displayed.

④ The function code data is changed with ∧ or ∨ , and the fixation of data pushes ⟷ or the cancellation of the data . change by ⟷ for keep pushing 1second more.

After fixes or cancels, it returns to ②, and data is compared again.

* Refer to (1) Function select and (2) Function setting for the manner of operation of each function code.

⑤ ～ Method of return to monitor mode ～

When be displayed the function code, keep pushing ⟷ for 1 second or more.

Or, do not operate it for 20 seconds.

Fig.8-2-7 Method of operating data check & change

8.3. Function code

8.3.1. Function code list

The function codes are used to select various functions of the APR main unit.
The function codes consist of the following 6 groups: Basic function (b code), feedback function (F code), network function (n code), alarm function (A code), Configuration option function (o code), Initial setting function (i code).

■ Checking and setting the function code data
The function code data has the one of a possible setting change and the impossible one.
The “data processing” field in the function code list on the next and subsequent pages presents the symbols that identify the classification.
◎: Can be checked and set freely.
○: Exclusively for setting
△: Data is protected by password. Customers can check the data but cannot set data.
×: Exclusively for checking
●: Data cannot be checked or set through network communication.

■ Skip function
The condition that the function code becomes non-display is shown in the column of "Skip" in the function code list.
○ : Displayed at all times. It is not skipped.
Function Code: It is the function code and functional code data leading to a skip.
Note: Setting is disabled if the function code is not displayed.

The following tables are lists of the function code.

Basic function 1 (1b. code)

Function Code	Name	Function code data (Settable range)	Increment	Unit	Factory setting	Data processing	Skip		Direct drive
							Function Code	Data	
1b.01	Digital manual setting	0 - 100.0 (%)	0.1	%	0	◎	○	–	○
1b.02	Digital gradient setting	0 - 200.0 (%)	0.1	%	100.0	◎	○	–	○
1b.03	Base load setting	0 - 100.0 (%)	0.1	%	0	◎	○	–	○
1b.04	Soft start time setting	Control type T or A : 0 - 100.0 (Sec) Control type B : 0.5- 100.0 (Sec)	0.1	Sec	0.5	◎	○	–	–
1b.05	Soft up time setting		0.1	Sec	0.5	◎	○	–	–
1b.06	Soft down time setting		0.1	Sec	0.5	◎	○	–	–

Basic function 2 (2b. code)

Function Code	Name	Function code data (Settable range)	Increment	Unit	Factory setting	Data processing	Skip		Direct drive
							Function Code	Data	
2b.01	Selection of manual setting device	Setting indicator : Aod External variable resistor : m - vr	–	–	m - vr	◎	○	–	–
2b.02	Selection of gradient setting device	Setting indicator : Aod External variable resistor : G - vr Voltage signal setting : 5vm0	–	–	Aod	◎	○	–	–
2b.03	Selection of auto setting voltage signal	1 - 5VDC (4-20mADC) : 1 - 5v 0 - 5VDC (0 / 12VDC) : 0 - 5v	–	–	1 -5v	◎	○	–	–
2b.04	Selection of firing mode	Phase control : PHA1 Burst firing : CyC Phase angle : PHA2	–	–	PHA1	◎	○	–	–
2b.05	Selection of output characteristics	Linearity : Lnr Square-law characteristics : SqU	–	–	Lnr	◎	○	–	–
2b.06	Selection of two-position control valid / switching	Two-position contorol valid : oFF Auto/manual changeover input : mAnU Setting indicator - HIGH : AP - H Setting indicator - LOW : AP - L	–	–	oFF	◎	○	–	–
2b.07	Selection of two-position control high / low lay out	L - 1b.01 , H - 1b.02 : LA.HA L - 1b.01 , H - Gradient VR : LA.Hv L - Manual VR , H - 1b.02 : Lv.HA L - Manual VR , H - Gradient VR : Lv.Hv	–	–	LA.HA	◎	○	–	–

Feedback function (3F. code)

Function Code	Name	Function code data (Settable range)	Increment	Unit	Factory setting	Data processing	Skip: Function Code	Skip: Data	Direct drive
3F.01	CLR setting	0-Rated current (A)	0.1	A	Rated current	◎	0i.03	t	○
3F.02	P control setting	0.100- 0.500 (times) : 100- 500	1	0.001 times	300	◎	0i.03	t	○
3F.03	I contorl setting	25-125 (mSec)	1	mSec	75	◎	0i.03	t	○
3F.04	Heater disconnection judgment level setting	0-100.0 (%)	0.1	%	0	◎	0i.03	t	○
3F.05	Heater disconnection judgment time setting	0-60 (Sec)	1	Sec	1	◎	0i.03	t	○
3F.06	Selection of Heater disconnection operation state	Continue operation : rUn Stop operation : StoP	—	—	rUn	◎	0i.03	t	—
3F.07	Selection of Heater disconnection detection valid / invalid	invalid : oFF valid : on	—	—	oFF	◎	0i.03	t	—
3F.08	Selection of operation mode	Normal operation mode : Fbon Test run mode : tESt	—	—	Fbon	◎	0i.03	t or A	—

Network function (4n. code)

Function Code	Name	Function code data (Settable range)	Increment	Unit	Factory setting	Data processing	Skip: Function Code	Skip: Data	Direct drive
4n.01	Selection of parallel operation Master / Slave	Master : no.1 Slave : no.2-	—	—	no.1	◎●	0i.04	nEt	—
4n.02	Unit setting	Select all : 0 Select unit : 1 - 255	1	—	1	◎●	0i.04	m - S	—
4n.03	Transmission speed	4800 bps : 4.80 9600 bps : 9.60 19200 bps : 19.20 38400 bps : 38.40	—	kbps	9.60	◎●	0i.04	m - S	—
4n.04	Selection of parity bit + stop bit	No parity bit + Stop bit (2 bits) : P0 Even parity bit + Stop bit (1 bit) : P1 Odd parity bit + Stop bit (1 bit) : P2 No parity bit + Stop bit (1 bit) : P3	—	—	P2	◎●	0i.04	m - S	—
4n.05	Host: Selection of operation at occurrence of an error	Immediate stop : SP - 3 Communication retry : SP - 4 Continue operation : SP - 5	—	—	SP - 5	◎●	0i.04	m - S	—
4n.06	Timer operation time	0 – 60 (Sec)	0.1	Sec	2.0	◎●	0i.04 4n.05	m - S SP - 3	○
4n.07	Communication disconnection detection time	No detection : 0 1 – 60 (Sec) : 1 - 60	1	Sec	0	◎●	0i.04	m - S	○
4n.08	Response intervals	0.001- 1 (Sec) : 1 - 1000	1	—	10	◎●	0i.04	m - S	○

