



Instruction Manual

Laser Gas Analyzer for EGCS

TYPE: ZQS-1

PREFACE

Thank you very much for purchasing Fuji Electric's laser gas analyzer for EGCS (Type: ZQS).

- First read this instruction manual carefully until an adequate understanding is acquired. Improper handling may result in an accident or a failure.
- The specifications of the laser gas analyzer may be changed, without prior notice, for further product improvement.
- Modification of the laser gas analyzer is strictly prohibited unless a written approval is obtained from the manufacturer. We will not be responsible for any accident attributable to such remodeling without permission. If it becomes necessary to modify the laser gas analyzer, contact the manufacturer in advance.
- This instruction manual shall be stored by the person who actually uses the laser gas analyzer.
- After reading the manual, be sure to keep it at a place easy to access.
- This instruction manual should be delivered to the end user without fail.
- If returning the product to Japan for repair, please append documentation indicating that the purpose of export is for repair. Please provide us with a certificate indicating that the equipment includes no restricted substances (substances stipulated by "The Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009" or laws and regulations of the exporting country). Fuji Electric shall not be held liable in the cases that re-exporting from Japan is not permitted due to imperfection of the above documents.

Manufacturer: Fuji Electric Co., Ltd.

Type: Described in nameplate on main frame

Date of manufacture: Described in nameplate on main frame

Product nationality: Japan

Request

- Transcription of a part or the whole of this manual without permission is prohibited.
- The contents of this manual are subject to change without prior notice.

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SAFETY INFORMATION

Before using this product, read the following safety precautions and use the product

The following items are important for safe operation and must be fully observed. These safety precautions are ranked in 2 levels; “DANGER”, “CAUTION” and “PROHIBITION”.

 DANGER	If operation is incorrect, a dangerous situation may occur, resulting in death or serious injury.
 CAUTION	If operation is incorrect, a dangerous situation may occur, resulting in minor to medium injuries or only physical damage to equipment.
 PROHIBITION	Items which must not be done are noted.

Installation and transportation	
 DANGER	<ul style="list-style-type: none"> ● When the analyzer (extraction unit) is installed on a flue, make sure the engine has stopped completely. Installing in the engine operation may cause high temperature exhaust gas blowing, resulting in burn. ● This analyzer is not explosion-proof. Do not use it in an atmosphere of explosive gas. This may result in serious accidents such as explosion, fire, etc.
 CAUTION	<ul style="list-style-type: none"> ● The analyzer should be installed in a place conforming to the installation requirements noted in this instruction manual, and where the weight of the analyzer can be endured. Otherwise, it may cause a tip-over, drop, electric shocks, fire or malfunction of the unit. ● Ask professional services or your dealer for installation, transportation, reinstallation, and associated piping and wiring work. Improper installation may result in a falling accident, electric shock, or injury. ● Check the installation site once every 6 months to make sure that the installation surface is free of rattling. If the instrument is used under insecure installation conditions, a falling accident may occur. ● During installation, make sure that the inside of the unit is free from cable chips and other foreign objects. Otherwise, it may cause fire, failure or malfunction. ● For lifting the gas analyzer, be sure to wear protective gloves. Bare hands may leave you prone to injury. If the temperature in the installation site is high, it is imperative to wear leather gloves to prevent burn. ● The analyzer is heavy. It should be transported carefully by two or more persons to prevent body harm or injury.
 PROHIBITION	<ul style="list-style-type: none"> ● Do not allow water to get into the equipment. It may result in electric shock or fire.

Wiring



CAUTION

- Connect a grounding wire securely. Failure to ground equipment may result in electric shock or malfunction.
- If the power supply voltage exceeds the rating, electric shock or damage to the instrument may result. Be sure to use the instrument within the specified rating range.
- Be sure to turn off the power before performing wiring work.
- Use a ground wire with a diameter of 1.5 mm or larger.
- Select input/output wires of materials and diameter that satisfy the rating of each device. If a wire which cannot endure the rating is used, electric shock or fire may occur.
- Fasten the input/output wires to the floor or wall, and use a wire protection device.

Operation



DANGER

- When handling the standard gas such as calibration gas, read the instruction manual of the standard gas carefully, and use the gas correctly.
- When toxic fumes, corrosive gas or inert gas is used as calibration gas, be sure that the position of the air ventilation or exhaust port is suitable. Otherwise you may inhale exhaust gas. Furthermore, suffocation, brain disorder, circulatory deficit, or contraction of the breathing system may occur, resulting in death.



CAUTION

- Do not touch the switch with a wet hand. Otherwise it may cause electric shock.
- Do not touch the detector during operation. It may get hot and cause burns.
- Do not operate the laser gas analyzer for long periods of time with the extraction unit or interface box front panel open. Atmospheric dust or dust may adhere to the insides, resulting in a fault.
- Do not touch the terminal block during operation. Otherwise, it may cause electric shock or injury.
- Before leaving the analyzer unused for a long time or restarting after left at such a status for an extended length of time, follow the instructions of instruction manual because they are different from normal starting or shutdown. Otherwise, adequate performance will not be provided. Furthermore, an accident or fault may be caused.
- Do not allow water to go into the gas analyzer. Otherwise, electric shock or fire in the instrument may be caused.
- Do not smoke nor use a flame near the gas analyzer. Otherwise, it may result in a fire.



PROHIBITION

- Do not put sticks or your fingers in the fan of the extraction unit because it may cause an injury.
- Do not touch the terminals in the interface box, the extraction unit, and the detection unit with your fingers or a piece of metal because it may cause an electric shock or injury.
- Do not smoke or use a flame near the gas analyzer. Otherwise, it may result in a fire.
- Do not allow water to go into the gas analyzer. Otherwise, it may result in an electric shock or a fire.

Maintenance and inspection



DANGER

- When the analyzer (receiver unit and transmitter unit) is installed on incineration facility, make sure the facility has stopped completely. Installing on the operating facility may cause high temperature gas injection, resulting in burn.
- If the analyzer is installed or removed from the location higher than operator's height, set up a fence to keep someone from approaching under or near the unit. If the analyzer inadvertently falls off and hits someone, serious injuries may occur, resulting in death.



CAUTION

- Be careful not to drop the analyzer on your foot. Otherwise, it may cause fracture of the bone.
- Do not touch the terminal block during operation. Otherwise, it may cause electric shock.
- Before working, take off a wrist watch, finger ring or other metallic accessories. Never touch the instrument with a wet hand to avoid electric shocks.
- If the fuse is blown, eliminate the cause, and then replace it with the one of the same capacity and type as before. Otherwise, it may cause electric shock or accident.
- Do not wash or splash water on the switch or electrical parts inside the device. Otherwise it may cause an electric shock, failure, or fire.
- Use only the parts that we specified for replacement. Otherwise, adequate performance will not be provided. Furthermore, an accident or fault may be caused.
- Dispose replacement parts as incombustibles in accordance with the laws and regulations of your country or areas.

Handling of laser equipment



CAUTION

This product can be used as Class 1 laser product. However, be sure to follow the safety instructions below for safety because the product emits laser beam when energized.

- Do not remove the transmitter unit, the receiver unit, or any part of them from the detection unit. Otherwise, it may cause a loss of eyesight and/or skin lesion.

Others



CAUTION

If the cause of any fault cannot be determined despite reference to the instruction manual, be sure to contact your dealer or Fuji Electric's technician in charge of adjustment. If the instrument is disassembled, you may get an electric shock or injury.

WARRANTY AND MAINTENANCE

1. Scope of application

To use this equipment, the following conditions must be met:

- the use of the equipment incurs no risk of a serious accident even if a failure or malfunction occurs on the equipment, and
- in case of product failure or malfunction, safety measures such as redundant design, prevention of malfunction, fail safe system, foolproof mechanism are provided outside of the equipment.

Be sure to use this instrument under the conditions or environment mentioned in this instruction manual.

Please consult us for specifications for the following applications:

Radiation-related facilities, systems related to charging or settlement, or other usages which may have large impact on lives, bodies, property, or other rights or interests.

2. Operating conditions and environment

Refer to "SAFETY INFORMATION" and "4. INSTALLATION".

3. Precautions and prohibitions

Refer to "SAFETY INFORMATION".

4. Warranty

4-1. Period of warranty

- 1) Warranty period for this product including accessories is one year after delivery.
- 2) Warranty period for the parts repaired by our service providers is six months after the completion of repair.

4-2. Scope of warranty

- 1) If any failure or malfunction attributable to Fuji Electric occurs in the period of warranty, we shall provide the product after repairing or replacing the faulty part for free of charge at the place of purchase or delivery.

The warranty does not apply to failure or malfunctions resulting from:

- a) inappropriate conditions, environment, handling or usage that is not instructed in a catalog, instruction book or user's manual, or overuse of the product
- b) other devices not manufactured by Fuji Electric
- c) improper use, or an alteration or repair that is not performed by Fuji Electric
- d) inappropriate maintenance or replacement of expendable parts listed in the instruction book or the catalog
- e) damages incurred during transportation or fall after purchase
- f) any reason that Fuji Electric is not responsible for, including a disaster or natural disaster such as earthquake, thunder, storm and flood damage, or inevitable accident such as abnormal voltage.

2) Regardless of the time period of the occurrence, Fuji Electric is not liable for the damage caused by the factors Fuji Electric is not responsible for, opportunity loss of the purchaser caused by malfunction of Fuji Electric product, passive damages, damage caused due to special situations regardless of whether it was foreseeable or not, and secondary damage, accident compensation, damage to products that were not manufactured by Fuji Electric, and compensation towards other operations.

5. Failure diagnosis

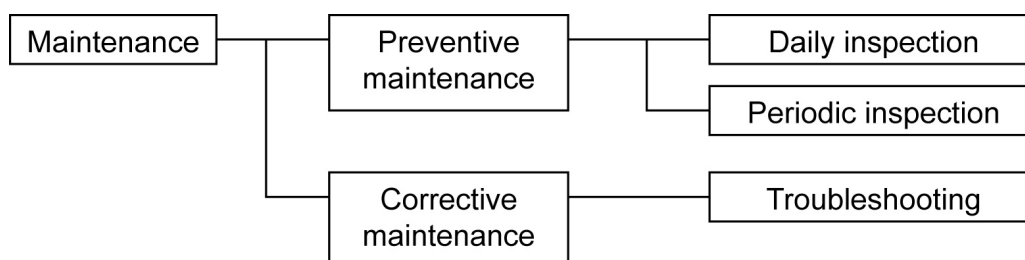
Regardless of the time period of the occurrence, if any failure occurs, the purchaser shall perform a primary failure diagnosis. However, at the purchaser's request, Fuji Electric shall provide the diagnosis service for a fee. In such a case, the purchaser shall be charged for the service.

6. Service life

This product, excluding limited-life parts and consumable parts, is designed to have a service life of 10 years when the average annual ambient temperature is 30°C. To ensure the service life, it is important to perform planned maintenance of the product including limited-life parts and consumable parts.

7. Maintenance plan

Maintenance can be divided into “preventive maintenance” and “corrective maintenance”. Preventive maintenance can further be classified into “daily inspection” and “periodic inspection”. Preventive maintenance is achieved through systematic implementation of "daily inspection" and "periodic inspection".



(1) Daily inspection

Be sure to perform daily inspection prior to operation to check for any problem in daily operation. For the specific items of daily inspection, refer to “8. MAINTENANCE”.

(2) Periodic inspection

Periodic inspection is to replace limited-life parts before their service lives are over, thus preventing failure.

Inspection interval: 6 months to 12 months. If you are using the instrument under harsh environment, we recommend you to shorten the inspection interval. For the specific items of periodic inspection, refer to “8. MAINTENANCE”.

(3) Corrective maintenance

Corrective maintenance is a measure to be taken after a trouble has occurred. Refer to “8. MAINTENANCE” and “10. TROUBLESHOOTING”. If the measures mentioned in this instruction manual do not solve the problem, please contact our sales office or service office.

8. Limited-life parts and consumable parts

This product contains the following limited-life parts and consumable parts which may affect the service life of the product itself.

- (1) Aluminum electrolytic capacitors (used for power supply inside interface box)
 - Design life: 10 years under general working conditions (annual average of ambient temperature: 30°C)
 - Symptoms when a capacitor loses its capacity: deterioration of power quality, malfunction
 - Factors which affect battery life: temperature. The life is shortened by half when the temperature rises by 10°C. (Arrhenius' law)
 - Replacement: Estimate the lifetime of capacitor according to your operating environment, and have the capacitor replaced or overhauled at appropriate time, at least once in 10 years. Do not use capacitors beyond its lifetime. Otherwise, electrolyte leakage or depletion may cause odor, smoke, or fire.
Please contact Fuji Electric or its service providers when an overhaul is required.
- (2) CPU module (PLC inside interface box) battery
 - The clock does not use the battery during the primary power supply.
 - Replacement: when the total time that no primary power is supplied has exceeded five years.

9. Spare parts and accessories

Refer to “2. CHECKING DELIVERED ITEMS” or “8. MAINTENANCE” for details.

10. Period for repair and provision of spare parts after product discontinuation (maintenance period)

The discontinued models (products) can be repaired for five years from the date of discontinuation. Also, most spare parts used for repair are provided for five years from the date of discontinuation. However, some electric parts may not be obtained due to their short life cycle. In this case, repair or provision of spare parts may be difficult even in the above period.

Please contact Fuji Electric or its service providers for further information.

1. GENERAL

1.1 General information

The laser gas analyzer for EGCS (ZQS) continuously monitors the concentrations of SO₂ and CO₂ contained in the gas emitted from a ship engine, and then cleaned by a scrubber. ZQS conforms to the Scheme B of the resolution MEPC 259 (68), the 2015 Guidelines for exhaust gas cleaning systems, adopted by the Marine Environment Protection Committee (MEPC), which is a branch of International Maritime Organization (IMO).

ZQS is composed of an extraction unit, a detection unit, and an interface box, connected with wires and tubes.

- The extraction unit extracts exhaust gas from a flue and preconditions sample gas.
- The detection unit measures the concentrations of the target gas components.
- The interface box accommodates terminals for power supply, signal input and output, and communication.

ZQS uses the semiconductor laser as light source, and absorption spectroscopy to identify the gas concentration. The analyzer targets only one spectrum line among a large number of absorption spectrum lines, and carries out a measurement while controlling the temperature and the driving current of the laser. Since the range of wavelengths to be measured is as narrow as a few nanometers, the analyzer receives minimum interference by other crossovers.

1.2 Compliance

This equipment is a dedicated analyzer for ship EGCS (Exhaust Gas Cleaning Systems). Do not use to measure gas other than exhaust gas from the EGCS scrubber.

First read this instruction manual carefully, and then make a plan for periodic inspection to perform appropriate maintenance management. To maintain the long-term performance of the laser gas analyzer for EGCS (ZQS), our periodic inspection contract is recommended.

This analyzer uses the invisible infrared laser. Do not remove the transmitter unit, the receiver unit, or any part of them from the detection unit. Otherwise, it may cause a loss of eyesight and/or skin lesion.

- Laser class: Class 1 (IEC/EN 60825-1)
- IP rating : IP44 (totally enclosed type, splash-proof). Only the extraction unit fan is IPX4.
- Measurement category : CAT II
- Pollution degree : 2
- Altitude : ≤ 2000 m

COMPLIANCE

IMO Resolution MEPC.259 (68), “2015 Guidelines for Exhaust Gas Cleaning Systems”

IMO Resolution MEPC.177 (58), “NOx Technical Code 2008”

2. CHECKING DELIVERED ITEMS

Please check if the correct quantity of the delivered items are supplied.

Separately supplied document takes priority over lists below.

2.1 Scope of delivery

Table 2-1 Products

Table 2-2 Standard accessories

No.	Product name	Quantity	No.	Product name	Quantity
1.	Extraction unit	1	1.	Bolt	4
2.	Detection unit	1	2.	Nut	4
3.	Interface box	1	3.	Spring washer	4
4.	Gas sampling probe	1	4.	Flat washer	4
5.	Communication cable between the extraction unit and the interface box	1	5.	Companion flange packing	3
6.	AC cable between the extraction unit and the interface box	1	6.	Replacement filter element	2
7.	Communication cable between the detection unit and the interface box	1	7.	Instruction manual	1
8.	AC cable between the detection unit and the interface box	1	8.	Tube cap(A)	1
9.	Cable between the transmitter unit and the receiver unit	1	9.	Tube cap(B)	2
10	Sampling gas tube	1	10	Interface box key	1
			11	Receiver/transmitter box key	1

Note: Distortion may be visible on cases of the extraction unit or the detection unit. However, this is not a defect.

This occurs when welding reinforcing material. This has no adverse influence on functionality or performance during use.

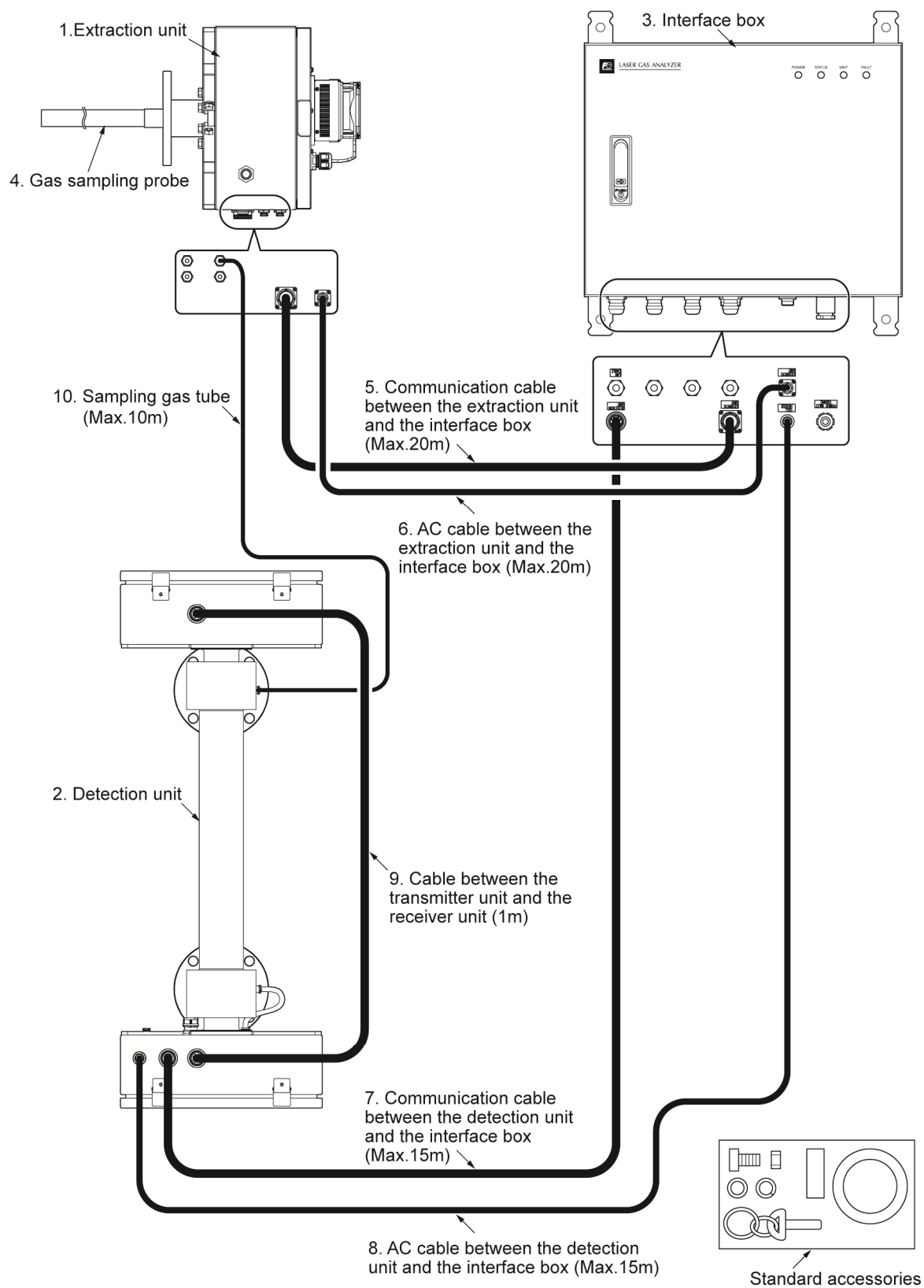


Fig. 2-1 Scope of delivery

3. PARTS AND FUNCTIONS

3.1 Overall composition

ZQS is composed of the extraction unit, the detection unit, and the interface box, connected with wires and tubes. SOx scrubber outlet flue exhaust gas can be measured at one location with this equipment.