Alarm function (5A. code)

Function Code	Name	Function code data (Settable range)	Increment	Unit	Factory setting	Data processing	Skip: Function Code	Skip: Data	Direct drive
5A.01	Selection of alarm for thyristor error		—	—	A1	◎	0i.03	t	—
5A.02	Selection of communication error alarm		—	—	A -	◎	○	—	—
5A.03	Selection of alarm for heater disconnection		—	—	A -	◎	0i.03	t	—
5A.04	Selection of power supply frequency error alarm		—	—	A -	◎	○	—	—
5A.05	Selection of alarm for abnormal phase rotation	Alarm output : A1 No selection : A -	—	—	A -	◎	○	—	—
5A.06	Selection of current limit setting detection alarm		—	—	A -	◎	0i.03	t	—
5A.07	Selection of alarm for setting signal disconnection		—	—	A -	◎	○	—	—
5A.08	Selection of data write / read error alarm		—	—	A -	◎	○	—	—
5A.09	Selection of power ON check alarm		—	—	A -	◎	○	—	—

Configuration option function (6o. code)

Function Code	Name	Function code data (Settable range)	Increment	Unit	Factory setting	Data processing	Skip		Direct drive
							Function Code	Data	
6o.01	Data check & change	Check start : ComP ⇒ No change : SAmE ⇒ Change : Function code	—	—	—	○●	○	—	—
6o.02	Selection of factory setting	Factory setting : yES ⇒ END : End	—	—	—	○●	○	—	—
6o.03	Selection of operation limit	Operation limit invalid : oFF Operation limit valid : on	—	—	oFF	◎	○		—
6o.04	Selection of standby state	Standby state : on Run state : oFF	—	—	on	◎	○	—	—
6o.05	Selection of main circuit power supply detection valid / invalid	detection valid : on detection invalid : oFF	—	—	oFF	◎	○	—	—
6o.06	Selection of auto/manual terminal function	(MANU-COM)Normal-(4C-5V-M0) Auto -(1-2-3)Manual : n-Am (MANU-COM)Normal-(4C-5V-M0)Manual-(1-2-3) invalid : n-m_ (MANU-COM) invert -(4C-5V-M0) Auto -(1-2-3)Manual : r-Am	—	—	n-Am	◎	○	—	—
6o.07	Selection of output current display	Nondisplay : oFF Display : on	—	—	oFF	◎	2b.04 0i.03	CyC t	—

Initial setting function (0i. code)

Function Code	Name	Function code data (Settable range)	Increment	Unit	Factory setting	Data processing	Skip		Direct drive
							Function Code	Data	
0i.01	Rated voltage setting	100-240	1	V	220V	◎	○	—	—
0i.02	Selection of rated current	20A : 20 45A : 45 60A : 60 100A : 100	—	A	Rated current	△●	○	—	—
0i.03	Selection of control system	No feedback control : t CLR : A ACR + CLR : b	—	—	Contorol tyape	△●	○	—	—
0i.04	Selection of communication system	Parallel operation : m - S Network system : nEt	—	—	Communication system	△●	○	—	—
0i.05	ROM version display	v *.**	—	—	ROM version	×	○	—	—

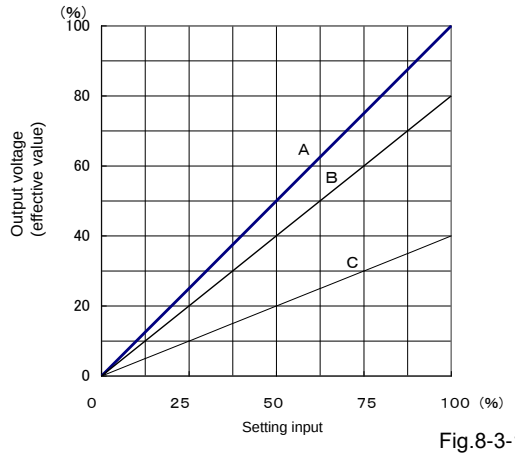
1b.01 Digital manual setting

It functions as substitution of an external variable resistor for the manual setting.
However, when **Aod** (setting indicator) has been selected in function code 2b.01 (selection of manual setting device), this function code is effective.
Moreover, when the LOW setting is allocated to the setting indicator in function code 2b.07 (selection of two-position control high / low lay out), this function code becomes LOW setting.

1b.02 Digital gradient setting

It functions as substitution of an external variable resistor for the gradient setting.
However, when **Aod** (setting indicator) has been selected in function code 2b.02 (selection of gradient setting device), this function code is effective.
Moreover, when the HIGH setting is allocated to the setting indicator in function code 2b.07 (selection of two-position control high / low lay out), this function code becomes HIGH setting.

- gradient setting : It is a function to set the size of the output in the setting signal arbitrarily.



Example of gradient setting value in left graph

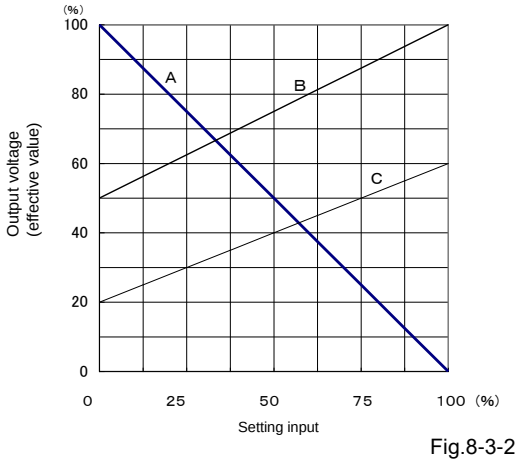
Characteristics	Range of output adjustment (%)	Base load setting (%)	Gradient setting (%)
A	0–100	0	100
B	0– 80	0	80
C	0– 40	0	40

Fig.8-3-1 Gradient setting characteristics

Note: The output voltage cannot be enlarged more than the voltage of the main circuit power supply input.

1b.03 Base load setting

- Base load setting : It is a function to set the size of the output at the setting signal 0% arbitrarily.



Example of base load setting value in left graph

Characteristics	Range of output adjustment (%)	Base load setting (%)	Gradient setting (%)
A	100– 0	100	0
B	50–100	50	100
C	20– 60	20	60

Fig.8-3-2 Base load setting characteristics

1b.04	Soft start time setting
1b.05	Soft up time setting
1b.06	Soft down time setting

• Soft start, soft up / down time:
It is time to increase (decrease) the output from 0 to 100% when control power ON or Instantaneous power interruption or setting signal is changed.

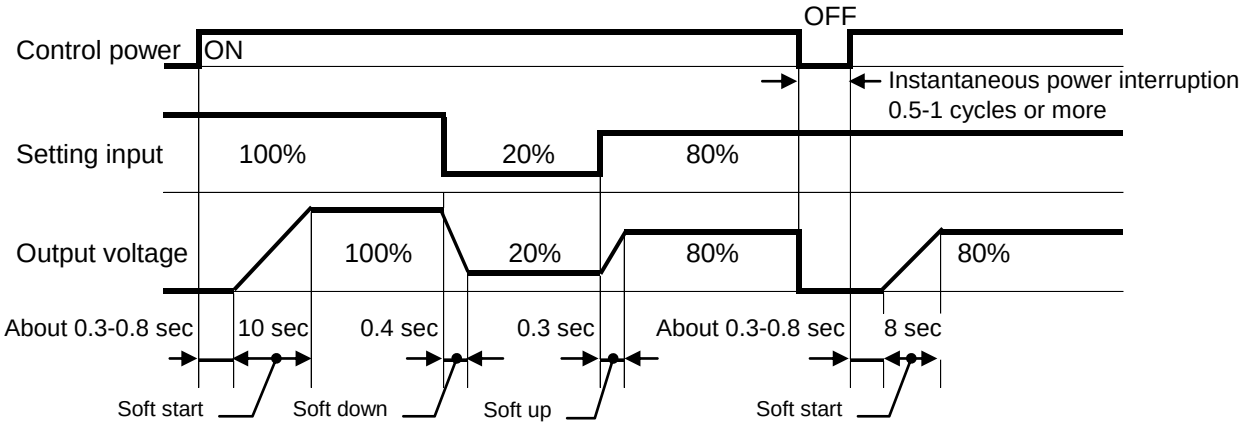


Fig.8-3-3 Soft start, soft up / down example of chart
(soft start time setting: 10sec, soft up / down time setting: 0.5sec, control type: T or A)

2b.01 Selection of manual setting device

Select one from **Aod** (setting indicator) and **m-vr** (external variable resistor).
Note: When the Auto/manual changeover input is a manual setting, a set value becomes effective.

2b.02 Selection of gradient setting device

Select one from **Aod** (setting indicator), **G-vr** (external variable resistor) and **5vm0** (voltage signal setting).
・If **0-5v** (0-5V_{DC} (0/12V_{DC})) is selected for function code 2b.03 (selection of auto setting voltage signal), **5vm0** (voltage signal setting) is not displayed.

2b.03 Selection of auto setting voltage signal

Select one from **1-5v** (1-5V_{DC}) and **0-5v** (0-5V_{DC} (0/12V_{DC})).
Note: Select **0-5v** (0-5V_{DC} (0/12V_{DC})) for SSC signal (0/12V_{DC}).
・If **5vm0** (voltage signal setting) is selected for function code 2b.02 (selection of gradient setting device), **0-5v** (0-5V_{DC} (0/12V_{DC})) is not displayed.

2b.04 Selection of firing mode

Select one from **PHA1** (phase control), **CyC** (burst firing) and **PHA2** (phase angle).
・If **SqU** (square-law characteristics) is selected for function code 2b.05 (selection of output characteristics), **PHA2** (phase angle) is not displayed.

- Phase control:
  It is a method to control 0-100% in the voltage that joins the load by controlling fire angle α at a power supply frequency half cycle.

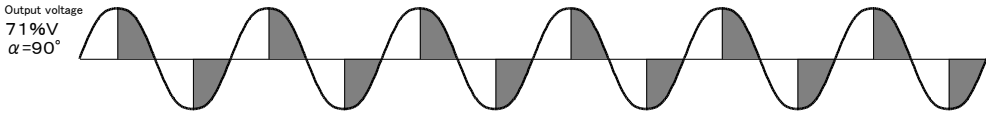


Fig.8-3-4 Phase control Output voltage waveform

- Burst firing:
  It is a method to control 0-100% in the voltage that joins the load by controlling the ratio of the power supply voltage one cycle in the constant period at an on-off period.

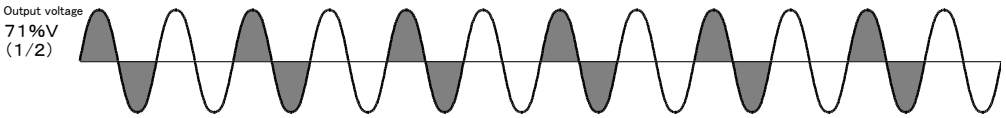
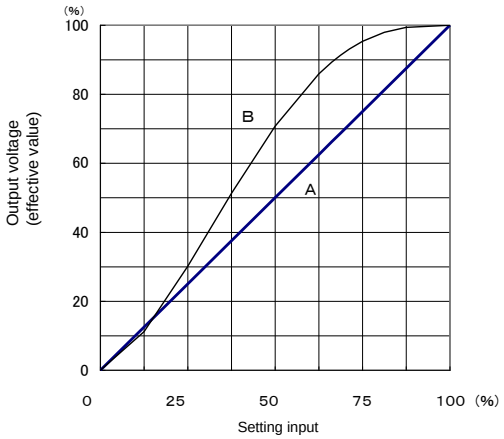


Fig.8-3-5 Burst firing Output voltage waveform

- Phase angle:
  It is a method that fire angle α is proportional to set input.



Characteristics	Firing mode
A	Phase control
B	Phase angle

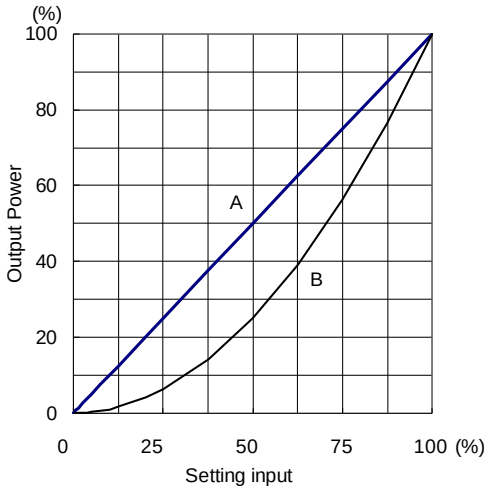
Fig.8-3-6 Phase control and phase angle characteristics

2b.05 Selection of output characteristics

Select one from **Lnr** (linearity) and **SqU** (square-law characteristics).

・If **PHA2** (phase angle) is selected for function code 2b.04 (selection of firing mode), **SqU** (square-law characteristics) is not displayed.

- Square-law characteristics:
  The output voltage is squared according to a setting input. The characteristic of the output power proportional to a setting input can be obtained.