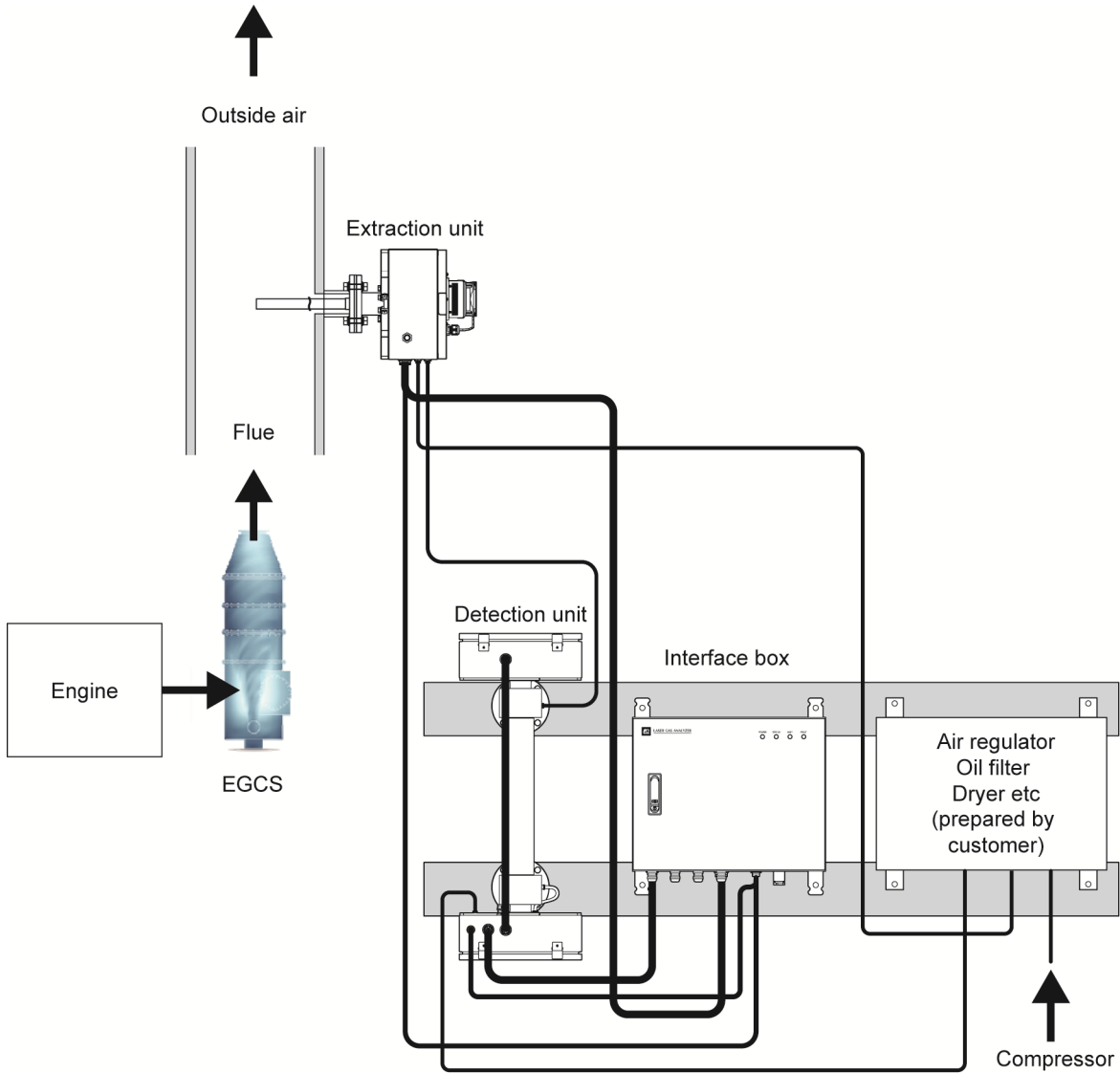


Fig. 3-1 Overall composition

3.2 Functions of each part

Table 3-1 Functions of each part

Name	Description
Extraction unit	It is attached to the flue for extracting exhaust gas. It removes dust, mist, and moisture from the sample gas, and then sends the sample gas to the detection unit.
Detection unit	It measures the concentrations of SO ₂ and CO ₂ by the method of the laser absorption spectroscopy. It is composed of the transmitter unit, the receiver unit, and the heated gas flow cell.
Interface box	It supplies the power to the extraction unit and the detection unit, and communicates with them. It also shows the status of the analyzer, and sends the signals of the analyzer status and the measured values to external devices.
Gas sampling probe	It is inserted close to the center of the flue to extract exhaust gas.
Sampling gas tube	Sample gas flows through this tube from the extraction unit to the detection unit.
Instrument air tube (prepared by customer)	Instrument air is supplied through this tube to the extraction unit and the detection unit.
Communication cable between the extraction unit and the interface box	It transmits electrical signals between the extraction unit and the interface box.
AC cable between the extraction unit and the interface box	It transmits electrical power from the interface box to the heater of the extraction unit.
Communication cable between the detection unit and the interface box	It transmits electrical signals between the detection unit and the interface box.
AC cable between the detection unit and the interface box	It transmits electrical power from the interface box to the heater of the detection unit.
Cable between the transmitter unit and the receiver unit	It transmits electrical signals between the transmitter unit and the receiver unit.

3.3 Status indicators on the interface box

A status indicator is located on the front of the interface box. From the left, these lamps (LEDs) are named POWER (Green 1), STATUS (Green 2), MNT (Amber), and FAULT (Red) as shown in Fig. 3-2. Operators are able to ascertain the equipment status based on a combination of the illumination status of these four LEDs, shown in Table 3-2.

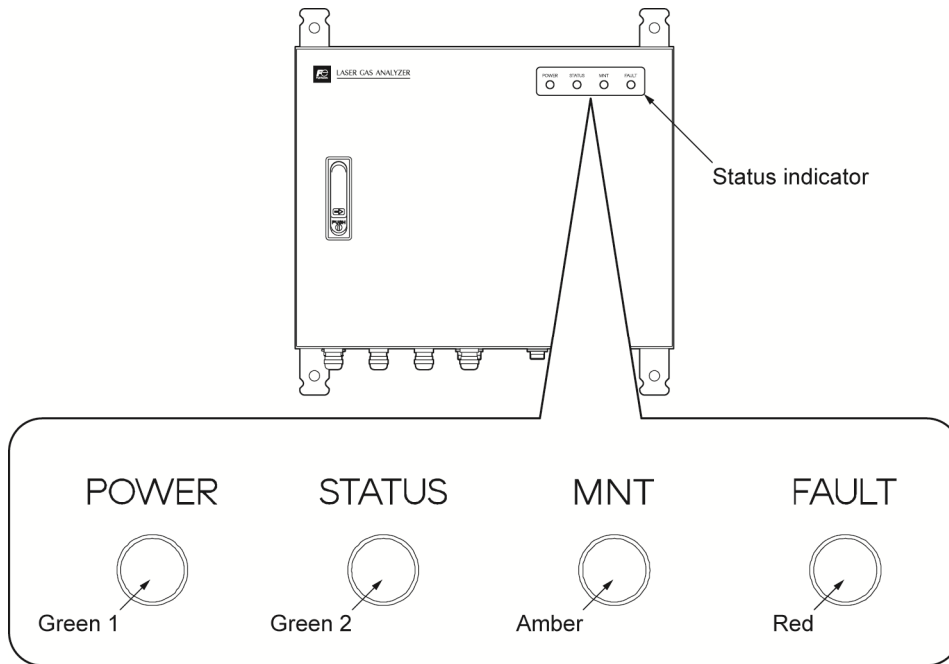


Fig. 3-2 Status indicators on the interface box

Table 3-2 Illumination patterns of status indicators

Status name	×: OFF, ●: ON, ◎ : Blinking, - Undefined			
	POWER (Green1)	STATUS (Green2)	MNT (Amber)	FAULT (Red)
Power OFF	×	×	×	×
Warm-up	●	◎	◎	◎
Measuring (normal operation)	●	●	×	×
Maintenance request (performing measurement)	●	●	●	×
Standby	●	◎	×	×
Maintenance request (while on standby)*2	●	◎	●	×
Analyzer error	●	×	×	●
PLC error*3	●	—	—	—

*1 During warm-up, The STATUS, MNT, and FAULT LEDs repeatedly turn ON in order and turn OFF. “Warm-up” takes priority over every items other than “power OFF”.

*2 Air backflush is performed while on standby (the measurement value will be “0”). Air backflush involves stopping the drawing of exhaust gas, and channeling instrument air from the gas sampling probe to the flue.

*3 PLC (CPU module) errors cannot be detected simply based on the status indicator. Please check with Modbus communication, or at the status indicator on the CPU module inside the interface box.

Refer to “6.2 CPU module” and “10. TROUBLESHOOTING” for details.

3.4 Inputs and outputs in the interface box

For installation and wiring, refer to “4. INSTALLATION”.

3.4.1 External power supply input

Connect the power line (100 V AC, 50 Hz or 60 Hz) and the grounding line (protective earth) to a terminal block shown in Fig. 3-3.

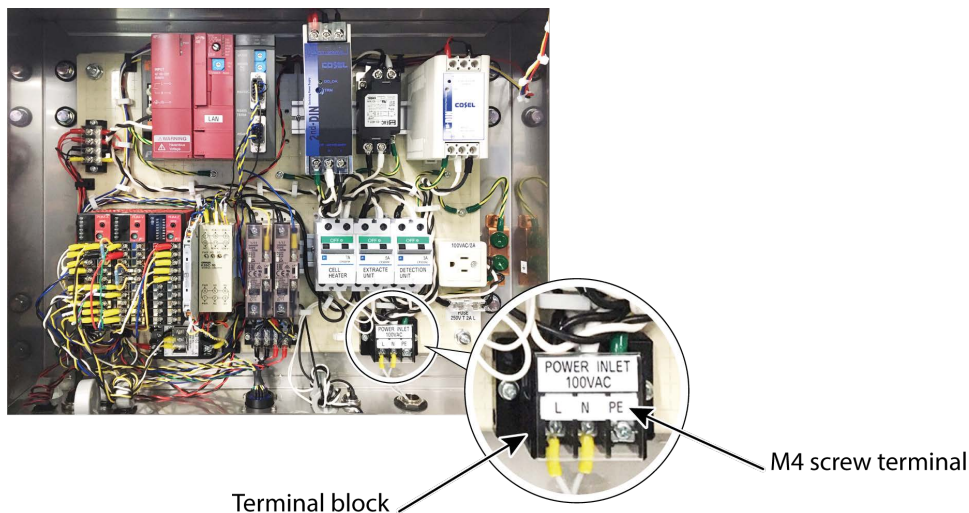


Fig. 3-3 Power terminal block inside interface box

3.4.2 Analog inputs and outputs

Table 3-3 Analog inputs and outputs

Name	Signal	Functions
SO ₂ concentration output	AO1+	Transmit the SO ₂ gas concentration in 4–20 mA signal Concentration range:0–300 ppm
	AO1-	
CO ₂ concentration output	AO2+	Transmit the CO ₂ gas concentration in 4–20 mA signal Concentration range:0–10%
	AO2-	
SO ₂ /CO ₂ output	AO3+	Transmit the SO ₂ /CO ₂ concentration ratio in 4–20 mA signal Range: 0–300 (ppm/vol%)
	AO3-	
Gas temperature input	AI1+	Input the temperature of the exhaust gas at the scrubber output in 4–20 mA signal. If the temperature is out of the range, the analyzer carries out an air backflush of the extraction unit. Gas temperature range: 0–100°C Input via Modbus communication is also possible (Analog input or Modbus input is required).
	AI1-	

*1 If the CO₂ gas concentration is 0.50 vol% or less (valid up to two decimal places, rounded off from third decimal place), a rate of 0 mA is output.

*2 Air backflush: a function of cleansing the sample gas tube by stopping the intake of the exhaust gas and making the instrument air pass through the gas sampling probe towards the flue. This is necessary for protecting the analyzer.

21		11
22		12
23		13
24		14
25		15
26		16
27		17
28		18
29		19
30		20

Analog output (AO)

- 11 AO1+ } SO₂ concentration output 4 to 20 mA
- 12 AO1- } (0 to 300 ppm)
- 16 AO2+ } CO₂ concentration output 4 to 20 mA
- 17 AO2- } (0 to 10 vol%)
- 24 AO3- } SO₂/CO₂ 4 to 20mA*
- 25 AO3+ } (0 to 300 ppm/vol%)

* 0 mA is output if the CO₂ gas concentration is 0.50 vol% or less.

Screw size: M3 × 7

Analog input (AI)

- 14 AI1+ } Gas temperature input 4 to 20 mA
- 15 AI1- } (0 to 100 °C)

Fig. 3-4 Analog output (AO)/input (AI) terminals (PUMV)

3.4.3 Digital inputs and outputs

Table 3-4 Digital inputs and outputs

Name	Signal	Functions
Maintenance, warm-up, sampling suspension	DO5	The contact is closed during maintenance, during start-up, and while sampling is stopped.
Maintenance request	DO6	The contact is closed when maintenance is necessary.
Analyzer error	DO7	The contact is closed when the analyzer error occurs.
Power interruption	DO8	The contact is closed when power is supplied.
Maintenance	DI1	Keep providing ON signal during maintenance. When this signal is input, exhaust gas sampling is stopped, and air backflush is performed. Input via Modbus communication is also possible (Analog input or Modus input is required).
EGCS on/off	DI5	Keep providing ON signal when the EGCS is in operation. ON signal input is a necessary condition for drawing exhaust gas. If there is no ON signal input, air backflush is performed (input by communication is also possible). Input via Modbus communication is also possible(Analog input or Modus input is required).

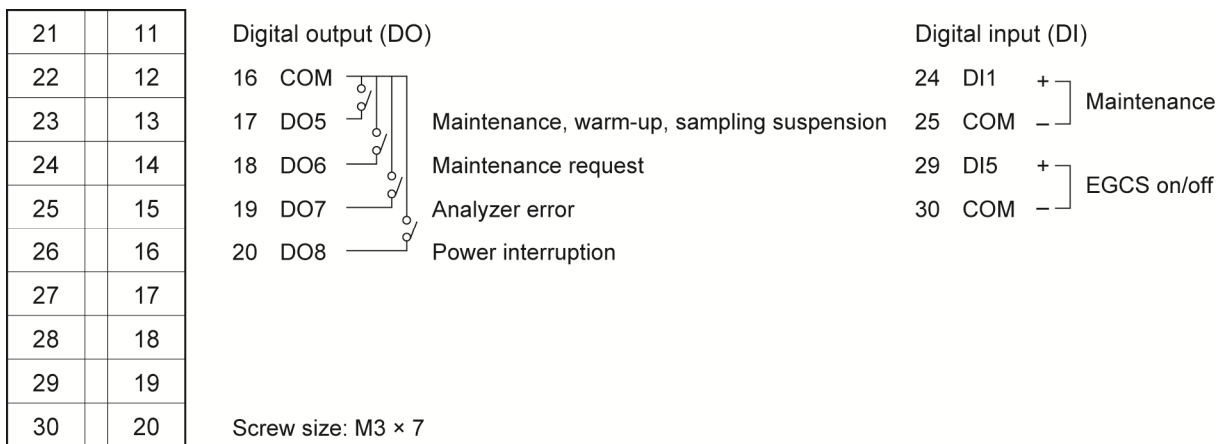


Fig. 3-5 Digital output (DO)/input (DI) terminals (PUME)



3.4.4 Ethernet communication (Modbus TCP)

The analyzer can transmit the readings and status information through Ethernet network. The communication protocol is Modbus/ TCP.

The analog input/output and digital input/output functions are interchangeable with Ethernet communication.

Refer to “6. COMMUNICATION” for the detail.

4. INSTALLATION

 DANGER	This analyzer is not explosion-proof. Do not use it in an atmosphere of explosive gas. Otherwise, it can result in serious accidents such as explosion, fire, etc.
 CAUTION	<ul style="list-style-type: none">• The analyzer should be installed in a place conforming to the installation requirements noted in this instruction manual. Otherwise, it may cause toppling, dropping, electric shocks, fire or malfunction of the unit.• Request the assistance from the professionals or the vendors when mounting, moving, re-mounting and carrying out piping and wiring works associated with these activities. A poor installation may cause accidental tip over, electric shock, injury, etc.• During installation, make sure that the inside of the unit is free from cable chips and other foreign objects. Otherwise, it may cause fire accident or malfunction.• For lifting the analyzer, be sure to wear protective gloves. Bare hands may leave you prone to an injury. If the temperature in the installation location is high, be sure to wear leather gloves. Otherwise, you may suffer a burn.• The analyzer is heavy. It should be transported carefully by two or more persons to prevent body harm or injury.

4.1 Installation conditions

4.1.1 Environmental conditions

To ensure the accurate measurement and avoid the analyzer failure, select a location that meets the following conditions.

Operating environment

- Ambient temperature:
 - Extraction unit: 0–65°C
 - Detection unit: 0–55°C
 - Interface box: 0–45°C*1
 - Sampling gas tube: 0–65°C
- Ambient humidity: ≤ 90% RH (no condensation)
- Vibration: ≤ 0.2 G (1.9 m/s²)

*1: The ambient temperature close to the top of a chimney is high. In order to satisfy ambient temperature conditions, it is recommended that the detection unit and interface box be installed near the bottom of the chimney.

Storage environment

- Ambient temperature: -20°C to 70°C
- Ambient humidity: ≤ 100% RH (no condensation)

4.1.2 Requirements on exhaust gas

This product is applicable only for the gas that meets the conditions below. If you use the product for other gases, not only the measurement may be unavailable, but the product may fail.

Condition

The exhaust gas must be cleaned with a SO_x scrubber before being sent to the analyzer, otherwise not only measurement is not possible, but an equipment fault may occur.

* Be sure to input an “EGCS on/off” signal either by digital input, or by Ethernet communication. By inputting an “EGCS on/off” signal, only exhaust gas that is currently being cleaned with a SO_x scrubber can be extracted, and for other exhaust gas, the equipment can be protected with air backflush.

Gas temperature

5°C to 60°C

The interface box has the analog input to which the exhaust gas temperature is provided. Use the air backflush function to cleanse the sample gas tube with the instrument air when the gas temperature exceeds the range of 5 to 60°C.

* Be sure to input an “exhaust gas temperature” signal either by analog input, or by Ethernet communication. Only exhaust gas that is currently being cleaned with a SO_x scrubber in the above temperature range only can be extracted, and for other exhaust gas, the equipment can be protected with air backflush..

Mist concentration

Not allowed.

Note: Measurement is available even if some amount of mist exists; just note that the higher the mist concentration is, the more serious adverse effect is. For example, it accelerates the corrosion of the pipes of the extraction unit and/or the clogging of the filter.

Water vapor concentration

≤ 20 vol% (below 60°C dew point)

Pressure

-10 kPa to 10 kPa

Gas composition

- SO₂: ≤ 300 vol ppm
- CO₂: ≤ 10 vol%
- NO_x: ≤ 1000 vol ppm
- CO: ≤ 2000 vol ppm
- O₂: 1 vol% to 21 vol%
- CH₄: ≤ 10 vol ppm
- NH₃: ≤ 10 vol ppm
- Balance N₂

4.1.3 Requirements on instrument air

This product uses instrument air and ejectors in order to extract exhaust gas from a flue. Prepare the instrument air that meets the following requirements. Using inadequate instrument air causes not only the measurement error but the product failure. If necessary, install an oil filter, an air filter, and an air dryer, etc. to clean the air from the compressor,

Flow rate

≤ 150 L/min

Pressure

0.3 to 0.4 MPa

Purity

ISO 8573-1: 2010 (JIS B 3892-1: 2012) Class 2.3.2

- Solid particle: Particle size 0.1 μm to 0.5 μm : Maximum number of particles per m^3 : 400 000
Particle size 0.5 μm to 1.0 μm : Maximum number of particles per m^3 : 6000
Particle size 1.0 μm to 5.0 μm : Maximum number of particles per m^3 : 100
- Pressure dewpoint: $\leq -20^\circ\text{C}$ (atmospheric pressure dewpoint: $\leq -34^\circ\text{C}$)
- Oil: ≤ 0.1 mg/m^3

4.2 Installation of the interface box

4.2.1 Installation location

The interface box must be installed in a place where:

1. Meets the environmental requirements described in 4.1.1.
2. Is close enough to the extraction unit.

The maximum length for the cable between the extraction unit and interface box is 20 m.

3. Is close enough to the detection unit.

The maximum length for the cable between the detection unit and interface box is 15 m.

4. The interface box is kept out of rain and water drop.
5. No dust or corrosive gas exists.
6. The level of vibrations is low.
7. The change in the ambient temperature in a day is small.
8. There is enough space for maintenance work.

4.2.2 Installation

The interface box outline is shown in Fig. 4-1, and the mounting dimensions are shown in Fig. 4-2. The interface box is a wall-mounted type. Mount the interface box on a wall in a way that the connector and the cable gland come to lower side. Bolt it to the wall at 4 locations with bolts (recommended size: M12, prepared by customer). The use of spring washers is recommended.

Note: The bolts for interface box are not provided. Provided bolts are for the extraction unit.