Characteristics	Output characteristics
A	Square-law characteristics
B	Linearity

Fig.8-3-7 Square-law and Linearity characteristics

2b.06 Selection of two-position control valid / switching

The invalidity of two-positional control function or the change equipment of the HIGH/LOW setting is selected as follows.

oFF ⋯ Two positional control function is invalidated.

mAnu ⋯ The HIGH/LOW setting is changed with control input connector [MANU, COM].

AP-H ⋯ A set equipment of the HIGH setting is effective.

AP-L ⋯ A set equipment of the LOW setting is effective.

Note: Select **mAnU** (Auto/manual changeover input), **AP-H** (Setting indicator - HIGH) or **AP-L** (Setting indicator - LOW) when you make two positional control function effective.

2b.07 Selection of two-position control high / low lay out

The setting device allocation of the HIGH setting and the LOW setting is selected as follows.

LA.HA (LOW setting：1b.01, HIGH setting：1b.02)
LA.Hv (LOW setting：1b.01, HIGH setting：Gradient setting)
Lv.HA (LOW setting：Manual setting, HIGH setting：1b.02)
Lv.Hv (LOW setting：Manual setting, HIGH setting：Gradient setting)

3F.01	CLR setting

・CLR setting：The output voltage is limited so that the output current should not exceed the CLR setting.

3F.02	P control setting

P control setting with CLR and ACR

3F.03	I control setting

I control setting with CLR and ACR

3F.04	Heater disconnection judgment level setting

In phase control, when output current value falls below the disconnection judgment level setting, it is judged that a disconnection has occurred.
In burst firing, load open judgment is made at 5% or higher.

3F.05	Heater disconnection judgment time setting

It is time from heater disconnection occurrence to the alarm transmission. During in this time has to be in the heater disconnection state.

3F.06	Selection of Heater disconnection operation state

Choose **rUn** (keep operating.) or a **StoP** (stop operation) after heater disconnection occurrence.

3F.07	Selection of Heater disconnection detection valid / invalid

Select whether enabling (starting) or disabling (stopping) disconnection judgment detection.

3F.08	Selection of operation mode

Select one from **Fbon** (normal operation mode) and **tESt** (test run mode).
If **tESt** (test run mode) is selected, feedback control system type A (AC CLR) is selected from feedback control type B (AC ACR + AC CLR).

4n.01 Selection of parallel operation Master / Slave

Select either **no.1** (master) or **no.2-** (slave) when parallel operation (option type: ZAP).
Note: Do not select **no.2-** (slave) when there is no communication board.

4n.02 Unit setting

Allocates each unit number to APR main unit when network operation (option type: ZAM). No.0 is exclusive for broadcasting.
Note: Units from 1 to 255 are selectable, but the maximum number of APRs is 31.

4n.03 Transmission speed

Select the transmission speed between the network device and the APR main unit.

4n.04 Selection of parity bit + stop bit

Select the parity bit and stop bit between the network device and the APR main unit.

4n.05 Host: Selection of operation at occurrence of an error

Select the operation of the APR after the occurrence of an error of communication between the host (network device) and the APR main unit.
Selectable items

SP-3: Alarm cord E_nt [communication error (network)] appears, and operation is stopped immediately.
SP-4: Communication is retried for the period of timer operation, and if normal communication is not restored, alarm code E_nt [communication error (network)] appears, and operation of the APR main unit is stopped. If normal communication is restored, the alarm code disappears, and operation of the APR main unit is restarted.
SP-5: Communication is retried for the period of timer operation, and if normal communication is not restored, error code E_nt [communication error (network)] appears, but operation is continued.

4n.06 Timer operation time

Appears when SP-4 or SP-5 is selected for function code 4n.05 (Host: Selection of operation at occurrence of an error).

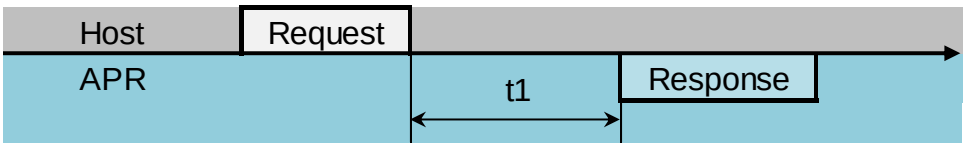
4n.07 Communication disconnection detection time

In the system in which devices (including APR) controlled by the host are to be accessed in specified time period, if no access is made due to a disconnection during operation, APR detects no access, and judges as a transmission error when specified communication disconnection detection time elapses.

4n.08 Response intervals

Set the time period from completion of receiving a request from the network device to returning the response. By setting the response intervals, appropriate timing can be selected for the device with slow processing speed.

t1 = Response interval + α
(α = Processing time within the APR, which varies depending on timing and type of command)



5A.01 – 5A.08 Selection of alarm

Select one from **A1** (alarm output) and **A-** (no selection).

5A.09 Selection of power ON check alarm

After the control power supply starts, the alarm output is turned on if **A1** (alarm output) has been selected. If alarm (alarm output ON) is generated, the alarm output is turned off. The alarm output turns on again when alarm is released afterwards.

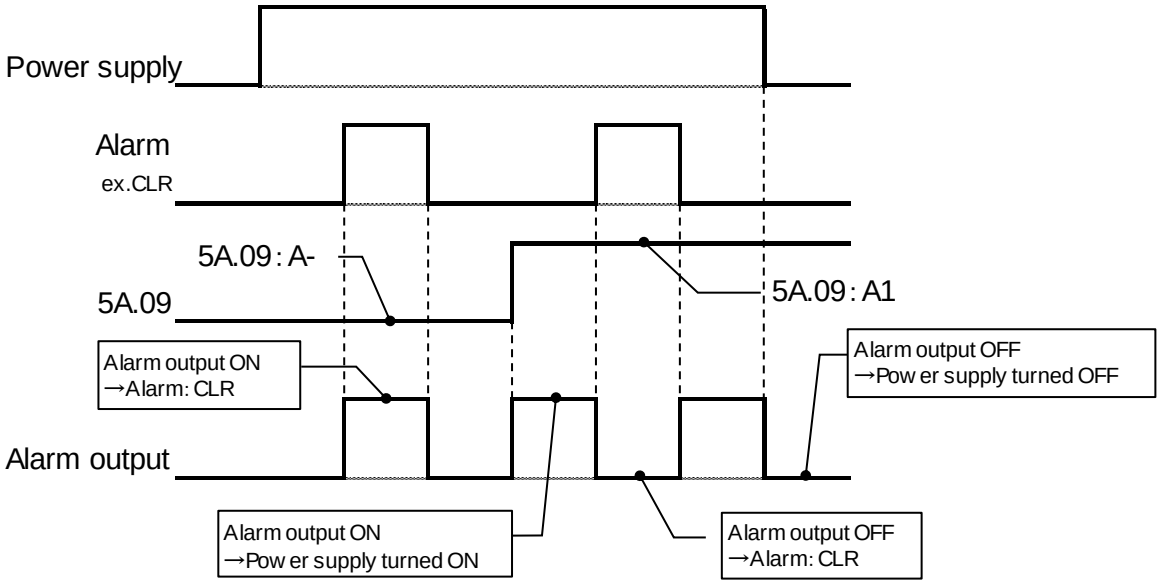


Fig.8-3-8 Time chart for selection of power ON check alarm

6o.01 Data check & change See Fig. 8-2-7

The function code changed from the factory setting is displayed. The function code data can be changed.
Note: Refer to 8.2.2.2. (3) Data check & change