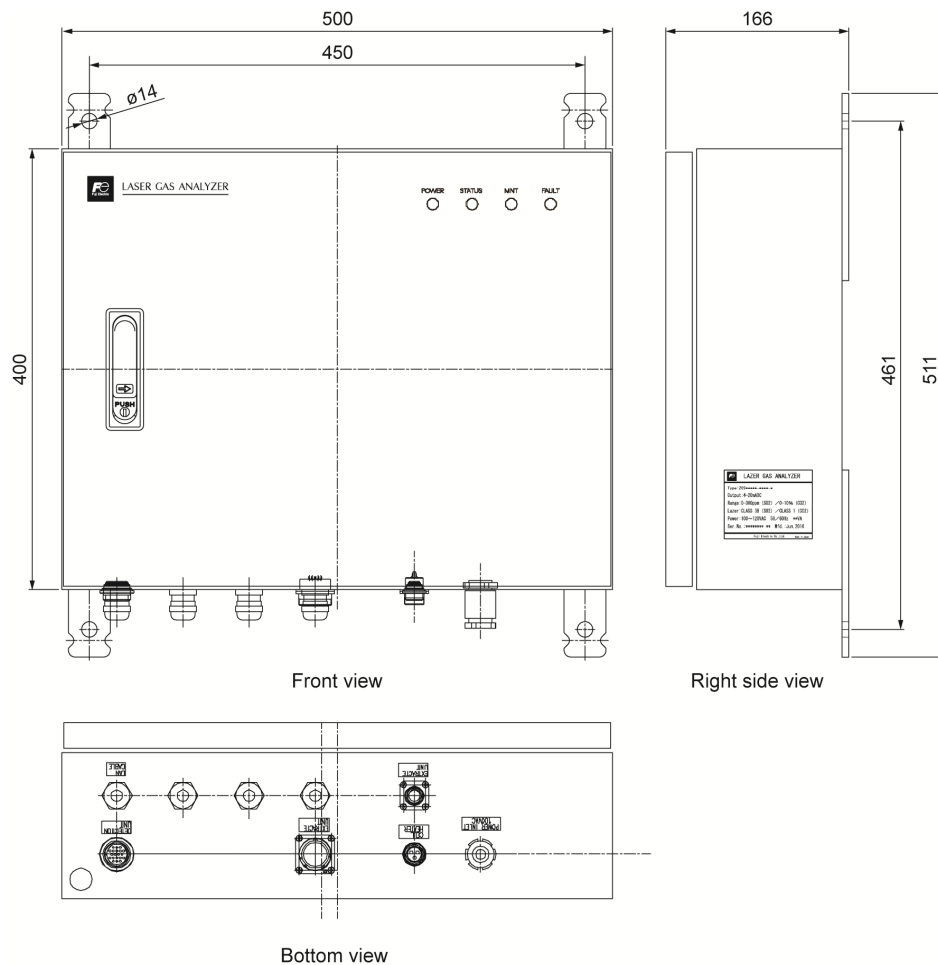


Fig. 4-1 Outline diagram of the interface box

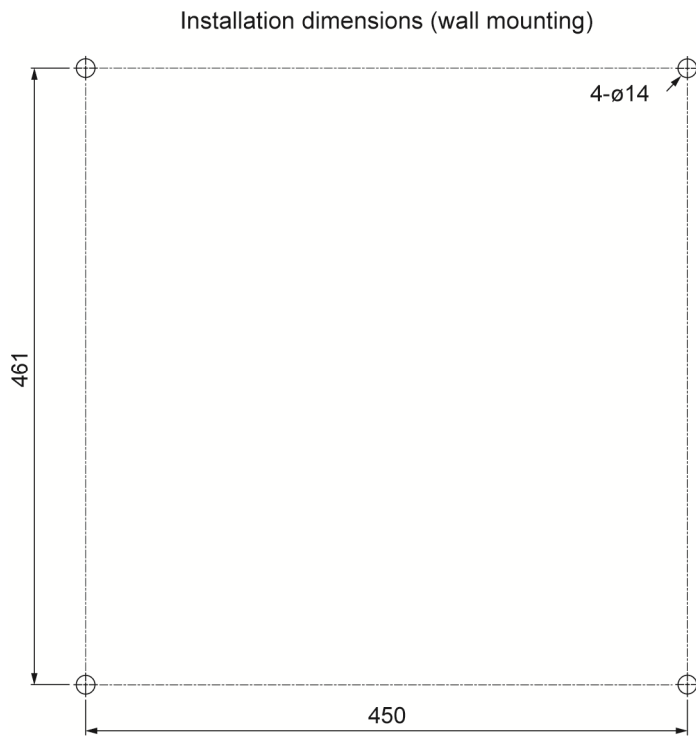


Fig. 4-2 Mounting holes dimensions

4.2.3 Clearance

The minimum required space for interface box installation is shown in Fig. 4-3, and the recommended installation space is shown in Fig. 4-4.

Ensure that the bottom face is 300 mm or more from the floor. This is due to the need for wiring space.

Furthermore, refer to Fig. 4-4 and install at a height that allows workers to perform operation and carry out maintenance easily.

Secure a space in front of the front panel of 520 mm or more in both the width and depth directions as shown in the following diagram. This is because it is necessary to open the front panel to perform operation and carry out maintenance.

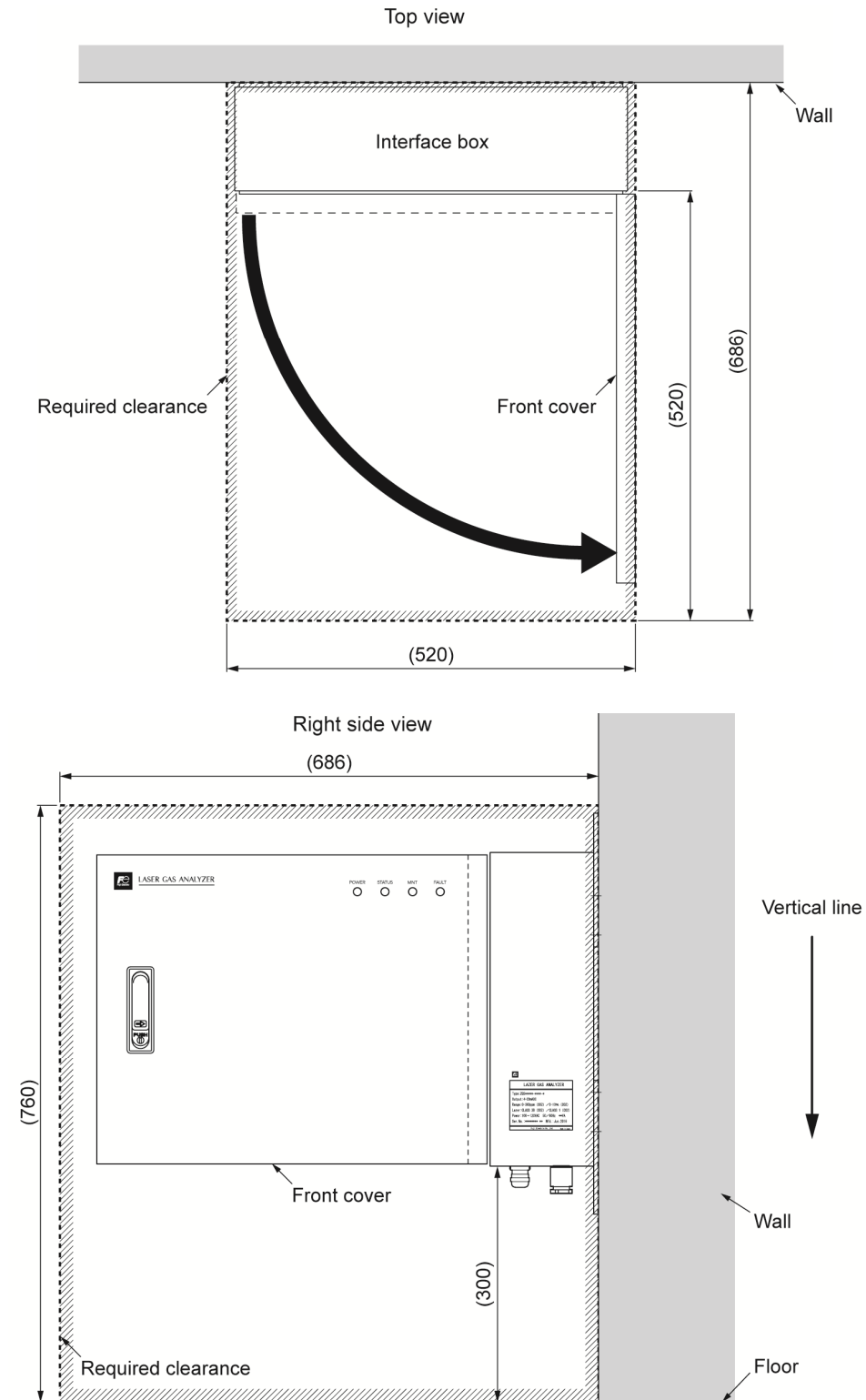


Fig. 4-3 Minimal installation space for the interface box

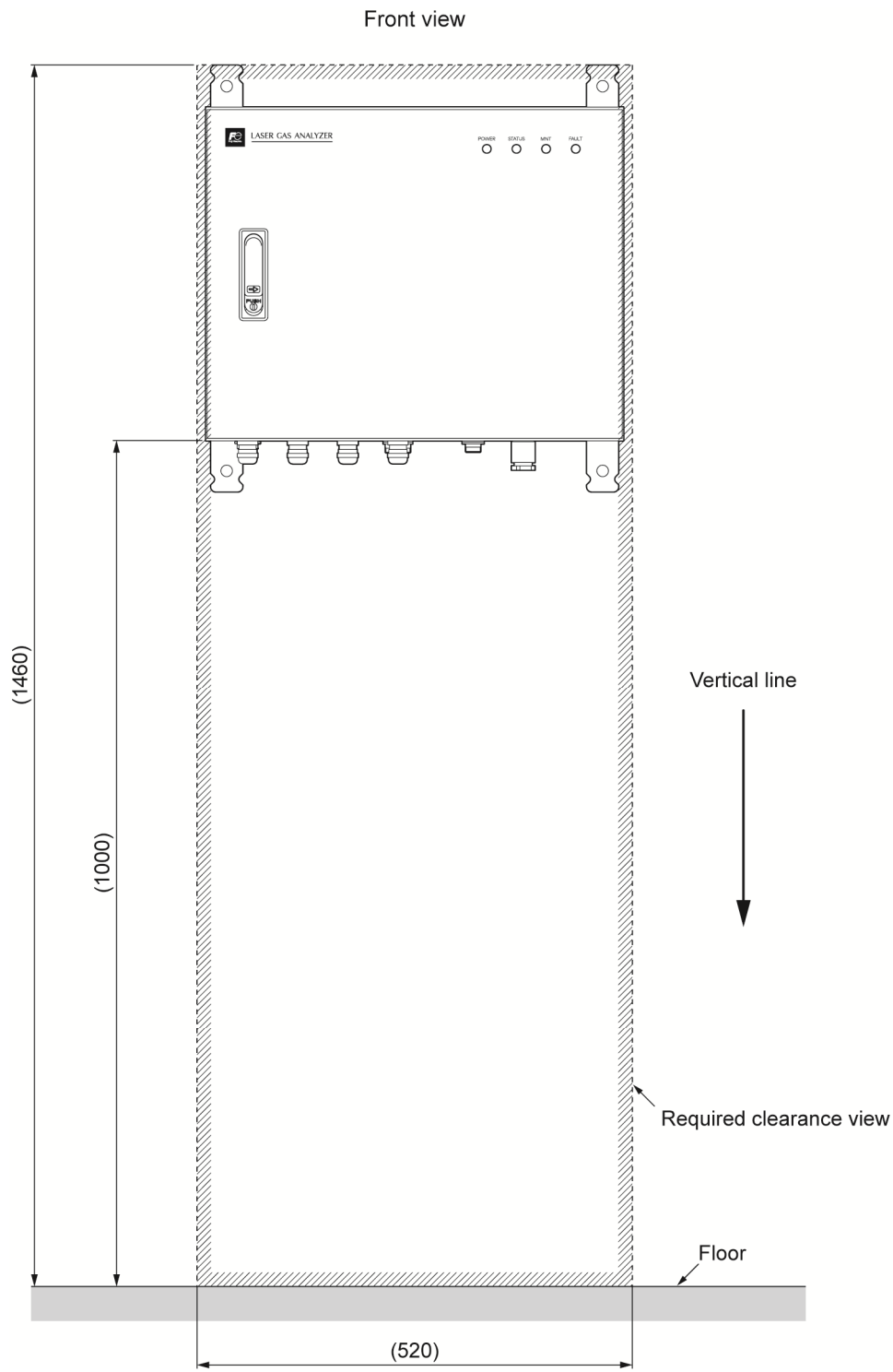


Fig. 4-4 Recommended installation space for height of the interface box

4.3 Installation of the detection unit

4.3.1 Installation location

The detection unit box must be installed in a place where:

1. Meets the environmental requirements described in 4.1.1.

2. Is close enough to the interface box.

The maximum length for the cable between the detection unit and interface box is 20 m.

3. Is close enough to the extraction unit.

The maximum length for the cable between the detection unit and interface box is 10m.

4. The detection unit is kept out of rain and water drop.

5. No dust or corrosive gas exists.

6. The level of vibrations is low.

7. The change in the ambient temperature in a day is small.

8. There is enough space for maintenance work.

4.3.2 Installation

The detection unit outline is shown in Fig. 4-5, and the mounting dimensions are shown in Fig. 4-6.

The detection unit has four bolt holes each at the top and bottom of the cell for mounting. The unit may be mounted on a wall or a flue, however, wall mounting is recommended for ease of installation and maintenance. Mount the unit vertically so that the transmitter comes to the upper side, and the receiver comes to the lower side. Bolt it to the wall with eight bolts (recommended size: M12, prepared by customer). The use of spring washers is recommended.

Both mounting surfaces are on the same flat surface. Ensure that the adjoining wall is also on the same flat surface (gap must be less than 5 mm). Refer to Fig. 4-7 for the installation side.

The two companion flange packings (thickness: 2 mm) in the standard accessories can be inserted to eliminate gap. Do not use the companion flange packings if there are no gap. If the detection unit is bolted when there are still gap, the optical axis will become displaced internally, possibly resulting in a drop in transmittance.

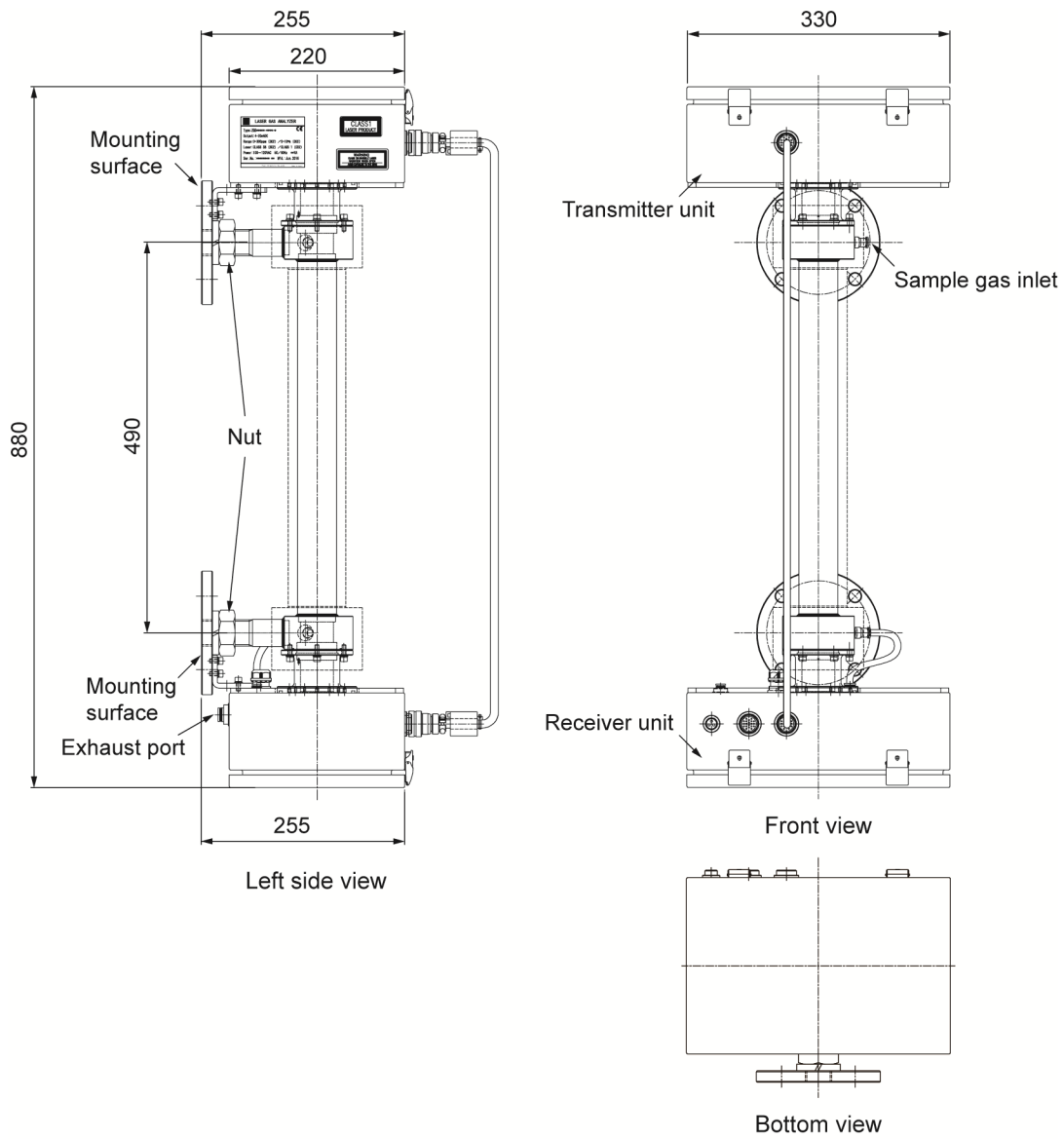


Fig. 4-5 Outline diagram of the detection unit

Installation dimensions (wall mounting)

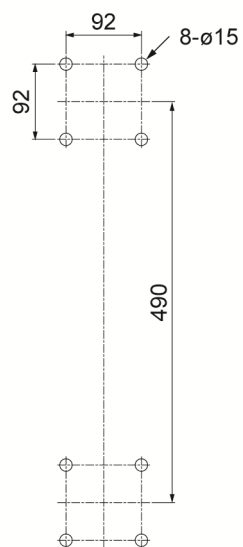


Fig. 4-6 Mounting holes dimensions

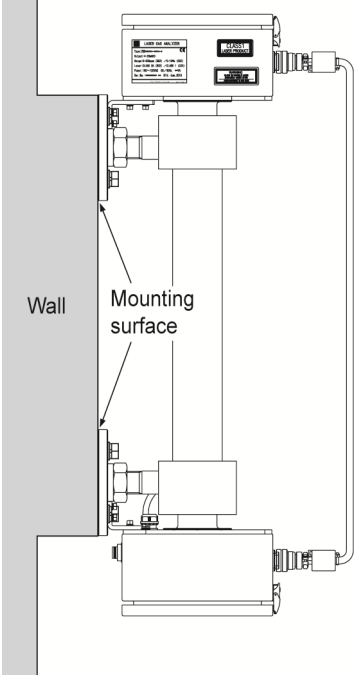
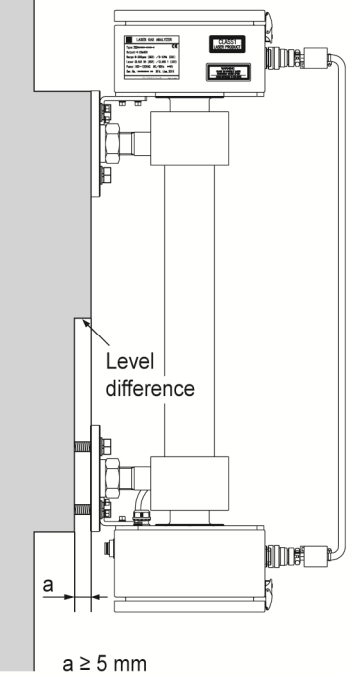
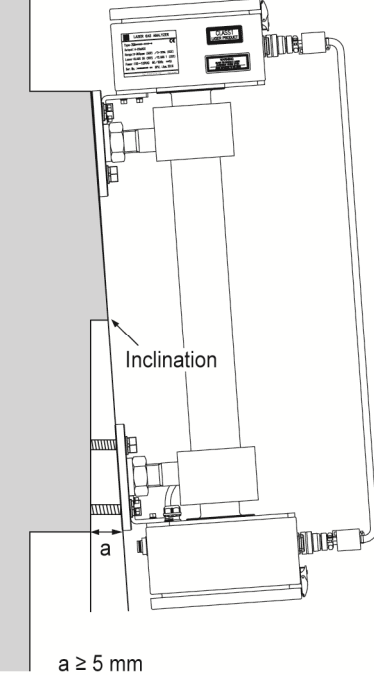
Example of good panel (side view)	Example of bad panel (side view)	
		
<p>Panels are on same flat surface.</p>	<p>Panels are at different levels and inclined, and when one mounting surface and panel are fastened with bolts with no gap between them, gap [a] between the other mounting surface and panel is $a \geq 5$ mm.</p>	

Fig. 4-7 Detection unit installation example

4.3.3 Clearance

Secure space for the detection unit of 300 mm or more above the transmitter, and 500 mm or more below the receiver as shown in Fig. 4-8.

It is recommended to meet the following conditions:

- There should be a floor surface directly below the detection unit.
- The detection unit should be at a height that allows workers to see inside the transmitter without the need for stepladders.

This is to allow service engineers to open the transmitter and receiver case panels to carry out work.

Secure space of 600 mm or more from the flat surface contacting the flange as shown in Fig. 4-8. Furthermore, if connecting a pipe to the exhaust port, secure the required space at the wall surface side.

Secure space of 600 mm or more in the width direction with the detection unit in the center as shown in Fig. 4-9.