6o.02 Selection of factory setting

Select one from **yES** (restores factory setting) and **no** (does not restore factory setting).
It is displayed when **yES** (restores factory setting) is chosen as **wAit** (in the middle of the setting change), is displayed **End** (normally terminated) afterwards, and the changed function code returns to the state of the factory shipment.

6o.03 Selection of operation limit

Select one from **oFF** (operation limit invalid) and **on** (operation limit valid).
Only the monitor mode functions when the operation limitation is valid.
Note: How to reset the operation limit
[1] Press the MODE/SET key in the monitor mode and "0000" is displayed.
[2] Display "0123" by operating the UP・DOWN key, and then press the MODE/SET key, it shift to the setting mode.
[3] Display the function code 6o.03 (selection of operation limit) by operating the UP・DOWN key, and then press the MODE/SET key.
[4] **oFF** (operation limit invalid) is displayed, and then press the MODE/SET key, the operation limitation is released.
E_10 (Password input error) appears if the set key is pressed without displaying "0123"

6o.04 Selection of standby state

Select one from **on** (standby state) and **oFF** (run state).
In the stand-by state, the data display (DRIVE MONITOR and alarm lamp are excluded.) part is turned off five minutes after it operates it at the end. Operate the key to light again.
Note: When the DRIVE MONITOR and alarm lamp has been turned off in the stand-by state, all the data display parts are turned off. Note it.

6o.05 Selection of main circuit power supply detection valid / invalid

Select one from **on** (detection valid) and **oFF** (detection invalid) when valid for soft start after main circuit power supply is turning on (option type: Z45).
Note: When **oFF** (detection invalid) is selected, option type: Z45 becomes invalid.

6o.06 Selection of auto/manual terminal function

The logic of Auto/manual changeover input and the function allocation of Auto setting input are selected as shown in the following figures.

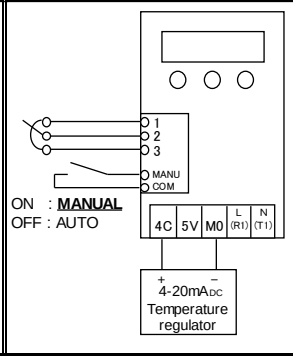
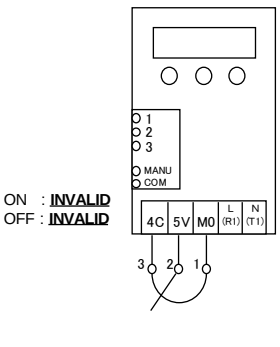
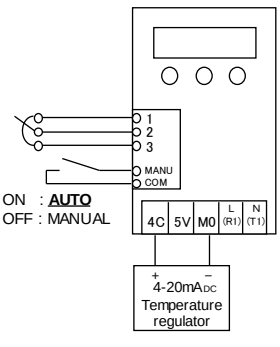
Function code data	**n-Am**	**n-m_**	**r-Am**
Auto/manual changeover input logic	Normal	Invalid	reverse
Auto setting input function	Auto setting	Manual setting	Auto setting
manual setting input function	Manual setting	Invalid	Manual setting
Explanatory drawing			

Fig.8-3-9 Selection of auto/manual terminal function

6o.07 Selection of output current display

Select either OFF (nondisplay) or ON (display) for "Output current" in the monitor mode.
Note: In inductive load, transformer primary control, and rectifier primary control, exact output current cannot be displayed.

0i.01 Rated voltage setting

Set the control power-supply voltage value. The linearity is adjusted in the I/O characteristic.
Set the control source when the voltage is different by the main circuit power supply and the control source.
Note: OFF/ON by the control source when you change the rated voltage setting. (The setting is reflected.)

0i.02 Selection of rated current

The rated current can be confirmed. Monitoring only is allowed. The setting cannot be changed.

0i.03 Selection of control system

The control system can be confirmed. Monitoring only is allowed. The setting cannot be changed.

0i.04 Selection of communication system

The communication system can be confirmed. Monitoring only is allowed. The setting cannot be changed.
Note: The display is m-S (parallel operation) when there is no communication board.

0i.05 ROM version display

ROM version can be confirmed. Monitoring only is allowed. The setting cannot be changed.

8.3.3. Heater disconnection

(1) Applicable condition

[1] Control system : Types A, B

[2] Load : Heaters made of alloy
(Load that feeds 40 to 100% of the rated current 100% output voltage)

[3] Number of units connected in parallel : 1 to 3 (Materials and capacity must be the same)

(2) Disconnection judgment setting

The function code data is set by the following procedures in the setting indicator.

[1] Disconnection judgment alarm output : Function code 5A.03 (Selection of alarm for heater disconnection)
→ **A1** (alarm output), **A-** (no selection)

[2] Disconnection judgment time setting : Function code 3F.05 (Heater disconnection judgment time setting)
→ **0** – **60** (sec)

[3] Disconnection operation state : Function code 3F.06 (Selection of Heater disconnection operation state)
→ **run** (Continue operation), **StoP** (Stop operation)

[4] Disconnection judgment level : Function code 3F.04 (Heater disconnection judgment level setting)
→ **0** – **100**(%)

●Phase control、Phase angle

・When set to lower than 5% : Disconnection judgment invalid

・When set to 5% or higher : Heater disconnection is detected when output current of approximately to 100% is fed.