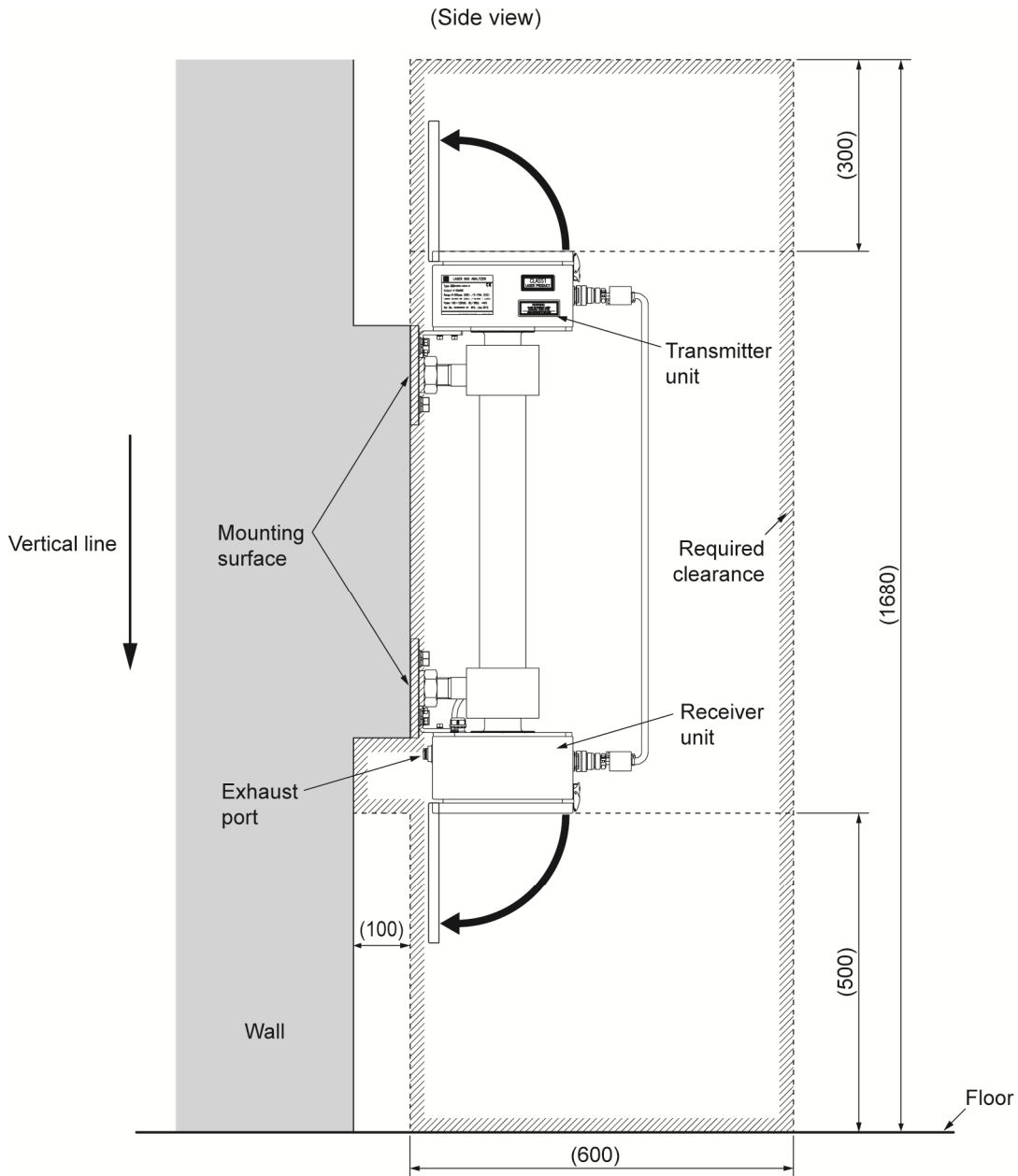


Fig. 4-8 detection unit clearance

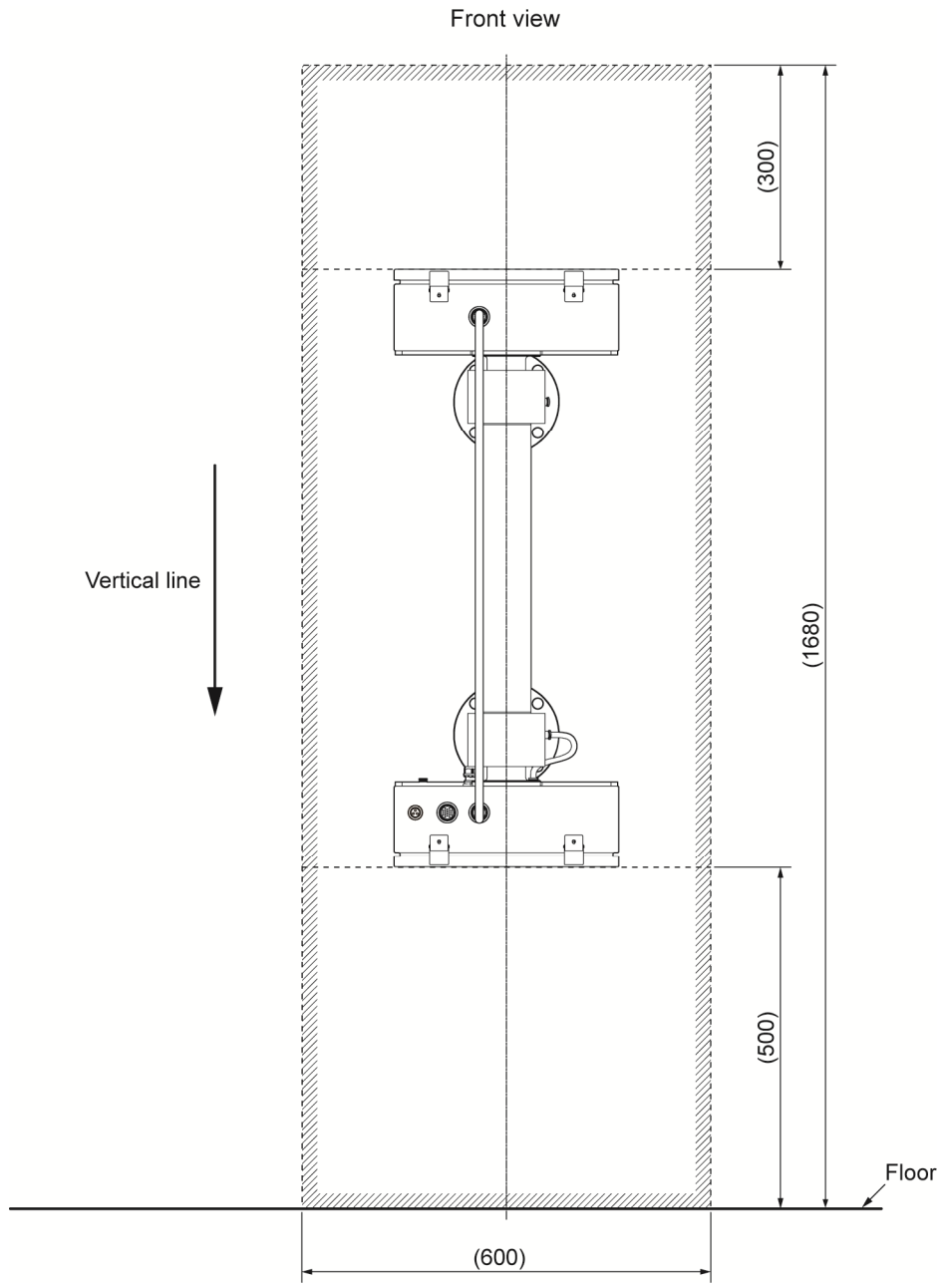


Fig. 4-9 detection unit clearance

4.4 Installation of the extraction unit

4.4.1 Installation location

The extraction unit must be installed in a place where:

1. Meets the environmental requirements described in 4.1.1.
2. Meets the gas requirements described in 4.1.2.
3. Is close enough to the interface box.

The maximum length for the cable between the extraction unit and interface box is 20 m.

4. Is close enough to the detection unit.

The maximum sampling gas tube length is 10 m.

5. The unit is kept out of rain and waterdrop.
6. No dust or corrosive gas exists.
7. The level of vibrations is low.
8. The change in the ambient temperature in a day is small.
9. There is enough space for maintenance work.
10. Allows the maintenance operator to open the panel of the extraction unit and carry out the maintenance work of the parts inside the unit without straining oneself.

4.4.2 Installation

The extraction unit outline is shown in Fig. 4-12. One flange has been provided for the extraction unit. There are holes at four locations for bolts. The flange standard is JIS 5K65A. Mount the extraction unit onto the flue vertically so that the connector and the cable gland come to the lower side as shown in Fig. 4-13.

It is necessary to mount the extraction unit onto the flue in order to sample exhaust gas. Follow the instructions below..

- (1) First, attach the gas sampling probe to the extraction unit. Wrap seal tape twice around the screw of the gas sampling probe as shown in Fig. 4-10.

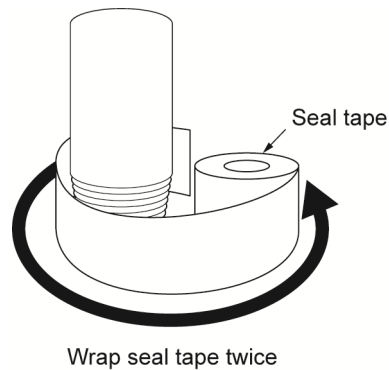


Fig. 4-10 How to wrap seal tape

- (2) Next, screw in the gas sampling probe in the direction shown in Fig. 4-11, and tighten it to the extraction unit. Use a pipe wrench ($\varnothing 28$ mm or larger, total length of 500 mm or longer) to tighten (recommended tightening torque: 100 N·m).

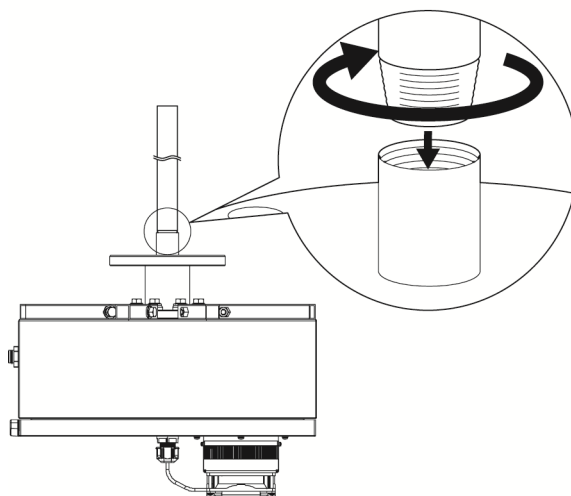


Fig. 4-11 Attachment of gas sampling probe

- (3) Companion flange installation

Fit a branch pipe and one companion flange to the flue. The size must match the extraction unit flange dimensions (example: companion flange JIS5K65A, branch pipe 65A). Ensure that the end of the gas sampling probe comes as near as possible to the center of the flue diametrical direction.

Fit the branch pipe and companion flange horizontally.

When attaching the extraction unit, ensure that the end of the gas sampling probe does not rise any higher than the horizontal direction. This could cause water to accumulate in the gas sampling probe, leading to corrosion.

Furthermore, attach the extraction unit so that the end of the gas sampling probe does not drop any more than 5° below the horizontal direction. This could allow dust or water to get into the extraction unit easily, hastening equipment corrosion.

Install the companion flange so that the position of the hole on the extraction unit flange matches those on the flue companion flange.

- (4) Installation of the extraction unit

Put the packing between the flange and the companion flange. Use the bolts (M12), flat washers, spring washers (M12), and nuts (M12) provided to bolt the extraction unit to the flue companion flange at four locations, and apply a tightening torque of 70 N·m. Use lubricant for the bolts.

- (5) Air backflush with instrument air

Begin air backflush with instrument air immediately after completing the extraction unit attachment. Air backflush is necessary to protect the equipment. Refer to section 4.5.2 for details on the instrument air piping method.

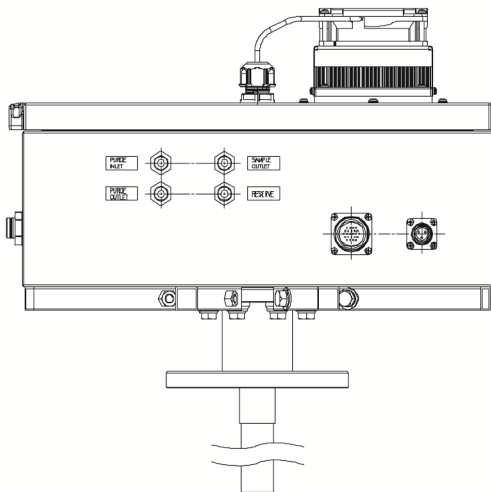
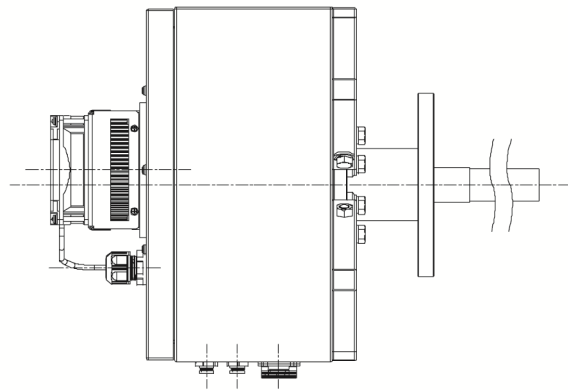
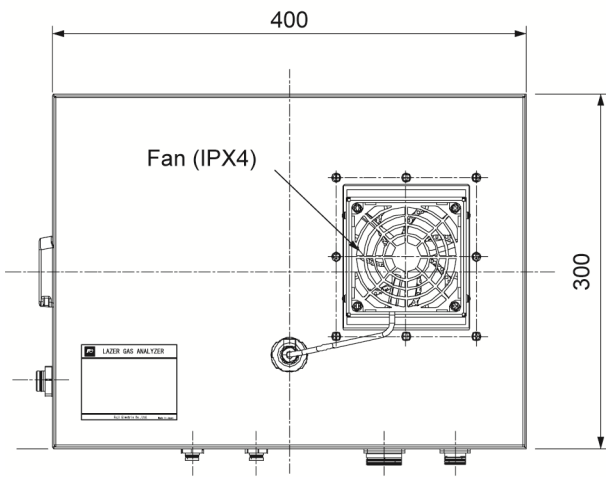
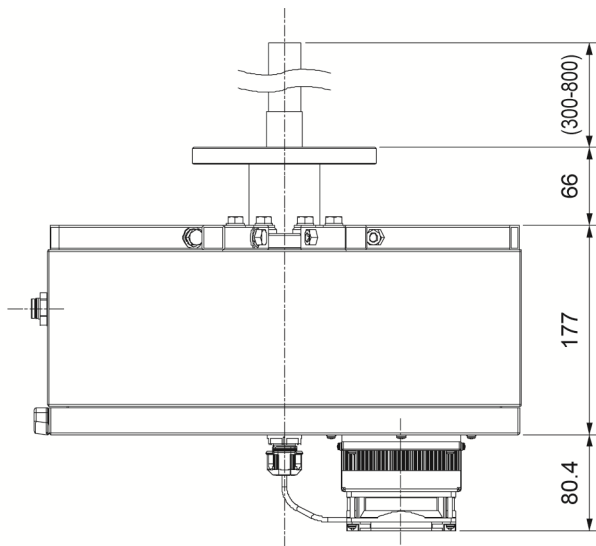


Fig. 4-12 Outline diagram of the extraction unit

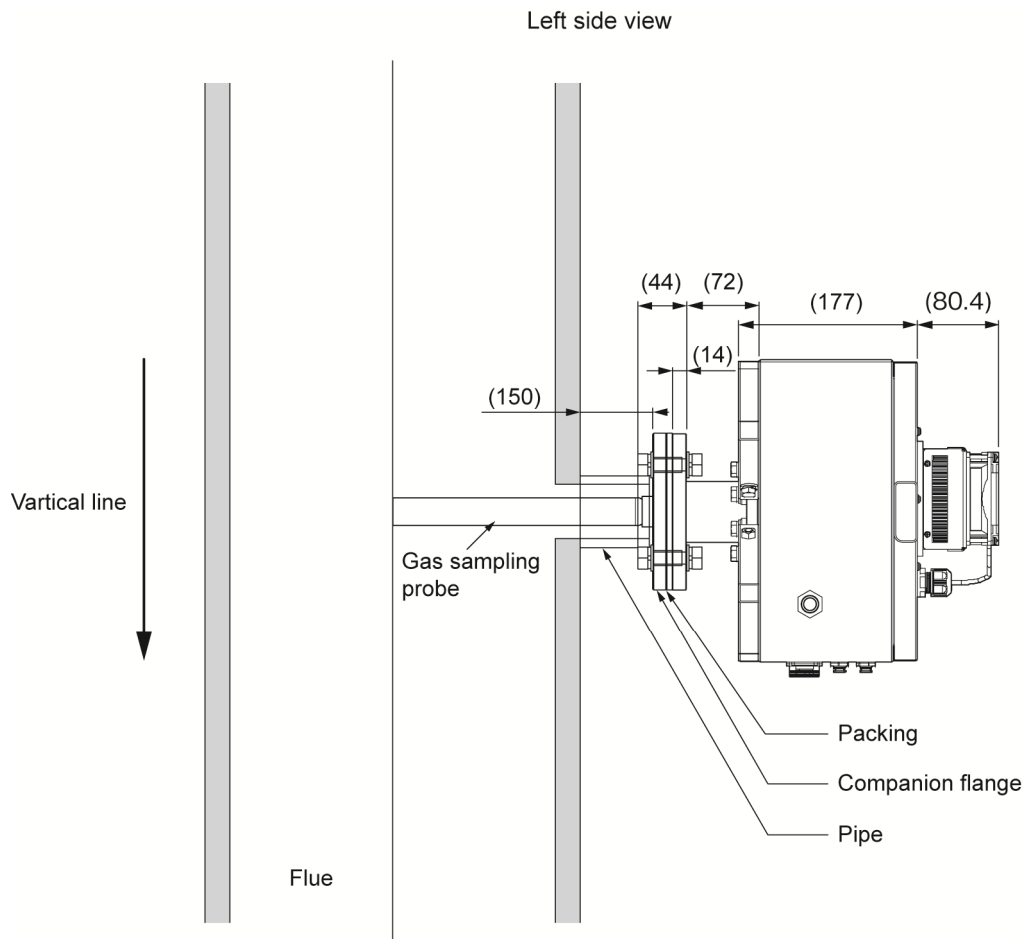


Fig. 4-13 Installation of the extraction unit

4.4.3 Clearance

Secure the minimum clearance as follows (refer to Fig. 4-14 to Fig. 4-15):

Secure space in front of the front panel of 400 mm or more. This is because it is necessary to open the front panel to carry out maintenance.

Furthermore, secure a space of 200 mm or more from the left side surface. This is necessary for the pipe from the exhaust gas outlet.

Secure minimum space in the height direction of 300 mm from the floor at the bottom. A space of 1000 mm from the floor is recommended at the bottom for ease of maintenance.

Use scaffolding if the floor mentioned above does not exist. Ensure a height of 300 to 1000 mm from the scaffolding to the extraction unit, and ensure that maintenance work can be carried out with the front panel open.

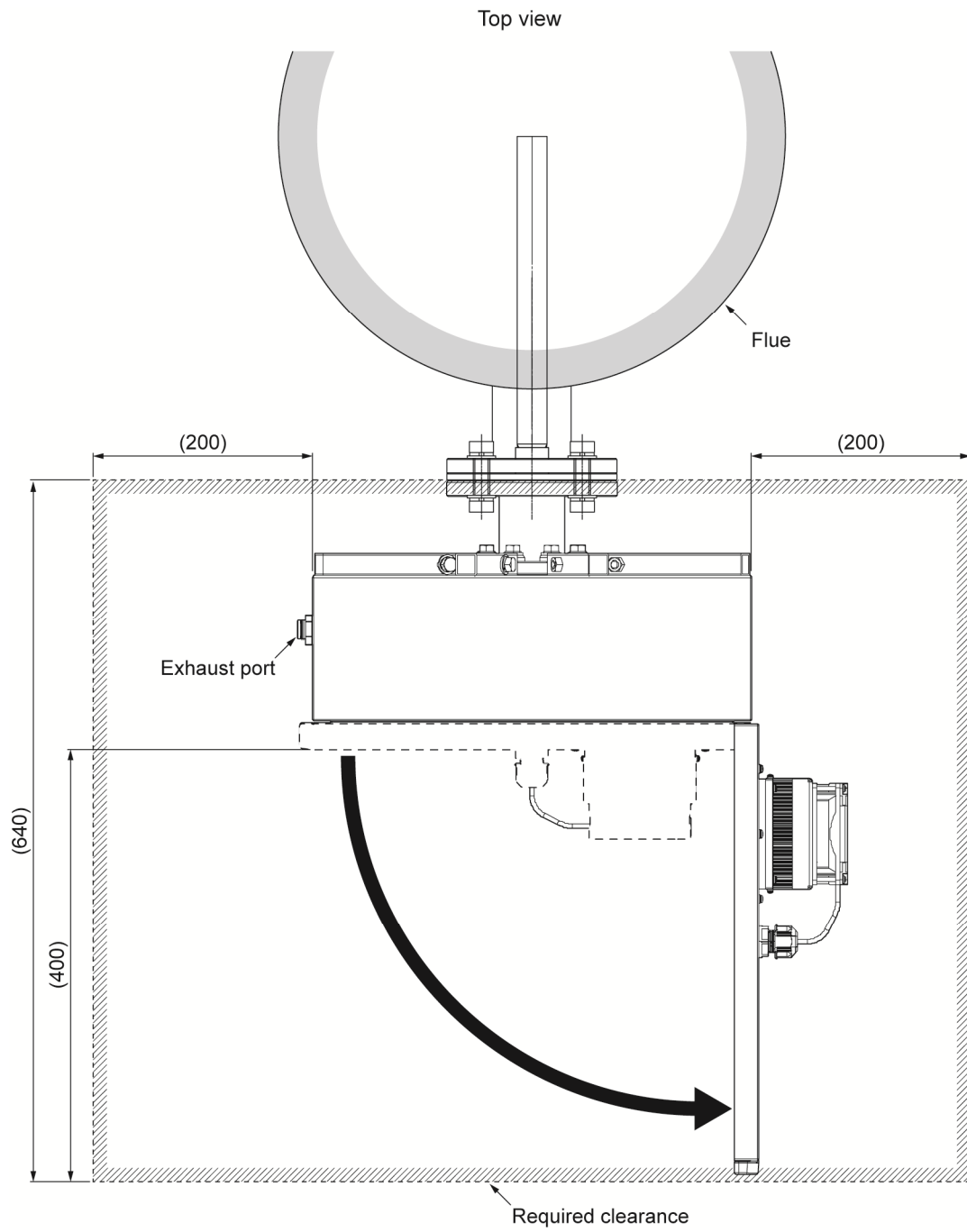


Fig. 4-14 Installation space for the extraction unit (depth direction)