●Burst Firing

・When set to lower than 5% : Disconnection judgment invalid

・When set to 5% or higher : Heater disconnection is detected when output current of less than 5% of rated current is fed. (Load open)

[5] Disconnection judgment start/stop : Function code 3F.07 (Selection of Heater disconnection detection valid / invalid)
→ **oFF**(invalid), **on**(valid)

(3) Judgment range : 30 – 100% (output reading)

(4) Judgment accuracy : ±5%FS or lower

(5) Alarm reset : Control source off

(6) Heater disconnection characteristics

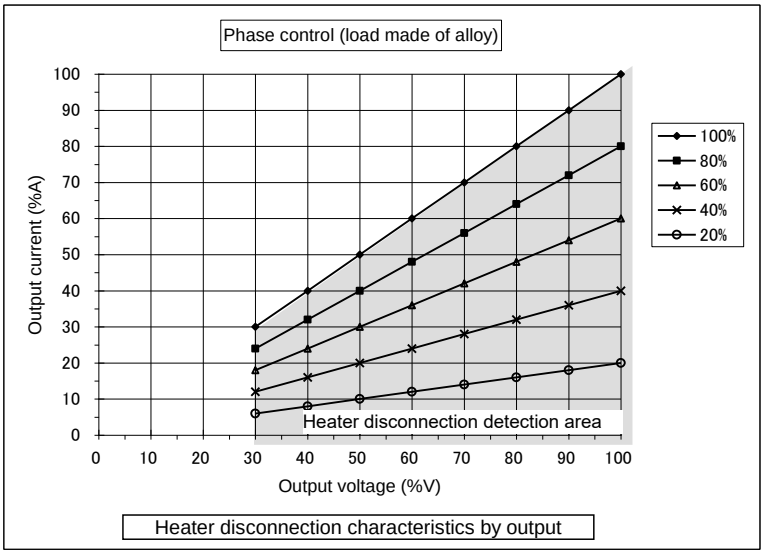


Fig.8-3-10 Heater disconnection characteristics

9. OPERATION

Observe the following during operation.

⚠ WARNING

- Check the installation and wiring carefully for improper wiring and poor connections.
- Be sure to mount the cover of the terminal block first, and then set the power to ON. Do not remove the cover in energized state.
- Do not operate switches with wet hand. Do not splash liquid such as water over the instrument.
- If an alarm is issued, or any abnormality such as emission of abnormal odor is found, turn off the input power, and then perform inspection. If the alarm or abnormal state recurs and the cause cannot be found, be sure to contact your dealer and never leave the problem unsolved.
- Do not touch the APR terminals while energized even if the instrument is suspended. (When function code 6o.04 (Selection of standby state) are **on** (Standby state), they may be all LED putting out lights.)

····· Electric shock or fire may result.

⚠ CAUTION

- Do not touch the heat sink because it becomes hot.

····· Injury or burns may result.

After installation and wiring are completed, perform the following to prepare for operation.

(1) Check the installation and wiring carefully for improper wiring and poor connections. Otherwise malfunction or failure may result.

(2) Check carefully that the input voltage and load are appropriate for the rating of the APR. If the load is less than 1/4 of the rated current of the APR, see (5) and (6).

(3) Do not remove any parts of the main unit, or change unnecessary function codes to avoid failure or malfunction.

(4) In the case of transformer primary control
 [1] If there is a possibility that no load is applied to the transformer, connect a resistance that feeds the current of approximately 0.5 A to the primary winding in parallel.
 [2] Allow sufficient magnetic flux density of the transformer. (1.0-1.2T or less)
 [3] Even when input voltage decreases to -15% or less, this product continues outputting. And, the overcurrent that results from bias magnetism might occur if input voltage returns normally.

(5) The APR cannot be operated normally unless a load is connected. Output voltage is generated through the CR for thyristor protection when the load is opened, which can be measured with a meter.

(6) The load current detection is necessary for control system B type (ACR+CLR) goods. If APR doesn't connect a real load, correct operation cannot be done. Set in the following function code when you do performance test by a temporary load with these APR.
 ・3F.08(Selection of operation mode): **tESt** (test run mode)
 Set back to Fbon(Normal operation mode) after test.

(7) Notes on the life of power cycles
 If the APR is operated and stopped in short cycles (operated for 30 minutes and then suspended for 30 minutes, for example) repeatedly, large temperature difference arises within the interior of the thyristor element, and consequently the life of the thyristor element is shortened significantly due to thermal fatigue. If the APR is used in such cycles, the temperature fluctuation range should be minimized.
 Specifically, reduce the duty cycle of the rated current to less than 80%. Or select an APR whose rated current is one stage higher to keep the duty ratio to less than 80% of the rated current.

10. MAINTENANCE AND INSPECTION

Pay attention to the following when performing maintenance/inspection.

⚠ WARNING

- Before performing inspections, turn off the power and wait for 5 minutes or longer. Check using a tester that there is no electric potential between the main circuit terminals L1 and U, and power supply terminals L and N. Before performing inspections, check the voltage between terminals as well as a terminal and the earthing with a tester, taking the entry of voltage from the output side into consideration.
- Do not perform maintenance and inspection or replace parts unless you are authorized to do so.
  ⋯⋯⋯ Electric shock or injury may result.
- Clean the cooling fin after it checks.

10.1. Alarm code display and remedy

If any abnormality is detected, alarm code displays in the display part and alarm lamp blinks. And if you set the alarm output to ON, the alarm output is set to ON.

Table.10-1 Alarm and remedy

Display	Alarm	Description	Operation after detection	Resetting method
E_tH	Thyristor error	Short circuit of thyristor element is detected by integrated CT.	Drive pulse stop	(1)
E_CP	CPU memory error	It is detected CPU memory error when APR starts up.	Output stop	(2)
E_nt	Communication error	Detects communication error of parallel operation.	Output stop	(3)
		Detects network error of network communication.	Output continued	(3)
E_Hb	Heater disconnection	Heater disconnection	Output continued/stop	(4)
E_LF	Power supply abnormal	When power supply frequency falls within the 45 to 65 Hz range	Output stop	(5)
E_PH	Antiphase detection	Detects antiphase	Output stop	(6)
E_CL	CLR detection	Detects load current that exceeds the CLR setting.	Output continued	(7)
E_Sm	Manual setting input disconnected	Detects disconnection of manual setter	Output stop	(8)
E_SG	Gradient setting input disconnected	Detects disconnection of gradient setter	Output stop	(8)
E_SA	Auto setting input disconnected	Detects break of current/voltage setting signals	Output stop	(8)
E_rw	Data read/write error	Detects Read/Write check error to EEPROM	Output continued	(2)
E_10	Password input error	Disagreement of password	Output continued	Automatically restored after 2 sec.

(1) If thyristor error occurs, the thyristor element is short-circuited. Contact us in this case.
(2) If CPU error (memory error) and data read/write failure should occur, contact us.
(3) If any abnormality is found during parallel operation, check the following.
  [1] In the case of parallel operation
    ・Check that function code: 4n.01(selection of parallel operation Master / Slave) is master when the alarm code displays it though APR does not operate in parallel.
    ・Check the cable for remote operation for disconnection.
    ・Check the control power supply of the APR on the previous stage for break.
  [2] In the case of network communication
    ・Refer to User's manual "Communication board Modbus RTU"(No.INR-MK31060E).
(4) If heater disconnection should occur, check the load after power off.
(5) If power supply abnormal should occur, check frequency of power supply.
  APR automatically restores by soft start after the frequency returns back to the 45 to 65 Hz range.