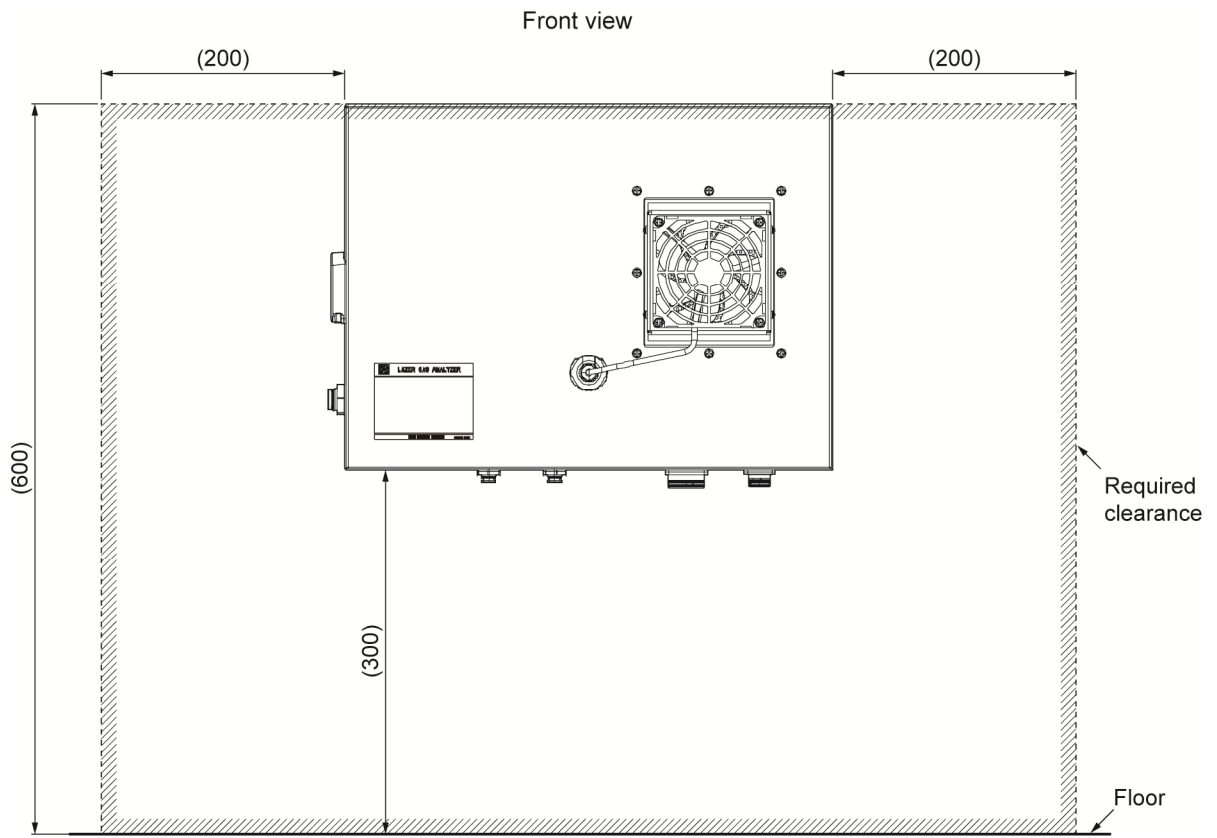


Fig. 4-15 Installation space for the extraction unit (width and height direction)

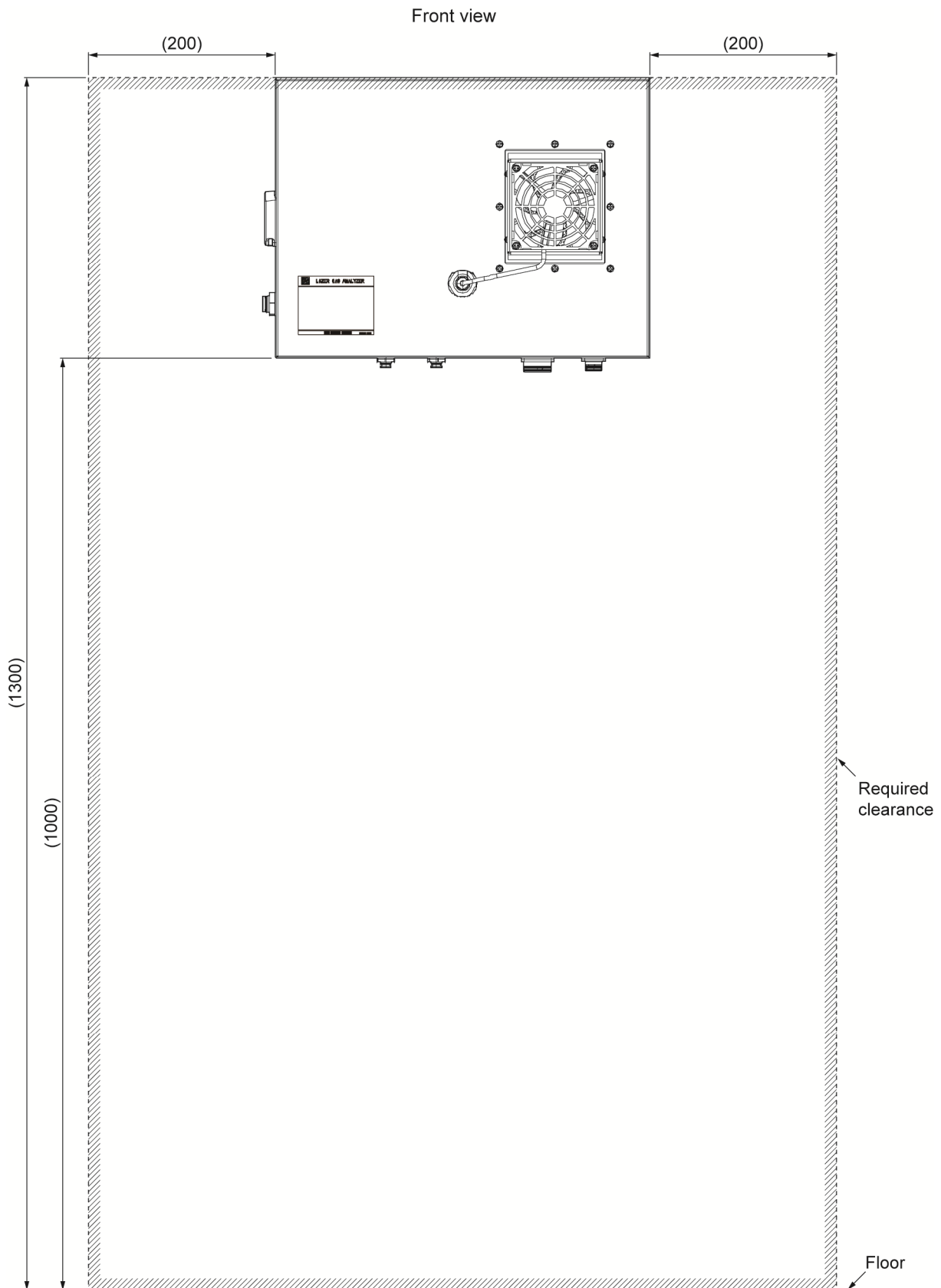


Fig. 4-16 Recommended installation space for the extraction unit

4.5 Piping

4.5.1 Sampling gas tube

Connect the sample gas outlet of the extraction unit and the sample gas inlet of the detection unit with the sampling gas tube (PTFE tube with outer diameter of 6 mm and inner diameter of 4 mm) provided as a standard accessory, shown in Fig. 4-17.

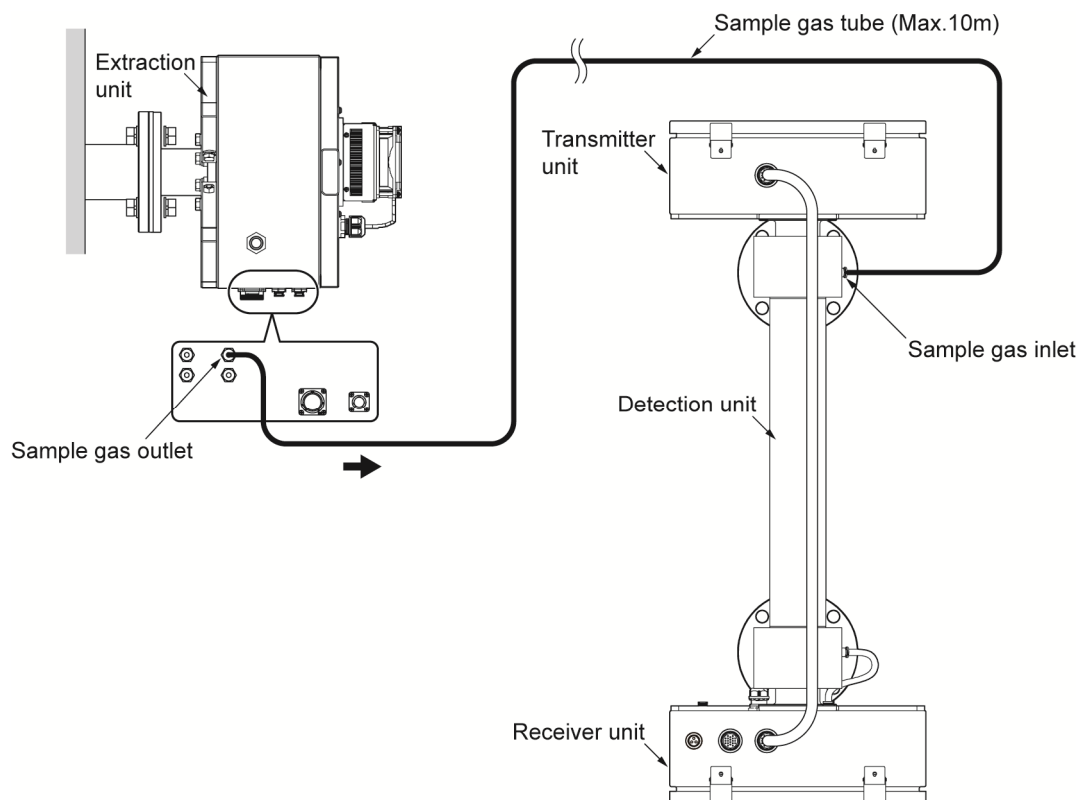


Fig. 4-17 Piping of sample gas tube

Notes

1. Do not arrange the sampling gas tube in the place where the ambient temperature may become lower than 0°C. It may cause water condensation in sample gas.
2. Install the sampling gas tube in the place where there is no risk of catching someone's hands or legs, or of someone stepping on the tube.
3. If bending the sampling gas tube, bend with radius greater than the minimum bending radius of 25 mm. If you bend it with a radius smaller than 25 mm, the tube may get damaged which results in leakage of the sample gas.
4. When connecting the sampling gas tube, push the end of the tube into the joint until it is firmly stuck in.
5. Do not pull, twist, or bend the joint because it causes damage to the joint.

4.5.2 Piping of the instrument air tube

Connect the instrument air tube (PTFE tube that has an outer diameter of 6 mm and an inner diameter of 4 mm) for the followings (refer to Fig. 4-18):

- (1) Between the instrument air outlet and the instrument air inlet of the extraction unit
- (2) Between the instrument air outlet and the instrument air inlet of the detection unit

Instrument air of approximately 30 L/min flows to each of the instrument air tubes. Ensure that the length of the air tube is 3 m or less in order to minimize pressure loss. If longer than 3 m, use an air tube with inner diameter of 8 mm or 6 mm to the area near the instrument air inlets, and convert to an inner diameter of 6 mm or 4 mm near the inlets.

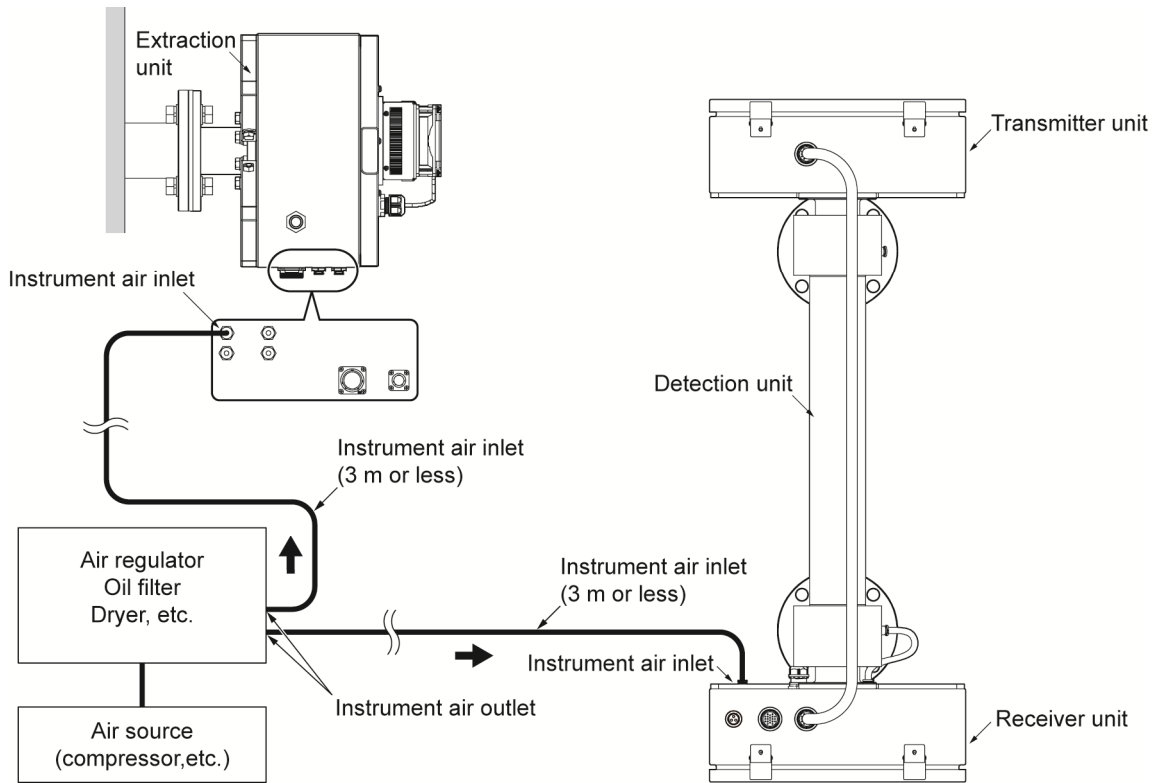


Fig. 4-18 Piping of the instrument air tube

Notes

- 1. Install the instrument air tubes in the place where there is no risk of catching someone's hands or legs, or of someone stepping on the tubes.
- 2. If bending the instrument air tubes, bend with radius greater than the minimum bending radius of 25 mm. If you bend them with a radius smaller than 25 mm, the tube may get damaged which results in leakage of the air.
- 3. When connecting the instrument air tube, push the end of the tube into the fitting until it is firmly stuck in.
- 4. Do not pull, twist, or bend the joint because it causes damage to the joint.

4.5.3 Exhaust gas tube

Connect an exhaust gas tube (PTFE tube with outer diameter of 10 mm and inner diameter of 8 mm, prepared by customer) at the following two locations as shown in Fig. 4-19. Exhaust gas should be guided to the flue or atmosphere. Droplets in the exhaust gas may also be discharged from the extraction unit exhaust port, and therefore it is recommended that exhaust port tubes be connected to the flue. However, these tubes must be no longer than 500 mm. If using pipes longer than 500 mm, it may not be possible to obtain accurate measurement because long tubes increase pressure loss in the ejectors, resulting in insufficient sample gas flow rate.

Furthermore, ensure that exhaust gas tubes shall be lower than the exhaust port. Note that exhaust gas tubes are not required when the discharge of exhaust gas inside rooms is permitted.

Refer to the following guidelines on exhaust gas flow rates.

(1) From extraction unit: 30 L/min (exhaust gas: 5 L/min, purge air 25 L/min)

(2) From detection unit: 30 L/min (exhaust gas: 0.5 L/min, purge air 29.5 L/min)

The detection unit exhaust port is close to the wall side. To ensure that the tube and wall surface do not interfere, an elbow fitting may be used for the tube. However, ensure that exhaust gas tubes are no longer than 500 mm.

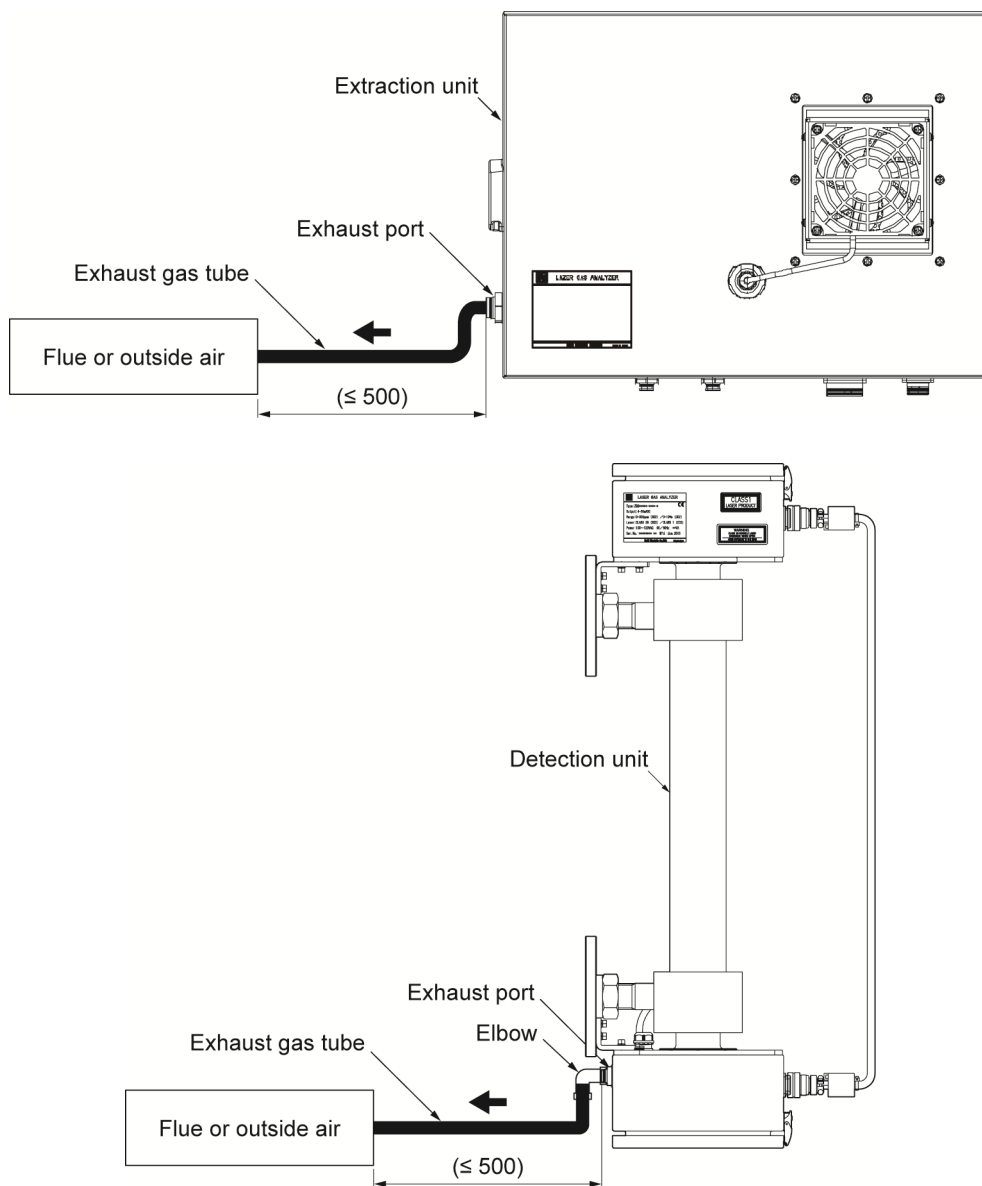


Fig. 4-19 Piping of exhaust gas tube

Notes

1. Install the exhaust gas tubes in the place where there is no risk of catching someone's hands or legs, or of someone stepping on the tubes.
2. If bending the exhaust gas tubes, bend with radius greater than the minimum bending radius of 80 mm. If you bend with a radius smaller than 80 mm, the tubes may get damaged which results in leakage of the exhaust gas.
3. When connecting the exhaust gas tube, push the end of the tube into the fitting until it is firmly stuck in.
4. Do not pull, twist, or bend the joint because it causes damage to the joint.

4.6 Cable connection and wiring



CAUTION

- Electrical connection should be done by qualified personnel because poor wiring may cause electric shock or injury.
- Connect a grounding wire securely. Failure to ground equipment may result in electric shock or malfunction.

Caution to wiring electrician

For avoiding electric shock, fire and injury, be sure to observe the followings:

- Before wiring, be sure to turn off the main power supplies. This is required for preventing an electric shock.
- For grounding, use a wire that has a diameter of 1.5 mm or larger and has a sufficient dielectric strength. Using inadequate wires may cause electric shock or malfunction.
- Select cables and wire diameters to match the equipment ratings for the input/output wiring. Use of wiring that is unable to tolerate the ratings may result in fire.
- For connection to input and output terminal blocks, be sure to use solderless terminals.
- For branching the output wires, use a terminal block.
- Be sure to fix the input/output wires on the floor, wall, etc. and put guards on the wires.
- Do not install the instrument near high frequency heating furnace, electric welding machine or others which considerably disturb the power waveforms. Do not share the power supply with these facilities.

4.6.1 Connecting the units

Connect the cables as shown in Fig.4-20.