(6) If antiphase should occur, check that main circuit and control circuit are the same phase after power off. The false detection by the fact that the power supply circumstances are bad (distortion and noise of power-supply voltage corrugate) is thought when detecting it by this minister. Set to **oFF** (invalid) in function code: 6o.05 (selection of main circuit power supply detection valid / invalid). (Only option type: Z45)

(7) If CLR detection should occur, APR automatically restores when load current decrease to the current limit (CLR) value or less.

(8) If manual setting input disconnecting, gradient setting input disconnecting and auto setting input disconnecting should occur (the detection time is 10 seconds), put following contents into effect. But, other function codes are the factory shipment set value.

[1] In the case of manual setting input disconnected (When you'd like to put "auto setting" into effect, refer to [3].)

- Check the cable for manual setter for disconnection.
- When connecting a manual setter to input/control terminal "M0 (1) - 5V (2) - 4C (3)", set function code 6o.06(selection of auto/manual terminal function) in **n-m_**.
- When connecting a manual setter to input/control terminal "1 - 2 - 3", set function code 2b.01(selection of manual setting device) in **m-vr**(external variable resistor) and connect between the control connector "MANU - COM".
- When signal setting is function code:1b.01(digital manual setting), set the function code: 6o.06(selection of auto/manual terminal function) in **r-Am** and the function code 2b.01(selection of manual setting device) in **Aod**(Setting indicator).

[2] In the case of gradient setting input disconnected

- Check the cable for gradient setter for disconnection.
- When connecting a gradient setter to the control connector "1A - 2A - 3A", set function code 2b.02(selection of gradient setting device) in **G-vr**(external variable resistor).
- When controlling gradient setting by voltage signal setting, make function code 2b.02(selection of gradient setting device) in **5vm0** (voltage signal setting). **Don't set voltage setting signal to $0V_{DC}$.**
- When using function code:1b.02(digital gradient setting), set function code 2b.02 (selection of gradient setting device) in **Aod** (Setting indicator).

[3] In the case of auto setting input disconnected (When you'd like to put "manual setting" into effect, refer to [1].)

- Check the cable for current/voltage setting signal(4-20mA_{DC}, 1-5V_{DC}) for disconnection.
- Confirm whether current/voltage setting signal are less than 4mA_{DC} or less than 1V_{DC}.
- When input signal is voltage setting signal (0-5V_{DC} (SSC signal: 0/12V_{DC})), set the function code 2b.03(selection of auto setting voltage signal) in **0-5v** (0-5V_{DC} (0/12V_{DC})).
- Open between the control connector "MANU - COM".

10.2. Notes on maintenance check

(1) How to reset alarms
Please remove the cause of alarm after shutting down the main circuit and the control circuit when alarms occur.
However, the alarm (communication error, CLR detection etc.) release might be automatically done. There is a possibility of displaying the same alarm again when the power supply is turned on again without removing the cause of alarm.

(2) Lifetime of memory
If setting is made or the instrument is operated or stopped via the setting indicator or a network device, the setting is stored in the non-volatile memory within the APR main unit. Note that the maximum times of write into this non-volatile memory allowed is one million times.
And when the power supply shut down, data for maintenance is written in the memory. Do not turn the power supply on and off frequently.

(3) Check with the DRIVE MONITOR whether the control circuit of the APR is operating normally. It lights when thyristor drive pulses occur.

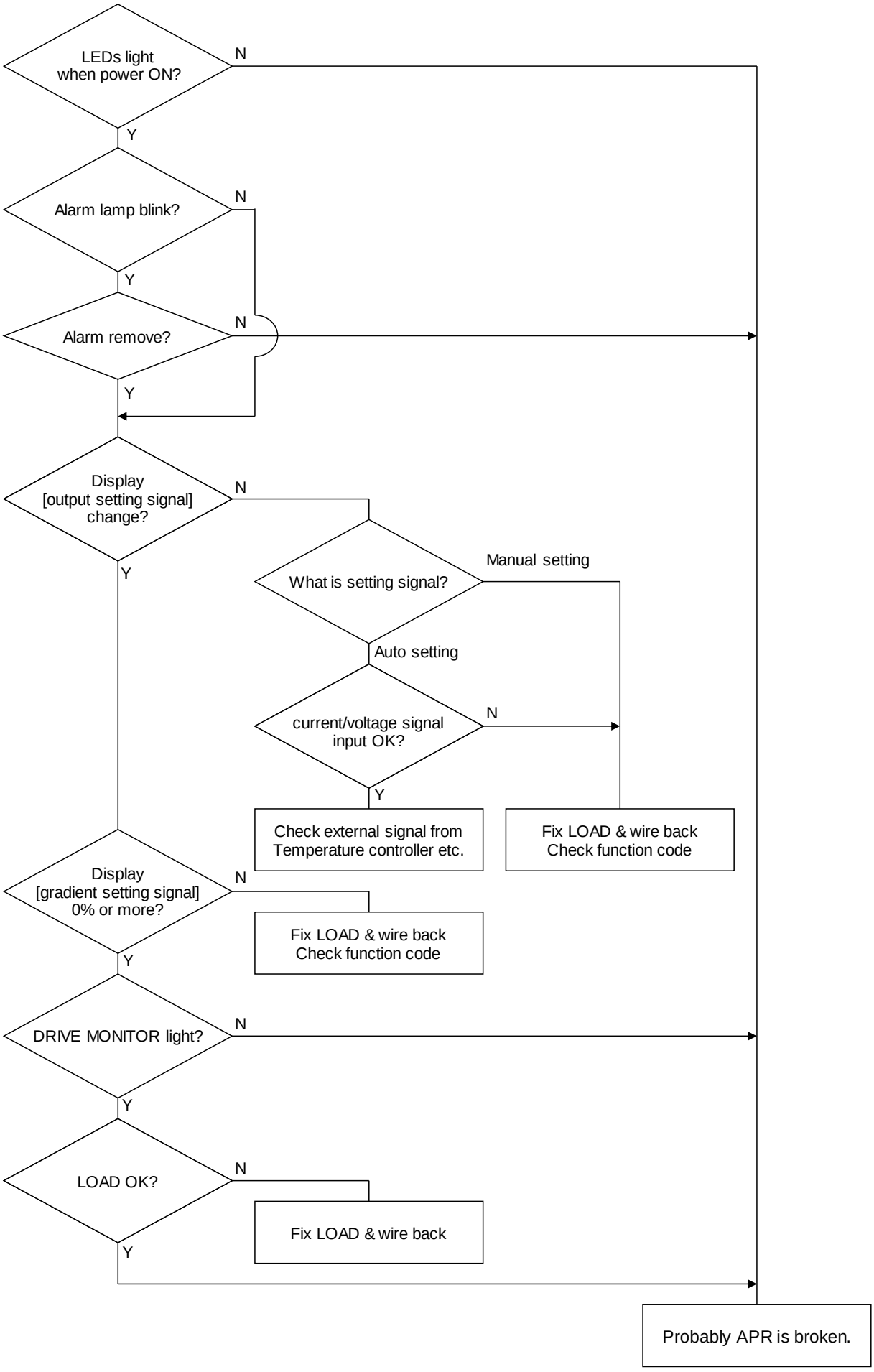
(4) Check each terminal periodically for contact failure.