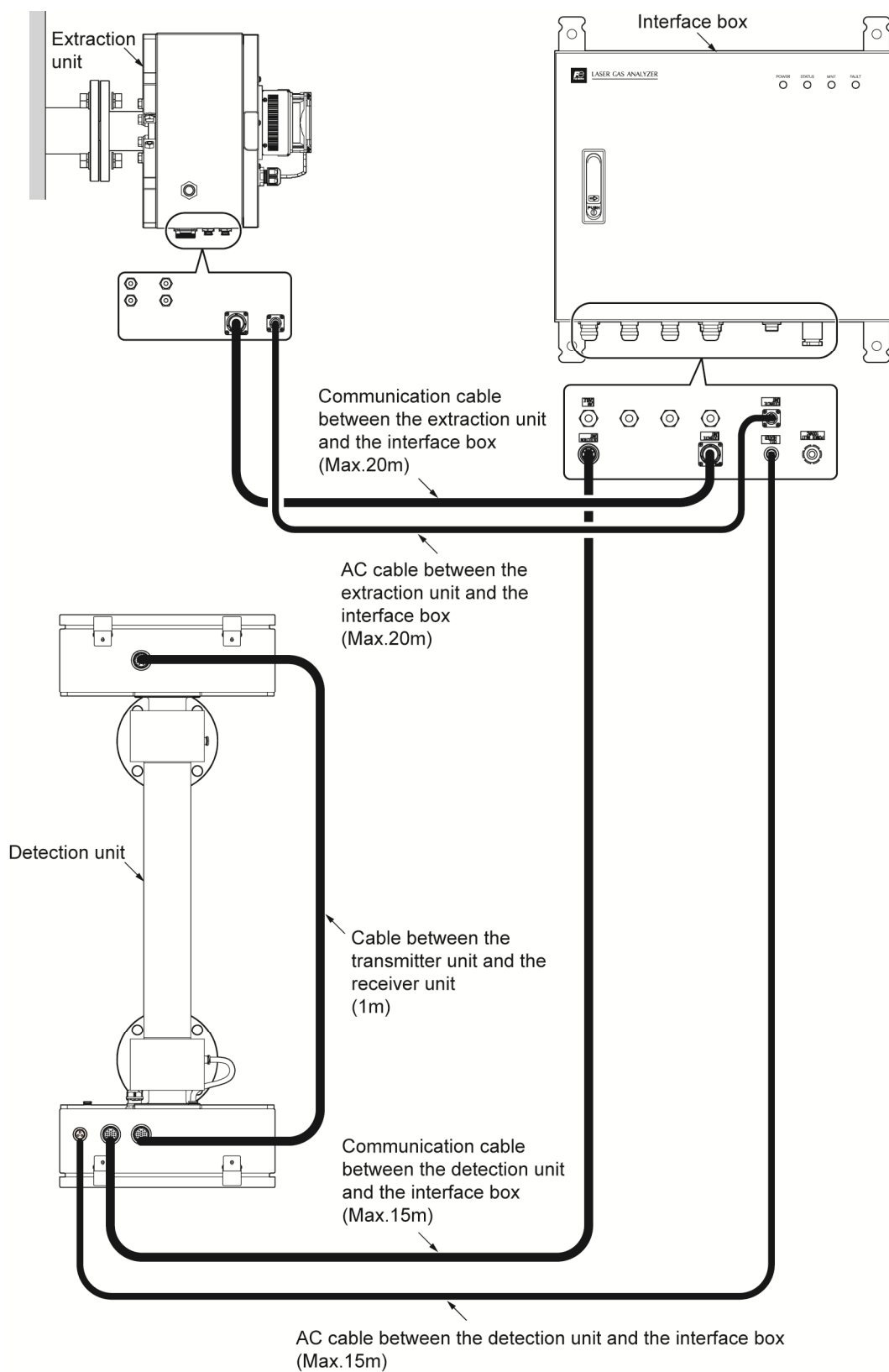


Fig. 4-20 Connecting the units

4.6.2 Electrical connections

Prepare the following cables.

	Diameter of conductor
Power line	1.5 mm to 2.6 mm
Grounding line	1.5 mm to 2.6 mm
Signal line	1.2 mm or larger

Before wiring, read through the instructions in this section.

Wire the cables through the cable glands shown in Fig. 4-21 to the terminal blocks in the interface box. Do not connect a cable to the terminal that is not identified.

Note: If the interface box ambient temperature exceeds 40°C, connect an instrument air tube (outer diameter: 10 mm, prepared by customer) to the instrument air inlet shown in Fig. 4-20, and ensure an instrument air flow rate of approximately 30 L/min.

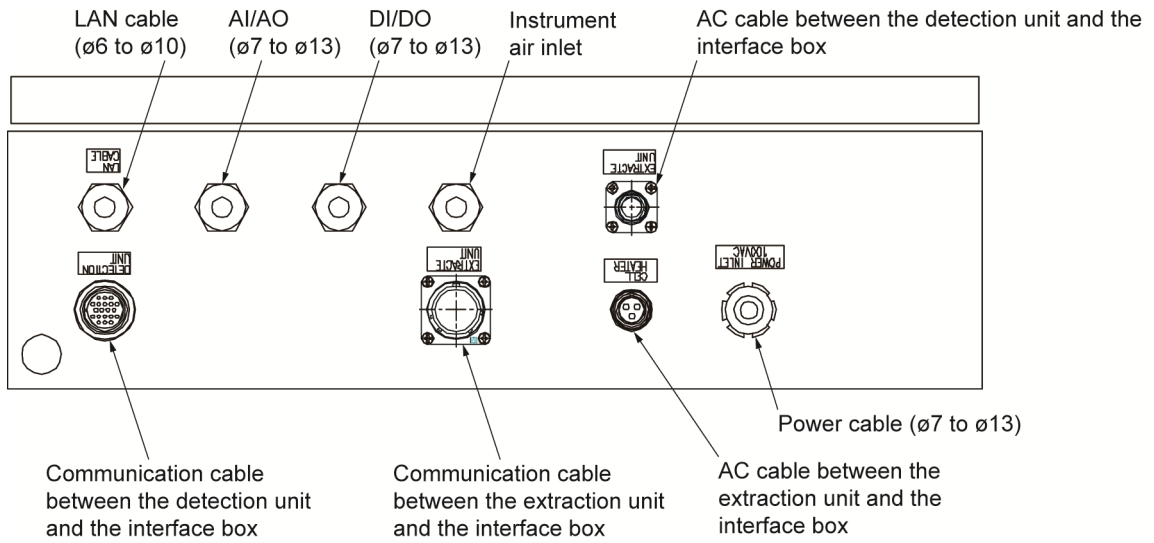


Fig. 4-21 Cable glands and cable connectors

4.6.3 Power cable and ground cable

Connect the power line and ground (protective earth, PE) wire (both prepared by customer) in order to supply power (100 V AC, 50/60 Hz) to the terminal block.

The terminal block to which the wiring is connected is shown in Fig. 4-22. Use M4 screw crimp connectors.

The service socket is a dedicated power supply for use with a laptop computer when carrying out service work. Do not use for other applications.

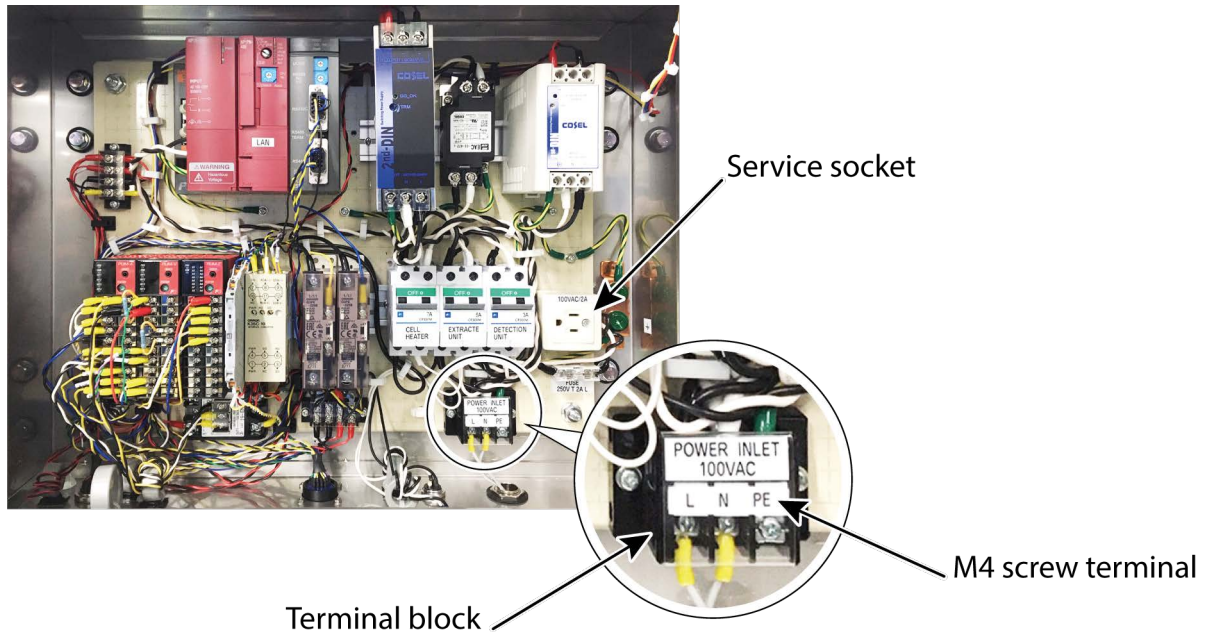


Fig. 4-22 Power supply and ground terminal inside the interface box

4.6.4 Analog input and output cables

Connect signal lines (prepared by customer) for the purpose of communicating all kinds of analog input/output signals to an analog input/output module (name: PUM-V). Signal names and functions are shown in Table 4-1 and Fig. 4-22. Use M3 screw crimp connectors. The wire connection precautions are as follows.

- To avoid the influence of inductive noise, signal wires should be separated from electric power lines or load lines.
- Wrap the analog output cable around the ferrite core four times.(See Fig. 4-23)
- Use M3 crimp connectors to connect to the terminal blocks.

Screw size: M3 × 7

Tightening torque: 0.78 N·m (8 kgf·cm)

[Important] Be sure to input the exhaust gas temperature near the gas sampling probe (scrubber outlet) using the analog input (AI1) or Modbus communication. The input exhaust gas temperature shall be less than 60°C. This condition is required to extract the exhaust gas. Air backflush* starts up when the exhaust gas temperature rises to 60°C or higher to protect the equipment. Air backflush is necessary to protect the analyzer especially when the gas sampling probe is exposed to gas that has not been cleaned by a scrubber.

*Air backflush: a function of cleansing the sample gas tube by stopping the intake of the exhaust gas and making the instrument air pass through the gas sampling probe towards the flue.

Table 4-1 Analog input / output terminal

Functions	Signal	Terminal No.	Signal	Functions
		21	11	AO1+
		22	12	AO1-
		23	13	
SO ₂ /CO ₂ 4–20 mA (0–300)	AO3-	24	14	AI1+
	AO3+	25	15	AI1+
		26	16	AO2+
		27	17	AO2-
		28	18	
		29	19	
		30	20	

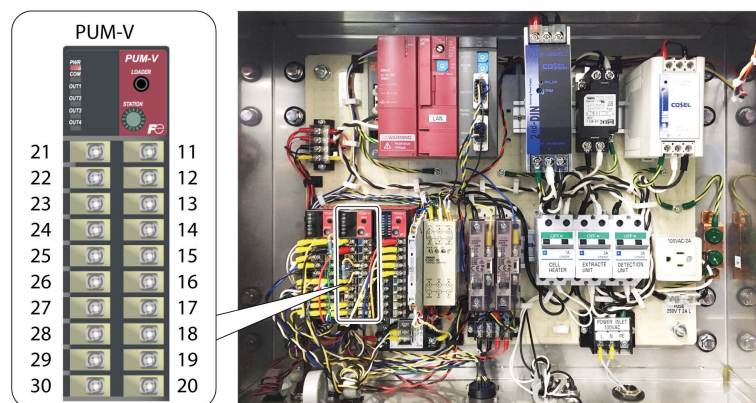


Fig. 4-23 Analog I/O module (PUM-V)

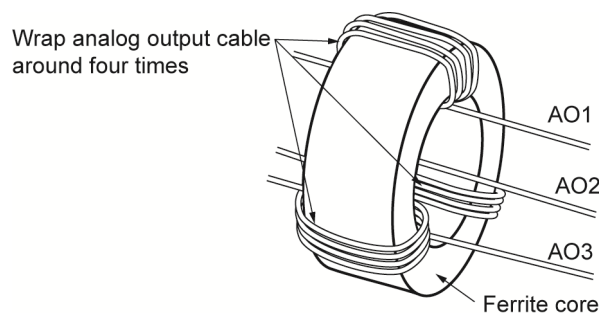


Fig. 4-24 Cable wrapping to ferrite core

4.6.5 Digital input and output terminals

Connect a signal line (prepared by customer) to communicate all digital input/output signals to the digital input/output module (name: PUM-E).

Signal names and functions are shown in Table 4-2 and Fig. 4-25. Use M3 screw crimp connectors. The wire connection precautions are as follows.

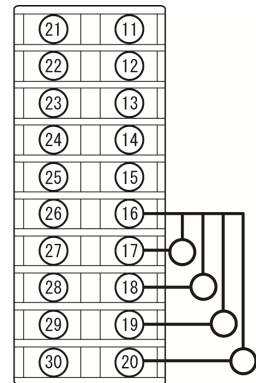
- Use shielded wires. Input signal wire and output signal wire should be separated from each other. And both should be shielded.
- If you use an inductive loads such as an electromagnetic switch for relay outputs, we recommend you to use a surge absorber to protect the contacts from switching surge.

Recommended specification for the surge absorber

Voltage	Nominal varistor voltage
100V	240V
200V	470V

Attachment position : Between the relay control output contacts.

- Use M3 crimp connectors to connect to the terminal blocks.
Screw size: M3 × 7
Tightening torque: 0.78 N·m (8 kgf·cm)
- To avoid the influence of inductive noise, input signal wires should be separated from electric power lines or load lines.



Surge absorber connection

[Important] Be sure to input EGCS run/stop signals using the digital input (DI5) or Ethernet communication.

The EGCS must be running (ON signal input) in order to extracting exhaust gas. If the EGCS stop signal (OFF signal input) is input, or the wiring is not connected, air backflush will start, and the equipment will be protected. Air backflush is necessary to protect the analyzer especially when the gas sampling probe is exposed to gas that has not been cleaned by a scrubber.

Table 4-2 Digital input /output terminal

Digital input Function	Signal	Terminal No.	Signal	Digital output Function	
		21	11		
		22	12		
		23	13		
Maintenance	DI1+	24	14		
	COM	25	15		
		26	16	COM	
		27	17	DO5	Maintenance, warm-up, sampling suspension
		28	18	DO6	Maintenance request
EGCS on/off	DI5+	29	19	DO7	Analyzer error
	COM	30	20	DO8	Power OFF

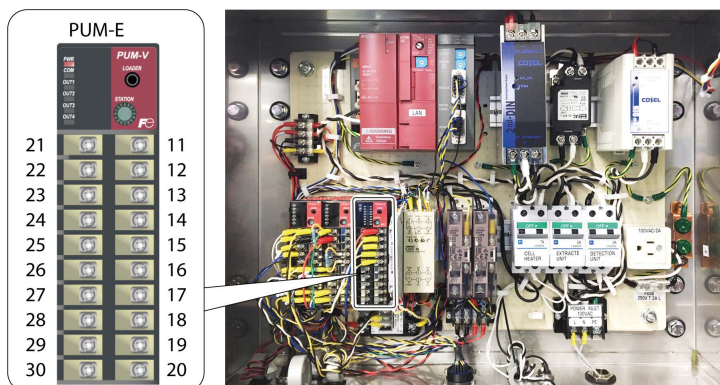


Fig. 4-25 Digital I/O module (PUM-E)

4.6.6 Ethernet (Modbus/TCP) terminal

Ethernet communication allows the analyzer to send the readings and the status of the analyzer to external devices. Use the LAN cable (10/100BASE-T RJ45 connector).

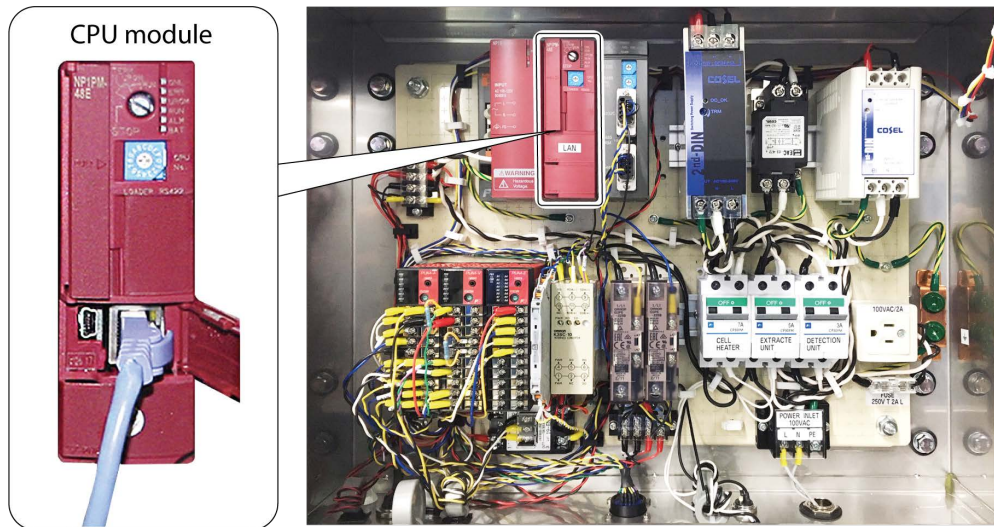


Fig. 4-26 CPU module

4.7 Commissioning

Follow the instructions in “5. OPERATION”.

5. OPERATION



CAUTION

- Do not touch the detection unit and the extraction unit during operation, otherwise you may get burned because their surfaces are hot.

5.1 Supplying the instrument air

- Supply the instrument air regardless if the analyzer is turned on or off. Confirm that the instrument air you are going to use meets the requirements described in 4.1.3 Requirements on instrument air. Never stop the supply of the instrument air.
- If the supply of instrument air stops when the analyzer is energized, the measurement becomes unavailable because the analyzer cannot extract exhaust gas and dehumidify it.
- If the supply of instrument air is stopped while the analyzer is de-energized, the air backflush function becomes unavailable. This causes the analyzer failure due to contamination and/or corrosion by exhaust gas.
- If you cannot supply the instrument air, read “10. TROUBLESHOOTING”.
- Adjust the instrument air supply pressure to 0.3 MPa. Read the purge pressure [kPaG] value by Modbus communication, and adjust so that it is 300 ± 10 [kPaG]. Refer to “6. COMMUNICATION” for details on Modbus communication.

*Air backflush: a function of cleansing the sample gas tube by stopping the intake of the exhaust gas and making the instrument air pass through the gas sampling probe towards the flue.

5.2 Turning on the analyzer

Open the front panel of the interface box, and then turn on the three power switches in order from right to left. The warm-up starts, and the fans of the extraction unit and the detection unit starts rotation, and the instrument air starts to flow to/from the extraction unit and the detection unit. You may hear the rotation sound, and air flowing sound but remember this is not abnormal.

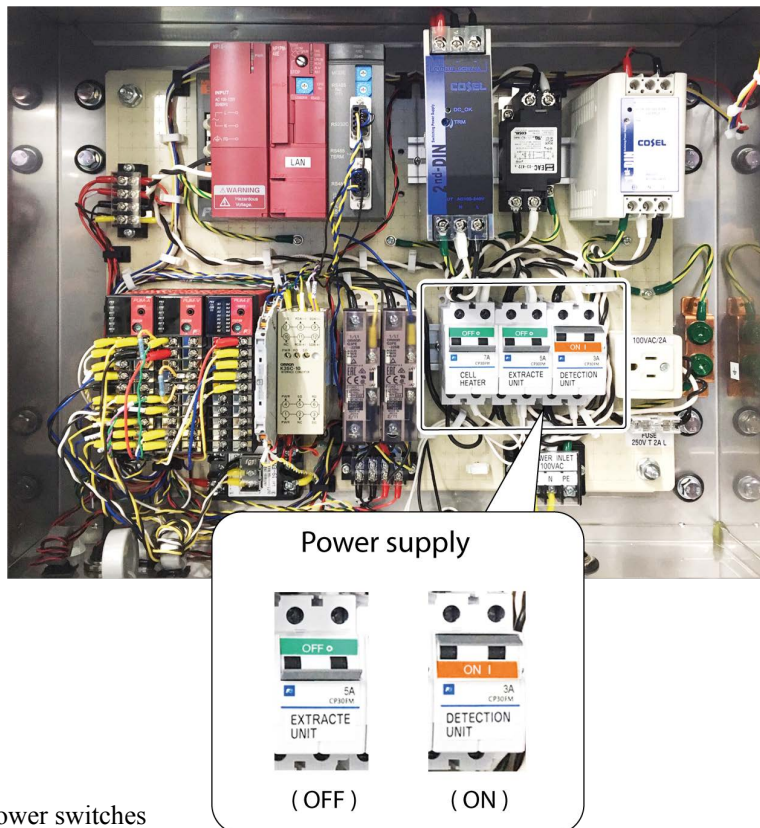


Fig. 5-1 Power switches

5.3 Warm-up

Warm-up takes about two hours. Do not touch the detection unit and the extraction unit during warm-up, otherwise you may get burned. Do not open the panel of the extraction unit because it disturbs the warm-up and may cause burns.

Note: The concentration reading is output by analog output or Modbus communication even during warm-up, however, this is not an accurate value. Furthermore, as air backflush is engaged during warm-up, instrument air flows to the detection unit.

5.4 Continuous measurement

When the warm-up time elapses, the analyzer moves on to a continuous measurement.

Do not touch the detection unit during continuous measurement, otherwise you may get burned.

Do not open the panel of the extraction unit because it causes condensation in the tubes which disturbs the measurement and causes burns.

Do not forget to close the front panel of the interface box. Leaving it open may cause water and/or dust to enter into the box which may result in failure.

During continuous measurement, the status indicator LEDs on the front of the interface box should indicate “Measuring” (green 1 is ON, green 2 is ON, amber is OFF, and red is OFF). If the status indicators are not as above, check if the digital inputs and outputs are normal, and refer to "10. TROUBLESHOOTING".

The conditions required to ensure continuous measurement are shown in Table 5-1.

Table 5-1 Conditions required for measuring

Item	conditions
Warm-up	120 minutes or longer should have elapsed since the power was turned ON.
Analyzer error	There should be no instrument errors. (DO7 is OFF)
Under maintenance	Maintenance should not be being performed. (DI1 is OFF, or Modbus communication “Maintenance is 1”)
EGCS on/off	EGCS operation (DI5 is ON, or Modbus communication “EGCS run/stop” is 1)
Gas temperature	5°C to 60 °C (AI1 is 4.8 to 13.6 mA, or Modbus communication “scrubber exhaust gas temperature (digital input) [°C × 10]” is 50 to 600)

5.5 Power interruption

You can turn off the power anytime. To turn off the power, switch off the three power switches in order from left to right. Close the panel of the interface box. Make sure the status indicators are as shown in the “Power OFF” column in Table 3-2; all LEDs are off.

6. COMMUNICATION

This chapter gives you the information on the Ethernet communication.

The CPU module in the interface box is used for communication.

The analog input/output and digital input/output functions are interchangeable with this communication. Furthermore, information necessary for device status diagnosis can be obtained.

6.1 Overview

Item	Specifications	
Interface	10BASE-T	100BASE-TX
Transmission speed	10 Mbps	100 Mbps
Interface changeover system	Auto negotiation (automatic changeover)	
Transmission medium	Twisted pair cable	
Max. segment length	100 m	
Access method	CSMA/CD	
Transmission protocol	Modbus / TCP (Slave)	
Transmission code	Binary	
IP address	IP address : 192.168.0.1 Subnet mask : 255.255.255.0	

6.2 CPU module

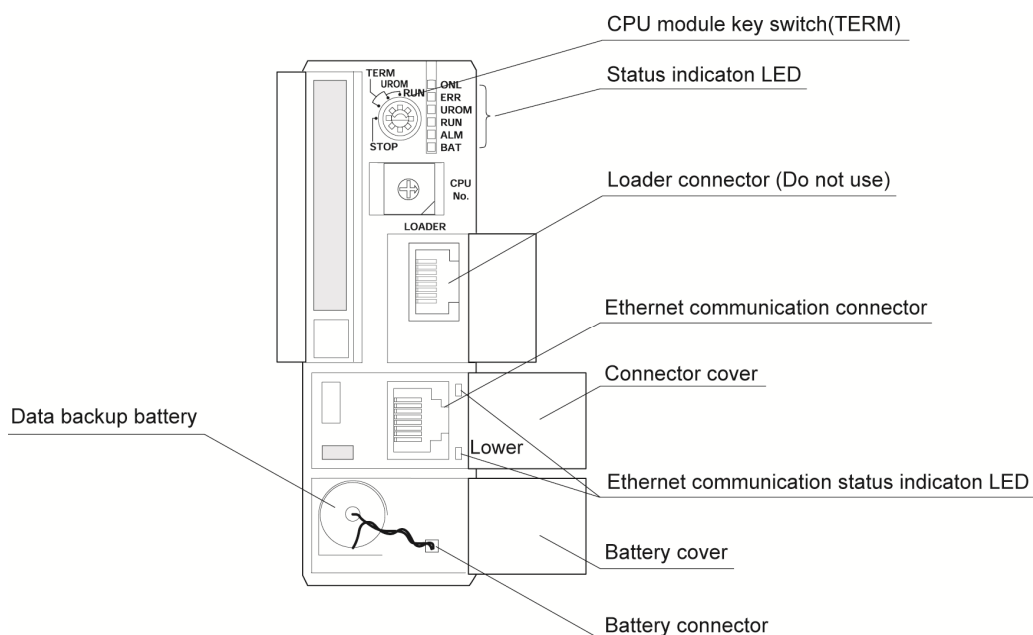


Fig. 6-1 Name of each part

Functions

1) Refer to the following table for details on the status indicator LEDs. CPU module errors can be checked based on the status indicator shown here.

Symbol	ERR	Description																		
ONL ERR	Green Red	Indicates the status of the self CPU module <Lighting pattern>																		
		<table border="1"> <thead> <tr> <th>ONL</th> <th>ERR</th> <th>Self CPU module status</th> </tr> </thead> <tbody> <tr> <td>OFF</td> <td>OFF</td> <td>The power is off or the module is being reset or initialized</td> </tr> <tr> <td>Blink</td> <td>-</td> <td>The SX bus is being established</td> </tr> <tr> <td>ON</td> <td>OFF</td> <td>The module is normally running</td> </tr> <tr> <td>Green</td> <td>Green</td> <td>Green</td> </tr> <tr> <td>Green</td> <td>Green</td> <td>Green</td> </tr> </tbody> </table>	ONL	ERR	Self CPU module status	OFF	OFF	The power is off or the module is being reset or initialized	Blink	-	The SX bus is being established	ON	OFF	The module is normally running	Green	Green	Green	Green	Green	Green
		ONL	ERR	Self CPU module status																
		OFF	OFF	The power is off or the module is being reset or initialized																
		Blink	-	The SX bus is being established																
		ON	OFF	The module is normally running																
Green	Green	Green																		
Green	Green	Green																		
UROM	Green	Turns ON when the CPU recognizes the user ROM card. Turns ON when the user ROM card is correctly inserted in the CPU module and the CPU mode selection switch is set at the “UROM” position. (For user ROM card adapted CPUs of SPH300, SPH2000/3000 only)																		
RUN ALM	Green Red	Indicates the status of the system that the self CPU module controls. <Lighting pattern> (Note)																		
		<table border="1"> <thead> <tr> <th>RUN</th> <th>ALM</th> <th>System status</th> </tr> </thead> <tbody> <tr> <td>OFF</td> <td>OFF</td> <td>The power is off or the application program is stopped</td> </tr> <tr> <td>ON</td> <td>OFF</td> <td>The system is normally</td> </tr> <tr> <td>ON</td> <td>ON</td> <td>The system is running in a nonfatal fault condition.</td> </tr> <tr> <td>OFF</td> <td>ON</td> <td>The system is stopped in a fatal fault condition.</td> </tr> <tr> <td>Blink</td> <td>-</td> <td>The CPU is accessing the user ROM.</td> </tr> </tbody> </table>	RUN	ALM	System status	OFF	OFF	The power is off or the application program is stopped	ON	OFF	The system is normally	ON	ON	The system is running in a nonfatal fault condition.	OFF	ON	The system is stopped in a fatal fault condition.	Blink	-	The CPU is accessing the user ROM.
		RUN	ALM	System status																
		OFF	OFF	The power is off or the application program is stopped																
		ON	OFF	The system is normally																
		ON	ON	The system is running in a nonfatal fault condition.																
OFF	ON	The system is stopped in a fatal fault condition.																		
Blink	-	The CPU is accessing the user ROM.																		
BAT	Orange	Turns ON when the data backup battery is disconnected or voltage is dropped.																		

2) Refer to the following table for details on the Ethernet status indicator LEDs.

LED position	Ethernet status
Lower side	Indicates the LINK status and turns ON when the LAN cable is connected to an external device (such as HUB). Indicates the TX/RX status and blinks while communicating with an external device.

3) Ethernet communication

Use a 10BASE-T or a 100BASE-TX communication cable.

6.3 Connection

Connect the interface box with your PC. For wiring, refer to “4.6.6 Ethernet (Modbus/TCP) terminal”.

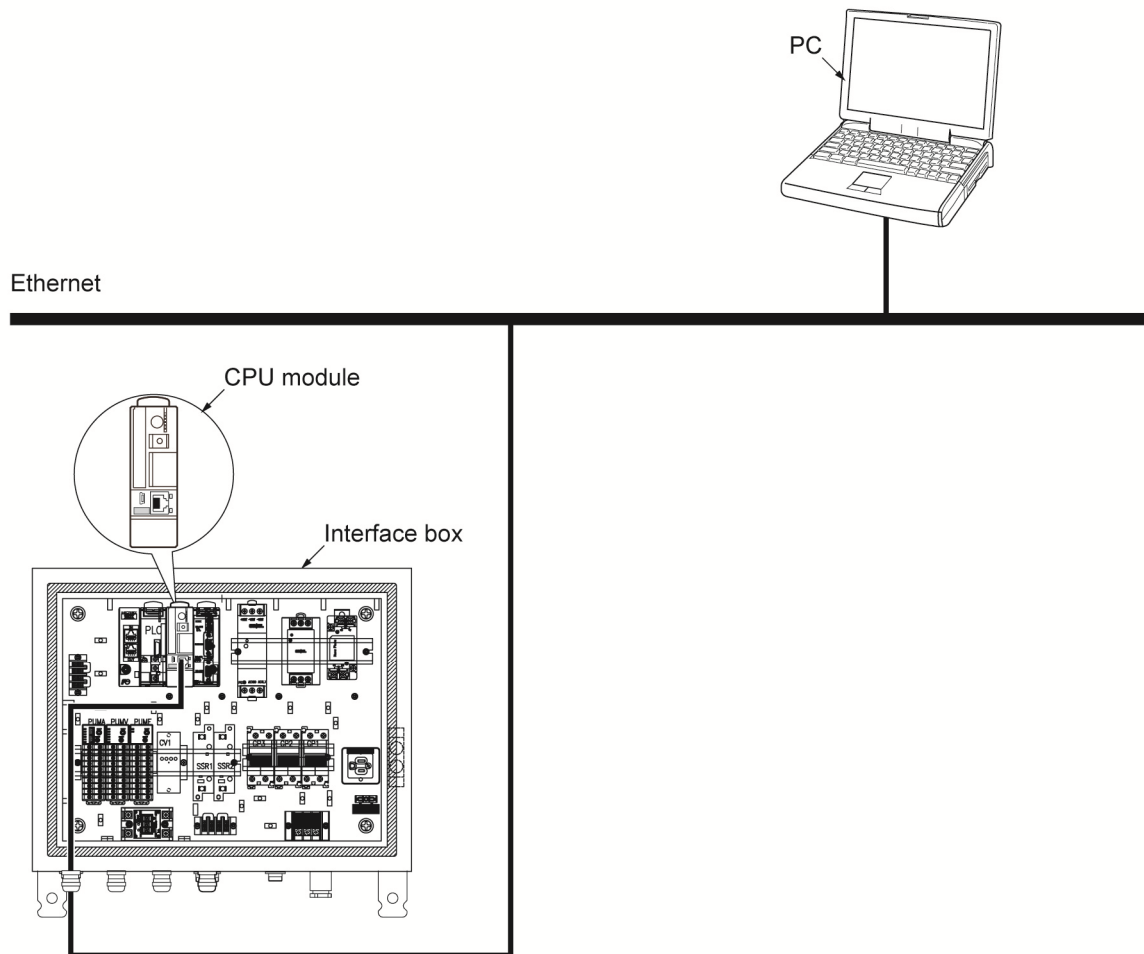


Fig. 6-2 Connection to Ethernet

6.4 Modbus register address map

Address maps are shown in Table 6-1 and Table 6-2.

Table 6-1 Address map word data [read/write]: function codes [03H, 10H]

register No.	Dater type	Memory details	read/write
42501	WORD	Scrubber exhaust gas temperature input setting	0: AI1 input (default) 1: Modbus input 2: Both (standby if value for AI1 or Modbus is outside 5 to 60°C range)
42502	WORD	Scrubber exhaust gas temperature (Modbus input) [°C × 10]	0 to 3000 (default value:0)
42503	WORD	EGCS on/off input setting	0: DI5 input (default) 1: Modbus input 2: Both (standby if value for DI5 or Modbus is 0)
42504	WORD	EGCS on/off (Modbus input)	0: EGCS off (default) 1: EGCS on
42505	WORD	Maintenance input setting	0: DI1 input (default) 1: Modbus input 2: Both (standby if value for DI1 or Modbus is 0)
42506	WORD	Under maintenance /Not under maintenance (Modbus input)	0: Not under maintenance (default) 1: Under maintenance

Table 6-2 Address map word data [read-only]: function code [04H]



register No.	Dater type	Memory details	read
32001	WORD	Scrubber exhaust gas temperature [°C × 10]	-32768 to 32767
32002	WORD	Instrument air pressure [kPaG]	-32768 to 32767
32003	WORD	Sample gas flow rate [mL/min]	-32768 to 32767
32004	WORD	Hot zone temperature in extraction unit [°C]	-32768 to 32767
32005	WORD	Cool zone temperature in extraction unit [°C]	-32768 to 32767
32006	WORD	Gass coll temperature [°C]	-32768 to 32767
32007	WORD	AI1: Gass temperature AD value	-32768 to 32767
32009	WORD	AI3: Instrument air pressure AD value	-32768 to 32767
32010	WORD	AI4: Sample gas flow rate AD value	-32768 to 32767
32011	WORD	AO1: SO ₂ concentration DA value	-3276 to 3276
32012	WORD	AO2: CO ₂ concentration DA value	-3276 to 3276
32013	WORD	AO3: SO ₂ /CO ₂ DA value	-3276 to 3276
32014	WORD	AO4: Proportional control valve DA value	-3276 to 3276
32015	WORD	DI1: Under maintenance	0:OFF 1:ON
32019	WORD	DI5: EGCS on/off	0:OFF 1:ON
32023	WORD	DO1: LED2	0:OFF 1:ON
32024	WORD	DO2: LED3	0:OFF 1:ON
32025	WORD	DO3: LED4	0:OFF 1:ON

register No.	Dater type	Memory details	read
32026	WORD	DO4: Air backflush start 0:Standby (backflush running), 1: Measuring (backflush stopped)	0:OFF 1:ON
32027	WORD	DO5: Maintenance, Warm-up, Sampling suspension	0:OFF 1:ON
32028	WORD	DO6: Maintenance request	0:OFF 1:ON
32029	WORD	DO7: Analyzer error	0:OFF 1:ON
32030	WORD	DO8: Power intarruption	0:OFF 1:ON
32031	WORD	PID auto tuning execution status	1:CH1 2:CH2 4:CH3 8:CH4
32032	WORD	PWM monitor	1:CH1 ON,2:CH2 ON,4:CH3 ON,8:CH4 ON
32033	WORD	SO ₂ /CO ₂ ratio[ppm/vol% × 100]	-32768 ~ 32767
32034	WORD	Gas cell temperature error	0: Normal, 1: Low temperature, 2: High temperature, 3: Burnout
32035	WORD	Hot zone temperature error	0: Normal, 1: Low temperature, 2: High temperature, 3: Burnout
32036	WORD	Cool zone temperature error	0: Normal, 1: Low temperature, 2: High temperature, 3: Burnout
32037	WORD	Instrument air	0: Normal, 1: Low pressure, 2: High pressure, 3: No output (0.8 V or less), 4: Maintenance request(low), 5: Maintenance request(hig)
32038	WORD	Sample gas flow rate error	0: Normal, 1: Low flow rate, 2: High flow rate, 3: No output (0.8 V or less), 4: Maintenance request(low) 5: Maintenance request(hig)
32039	WORD	Light transmittance error	0: Normal, 1: Low, 2: Over
32040	WORD	LD temperature control error	0: Normal, 1: Abnormal
32041	WORD	Receiver temperature error	0: Normal, 1: Abnormal
32042	WORD	Transmitter temperature error	0: Normal, 1: Abnormal
34023	DWORD	SO ₂ Concentration[ppm × 100] [high order word]	-2147483648 to 2147483647
34024	DWORD	SO ₂ Concentration[ppm [ppm × 100] [low order word]	
34025	DWORD	SO ₂ zero gas concentration [ppm × 100] [high order word]	-2147483648 to 2147483647
34026	DWORD	SO ₂ zero gas concentration [ppm × 100] [low order word]	
34027	DWORD	SO ₂ span gas concentration [ppm × 100] [high order word]	-2147483648 to 2147483647
34028	DWORD	SO ₂ span gas concentration [ppm × 100] [low order word]	
34029	DWORD	SO ₂ zero calibration coefficient (%FS offset) [%FS × 100] [high order word]	-2147483648 to 2147483647
34030	DWORD	SO ₂ zero calibration coefficient (%FS offset) [%FS × 100] [low order word]	
34031	DWORD	SO ₂ span calibration coefficient [% × 100] [high order word]	-2147483648 to 2147483647

register No.	Dater type	Memory details	read
34032	DWORD	SO ₂ span calibration coefficient [% × 100] [low order word]	
34033	WORD	SO ₂ analyzer laser temperature control: Peltier controller temperature measurement value [°C × 100]	-32768 to 32767
34034	WORD	SO ₂ analyzer laser temperature control: Peltier controller current measurement value [A × 100]	-32768 to 32767
34035	WORD	SO ₂ analyzer laser temperature control: Peltier controller voltage measurement value [V × 10]	-32768 to 32767
34036	WORD	SO ₂ analyzer laser temperature control: Peltier controller alarm information	0x000: Normal 0x002: Peltier current limit 0x004: Temperature alarm 0x008: Heat sink temperature alarm 0x010: Temperature sensor alarm 0x020: Peltier connection alarm 0x040: Input voltage alarm 0x100: Heater temperature alarm 0x200: Board temperature alarm 0x800: Interlock
34037	WORD	SO ₂ analyzer laser temperature control: Peltier controller status information	0: Temperature stable 1: Under control 2: Performing auto tuning 3: On standby
34038	WORD	SO ₂ analyzer laser temperature control: Peltier controller heat sink temperature [°C × 100]	-32768 to 32767
34039	WORD	SO ₂ analyzer laser temperature control: Peltier controller board temperature [°C × 100]	-32768 to 32767
34040	WORD	SO ₂ analyzer laser temperature control: Peltier controller heater temperature [°C × 100]	-32768 to 32767
34041	WORD	SO ₂ analyzer laser temperature control: Peltier controller laser temperature control setting value [°C×100]	-32768 to 32767
34064	DWORD	CO ₂ Concentration[vol% × 100] [high order word]	-2147483648 to 2147483647
34065	DWORD	CO ₂ Concentration reading [vol% × 100] [low order word]	
34066	DWORD	CO ₂ zero gas concentration [vol% × 100] [high order word]	-2147483648 to 2147483647
34067	DWORD	CO ₂ zero gas concentration [vol% × 100] [low order word]	
34068	DWORD	CO ₂ span gas concentration [vol% × 100] [high order word]	-2147483648 to 2147483647
34069	DWORD	CO ₂ span gas concentration [vol% × 100] [low order word]	
34070	DWORD	CO ₂ zero calibration coefficient (%FS offset) [%FS × 100] [high order word]	-2147483648 to 2147483647
34071	DWORD	CO ₂ zero calibration coefficient (%FS offset) [%FS × 100] [low order word]	
34072	DWORD	CO ₂ span calibration coefficient [% × 100] [high order word]	-2147483648 to 2147483647
34073	DWORD	CO ₂ span calibration coefficient [% × 100] [low order word]	
38001	DWORD	Status (2 words) [high order word]	0 to 1111 1111 1111 1111 1111

register No.	Dater type	Memory details	read
38002	DWORD	Status (2 words) [low order word]	1111 1111 1111 (BIN) (binary, 32 bits)
38003	WORD	Receiver temperature (°C)	-55 to 150°C
38041	WORD	SO ₂ analyzer: Transmittance [%× 100]	0 to 10000% × 100
38073	WORD	CO ₂ analyzer: Transmittance [%× 100]	0 to 10000% × 100

7. CALIBRATION AND LEAKAGE CHECK

 DANGER	When toxic fumes, corrosive gas or inert gas is used as calibration gas, check if the position of the air ventilation or exhaust port is suitable. Otherwise you may inhale exhaust gas. Suffocation, brain disorder, circulatory deficit, or contraction of the breathing system may occur, resulting in death.
 CAUTION	<ul style="list-style-type: none"> • Do not dismount the transmitter unit during calibration and while the analyzer is energized. If you direct the laser beam to the eyes of people, the laser beam may damage their cornea. • The laser beam is the invisible infrared light. Do not directly watch the laser beam or scattering light. • Do not watch the laser beam directly with the optical measuring device. Otherwise, it may cause serious damage to your eyes. • There is a possibility that exhaust gas in the pipes may contain acid. Wear acid-resistant gloves and safety glasses when carrying out work.

This chapter describes how a service engineer should carry out calibration and leakage check.

7.1 Items required

Carry out calibration according to the Appendix 4 of MEPC.177 (58); Amendments to The Technical Code on Control of Emission of Nitrogen Oxides from Marine Diesel Engines (NOx technical code 2008).

7.1.1 Items required

Table 7-1 Items required for calibration

Item	Q'ty	Remarks
Zero gas (purified N ₂)	1	Contamination: ≤ 1 ppm C, ≤ 1 ppm CO, ≤ 400 ppm CO ₂ , ≤ 0.1 ppm NO
Span gas (purified N ₂ + SO ₂)	1	SO ₂ concentration: 240 ppm or more and less than 300 ppm
Span gas (purified N ₂ + CO ₂)	1	CO ₂ concentration: 8% or more and less than 10 %
Pressure regulator	1	Separate order Items
Calibration gas tube	Several meters	PTFE tube, with an outer diameter of 6 mm and an inner diameter of 4 mm
Exhaust gas tube	Several meters	PTFE tube, with an outer diameter of 6 mm and an inner diameter of 4 mm
Flowmeter	1	0.5 L/min or more
PC	1	For using the parameter loader software

7.1.2 Preparation

1. Turn on the analyzer, and wait about two hours until the warm-up is completed. Check that the analyzer is in measurement mode.
2. Keep Inputting an ON signal to DI1 (under maintenance).
Failure to input and maintain an ON signal will result in an error in the reading, which the host system may recognize as a concentration abnormality.
3. Remove the tube of the receiver unit from the fitting as shown in Table 7-1. The calibration gas is to be exhausted from this fitting.