(5) Check the insulation resistance of the APR and the loads periodically.

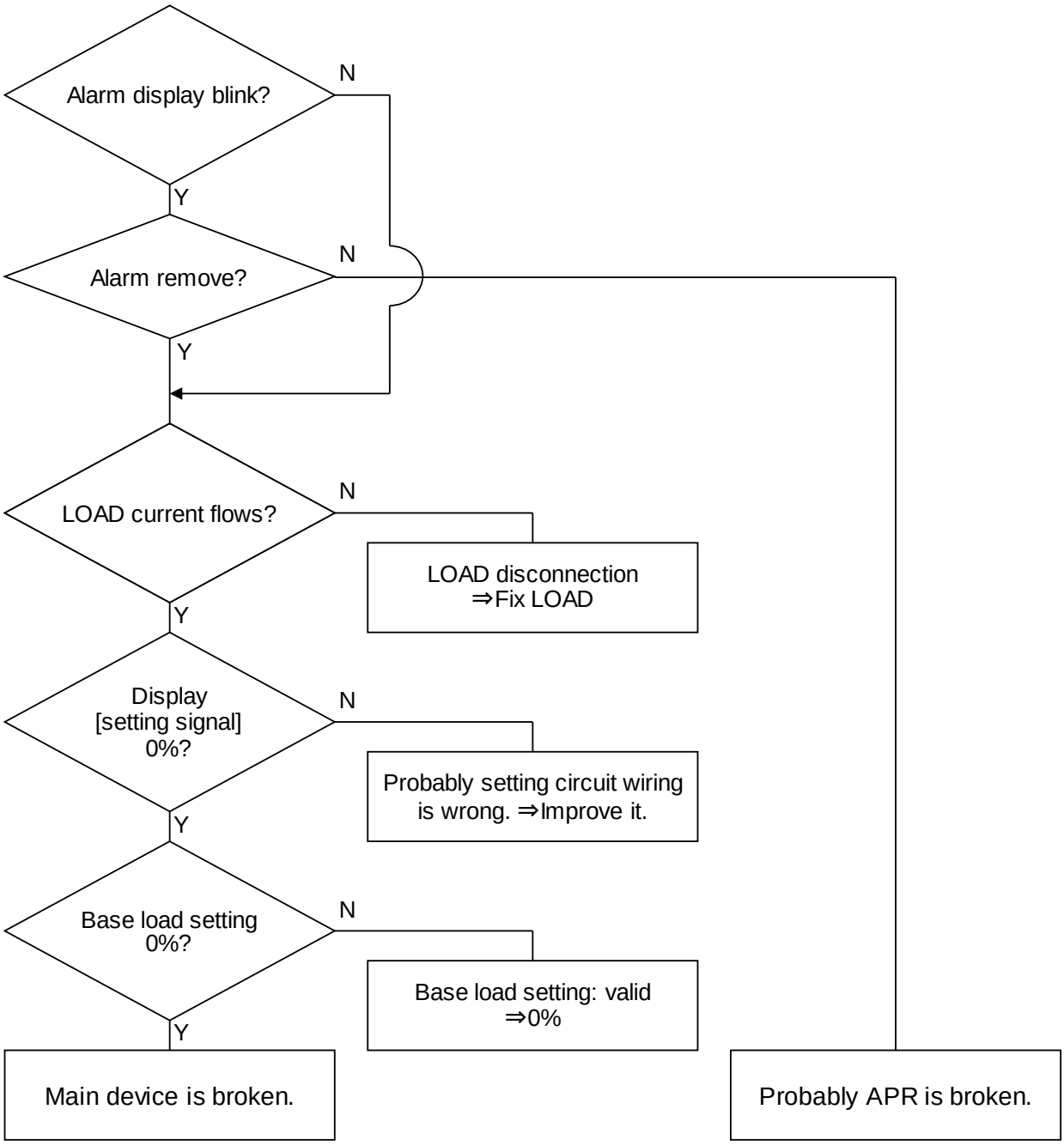
(6) Blow the cooling fin with compressed air periodically to avoid accumulation of dust. Otherwise cooling effect deteriorates, thus causing a failure.

11. TROUBLESHOOTING

(1) No output



(2) Output does not stop



12. GUARANTEE PERIOD

The APR undergoes strict test and inspection processes before delivery, but if any defects should be found, contacts your dealer or our sales representative.

The guaranteed term of the product becomes a period until either of "One year after it purchases it" or "18 months from the manufacturing years described in the rating plate" passes early. However, it becomes an investigation for a fee and a repair in the following cases in the guaranteed term it.

(1) Caused by the mistake in use and an improper repair and remodeling.
(2) When using it within the range to have exceeded the standard specification value.
(3) Caused by damage and the damage when it falls and it is transporting after it purchases it.
(4) Caused by an earthquake, a fire, damage from storm and flood, lightning, an abnormal voltage, other natural disasters, and the second disasters.
(5) When the customer has the responsibility origin.

13. DISPOSAL

Dispose of the instrument as industrial waste by consigning the disposal to an expert waste disposal service.

14. CONTACT

If failure, damage, and other problems should be found, contact your dealer or our sales representative nearest to you, providing the following information:

(1) Type of APR
(2) Serial No.
(3) State of alarm code (At and after power ON)
(4) State of drive monitor
(5) Change in function code data
(6) ROM version
(7) Time of purchase
(8) Details of inquiry (such as position and degree of damage, questionable points, faulty phenomenon, situations, etc.)

……

Note: Contact your dealer or our sales representative nearest to you if you find any unclear points or have questions.
The contents of this manual are subject to change without prior notice.
We are not responsible for the result of operation of the instrument despite the foregoing description.

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