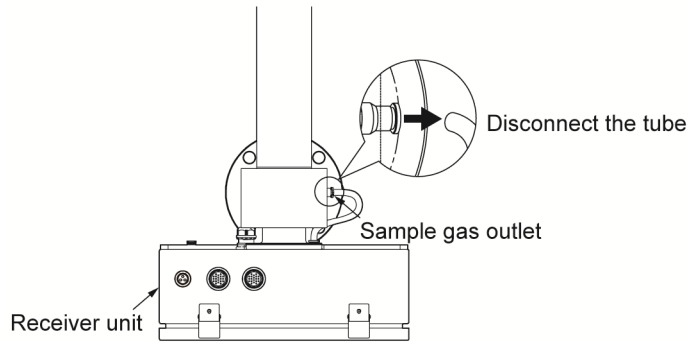


Fig. 7-1 Disconnect the tube from the sampling gas outlet

4. Connect one end of the exhaust gas tube, and install the other end in the flue or outside.

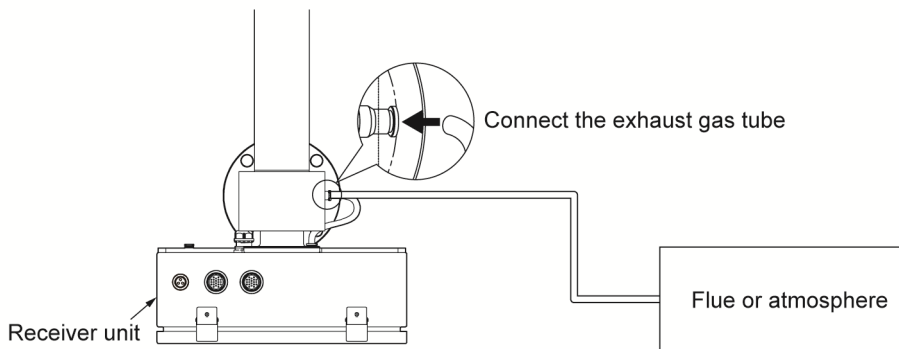


Fig. 7-2 Exhaust gas tube connection

5. Remove the sample gas tube from the fitting of the transmitter unit.

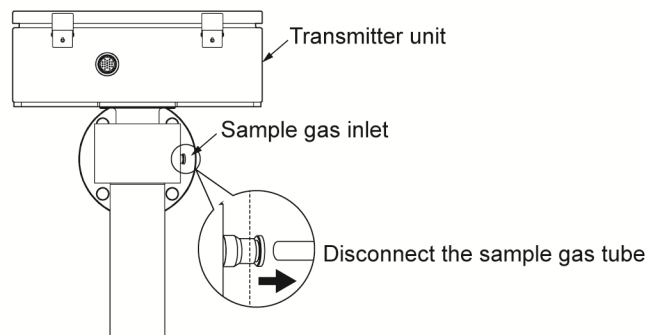


Fig. 7-3 Disconnect the tube from the sample gas inlet joint

6. Connect the calibration gas tube to the fitting of the transmitter unit and to the calibration gas cylinder.

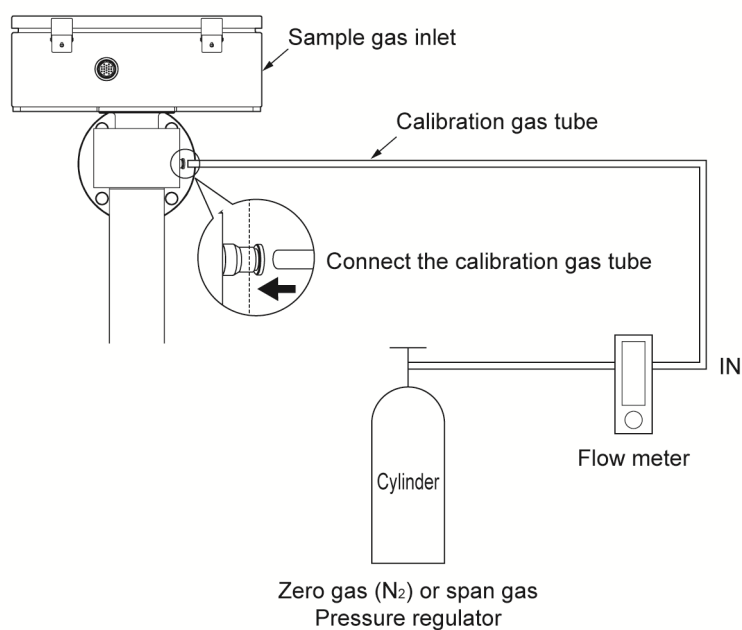


Fig. 7-4 Calibration gas tube connection

7. When the pipe is connected, allow the calibration gas to flow.
8. Adjust the flow rate to 0.5 L/min.

Note: Use new pressure regulator, flowmeter, and calibration gas tubes to ensure accurate calibration. For SO₂ gas, do not use the equipment or tubes that was used for alkaline gas like ammonia. Otherwise, SO₂ gas adsorbs other gases inside the equipment and the indication value may become unstable.

7.1.3 Calibration procedure

Zero calibration

1. Supply the zero gas according to “7.1.2 Preparation”. After five minutes, check the followings:
 - SO₂ reading shall be within 0 ± 6 ppm
 - CO₂ reading shall be within 0 ± 0.2 vol%
2. If the results satisfies the above, the zero calibration is successfully completed. If not, carry out “7.1.4 Adjustment of calibration coefficient” and then check if the readings fall within the above ranges.

SO₂ span calibration

1. Supply the SO₂ span gas according to “7.1.2 Preparation”. After five minutes, check the followings
2. Ensure that the SO₂ gas concentration reading is within $\pm 2\%$ of the nominal span gas concentration. For example, when the nominal concentration of the span gas is 280 ppm, “ $\pm 2\%$ of the nominal value” is ± 5.6 ppm, and therefore it is necessary to ensure that the SO₂ gas concentration reading is in the 274.4 ppm to 285.6 ppm range.
3. If the results satisfies the above, the span calibration is successfully completed. If not, carry out “7.1.4 Adjustment of calibration coefficient” and then check if the reading falls within the above range.

CO₂ span calibration

1. Supply the CO₂ span gas according to “7.1.2 Preparation”. After five minutes, check the followings
2. Ensure that the CO₂ gas concentration reading is within $\pm 2\%$ of the nominal span gas concentration. For example, when the nominal concentration of the span gas is 9.0 vol%, “ $\pm 2\%$ of the nominal value” is ± 0.18 vol%, and therefore it is necessary to ensure that the CO₂ gas concentration reading is in the 8.82 vol% to 9.18 vol% range.
3. If the results satisfies the above, the span calibration is successfully completed. If not, carry out “7.1.4 Adjustment of calibration coefficient” and then check if the reading falls within the above range.

7.1.4 Adjustment of calibration coefficient

If the reading during calibration is out of the range, adjust the calibration coefficient by the following method.

1. Connect your PC and the Ethernet terminal of the interface box with a LAN cable.

Connect an AC adapter to the service socket, allowing power to be supplied.

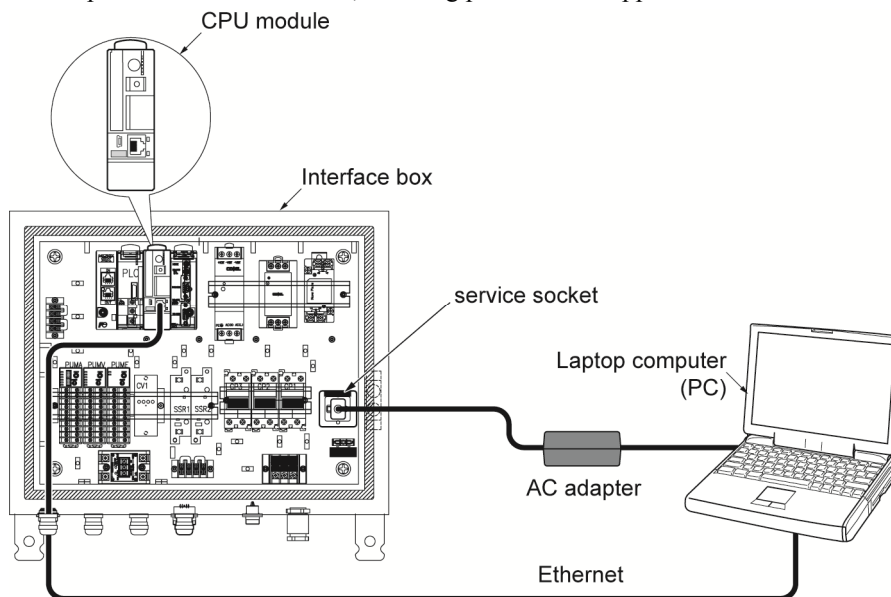



Fig. 7-5 Connect LAN cable

2. Start the parameter loader.
3. Select the Calibration tab.
 - If you are in zero calibration, click the “zero coefficient” button. The reading is set to zero (ppm or vol%).
 - If you are in SO₂ span calibration, enter the nominal value into the “SO₂ span gas” cell and click the “SO₂ span coefficient” button. The reading is set to the nominal concentration (ppm) of the span gas.
 - If you are in CO₂ span calibration, enter the nominal value into the “CO₂ span gas” cell and click the “CO₂ span coefficient” button. The reading is set to the nominal concentration (vol%) of the span gas.

7.1.5 Restoring the analyzer after calibration

1. Connect the tube of the receiver unit to the fitting.
2. Remove the sample gas tube from the fitting of the transmitter unit. Connect the fitting and the calibration gas cylinder with the calibration gas tube.
3. Input an OFF signal to DI1 (under maintenance).

7.2 Leakage test

 CAUTION	<ul style="list-style-type: none">• Inside the extraction unit is hot when the analyzer is energized. Be sure to turn off the analyzer before opening the front panel of the extraction unit. Do not touch anything inside the extraction unit until the temperature inside becomes cool enough after opening the panel.• There is a possibility that exhaust gas in the pipes may contain acid. Wear acid-resistant gloves and safety glasses when carrying out work.
--	---

Carry out a leakage test according to the Appendix 4 of MEPC.177(58); Amendments to The Technical Code on Control of Emission of Nitrogen Oxides from Marine Diesel Engines (NOx technical code 2008).

Note: When carrying out leakage tests, it is necessary to stop the instrument air flow for air backflush. By stopping the instrument air flow, the equipment will no longer be protected from exhaust gas. Carry out a leakage test when no exhaust gas is being produced.

7.2.1 Items required

Table 7-2 Items required for leakage test

Item	Q'ty	Remarks
Tube cap (A) (for 6-mm diameter tube)	1	Plug a tube end of the sampling gas tube inside the extraction unit
Tube cap (B) (for 6-mm diameter tube)	2	Plug a joint inside the extraction Plug a joint on the detection unit air purge inlet
Pump	1	Pump with maximum ultimate vacuum of -10 kPa or higher
Flowmeter	1	Flowmeter with detection limit of 2.5 mL/min or less

7.2.2 Preparation

1. Turn off the analyzer, and open the front panel of the extraction unit to cool down inside the unit.
2. Stop the instrument air flow. Without stopping the instrument air, air will come shooting out of the air tube. To prevent this danger, be sure to stop the instrument air flow.
3. After 10 minutes, remove the tube fitting of the extraction unit. To remove the fitting, turn the nut counterclockwise with a monkey wrench or the like.

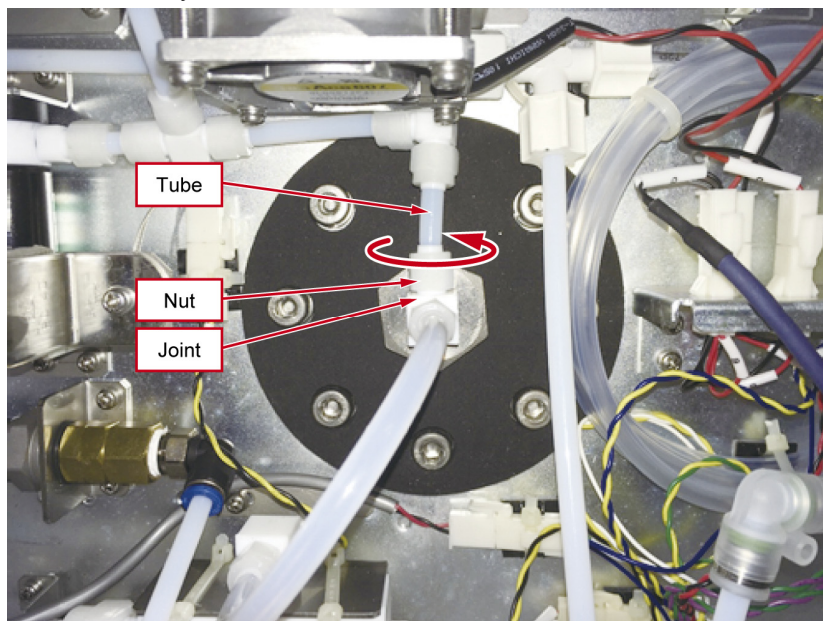


Fig. 7-6 Disconnect the nut inside the extraction unit

4. Pull the tube of the filter side out of the fitting.
5. Remove the nut from the tube. Be sure not to lose the nut because you will need it for putting the parts back after the test.
6. Put the tube cap (A) and plug the tube.

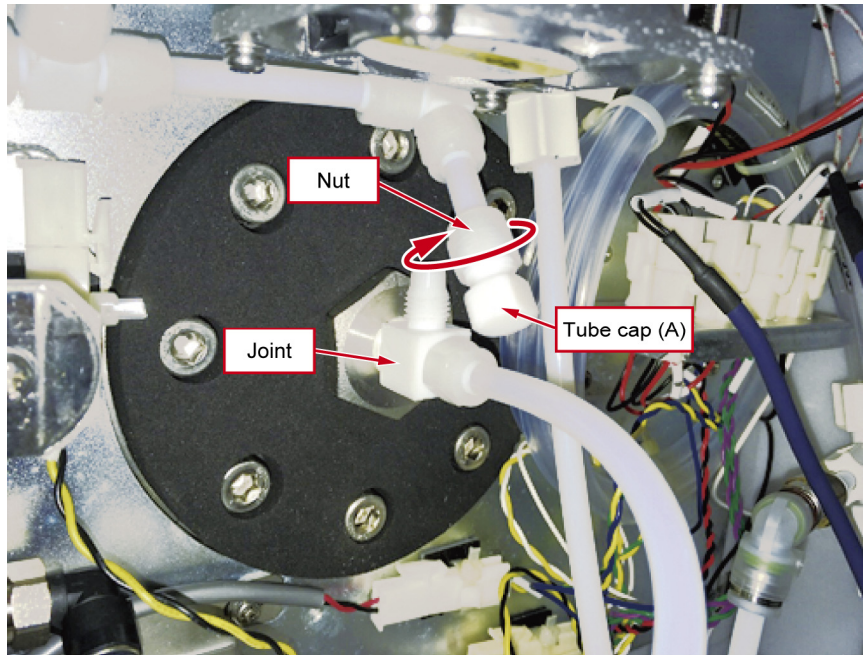


Fig. 7-7 Connect the tube cap (A) to the filter side line

7. Pull the air tube from the joint in the lower left of the inside of the extraction unit as shown in Fig. 7-8. The air tube is removed by pulling it while pushing the ring at the joint insertion opening to the joint side.

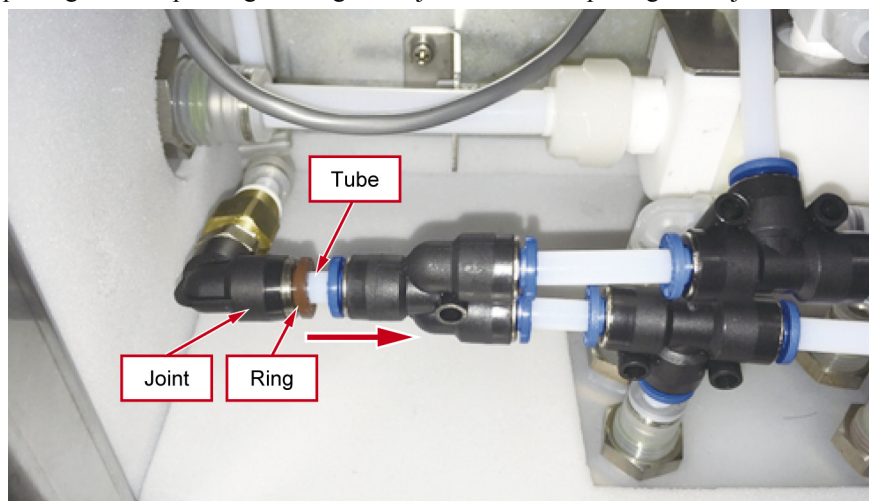


Fig. 7-8 Pull out the tube from the joint

8. Insert the tube cap (B)1 into the joint and plug it as shown in Fig. 7-9. Insert until the cap will go no further.

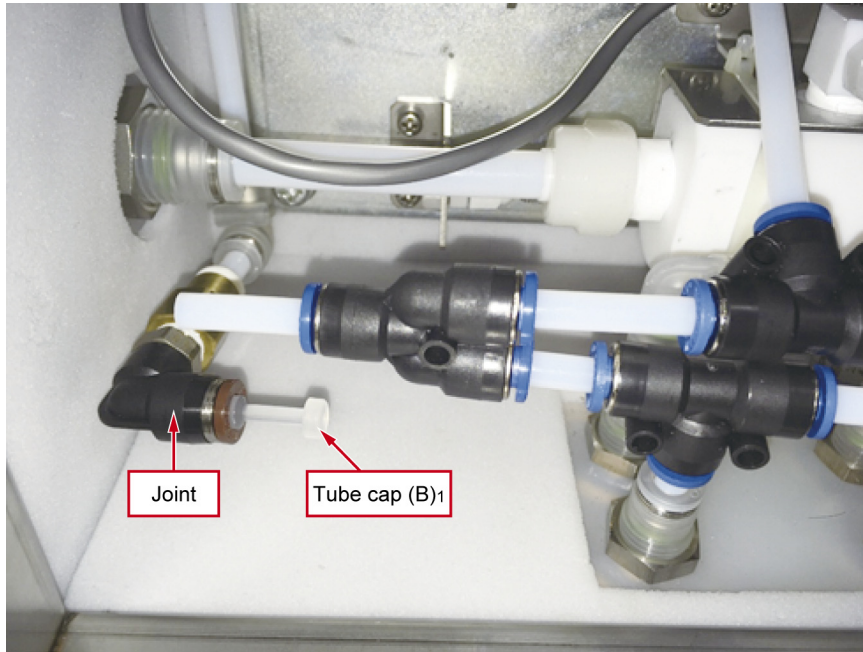


Fig. 7-9 Attach the tube cap (B)₁ to the joint

9. Close the front panel.
10. Next, stop the detection unit instrument air flow. Without stopping the instrument air, air will come shooting out of the air tube. To prevent this danger, be sure to stop the instrument air flow.
11. Pull out the instrument air tube connected to the instrument air inlet at the bottom of the detection unit. Insert the tube cap (B)2 into the joint and plug it as shown in Fig. 7-10. Insert until the tube cap will go no further.

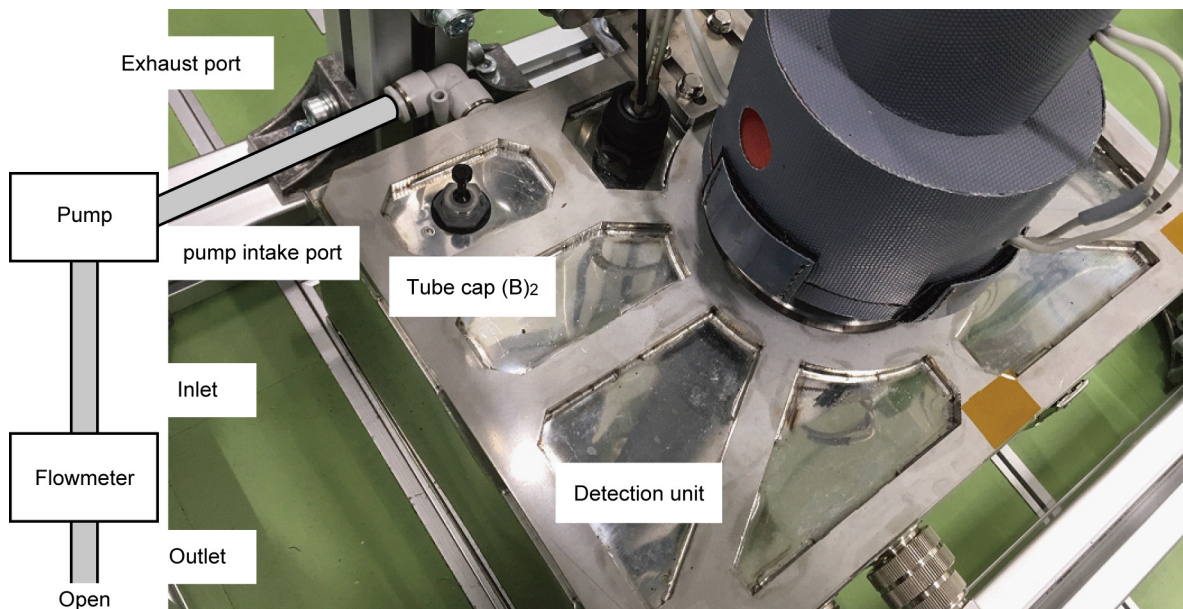


Fig. 7-10 Connect the tube cap (B)₂ to the joint

12. Connect the detection unit exhaust port and pump intake port with an air tube.
13. Connect the pump exhaust port and flowmeter intake port with an air tube. Open the flowmeter outlet.
14. The flowmeter is equipped with an adjustable aperture which should be fully opened.
15. Turn on the equipment power.
16. Keep Inputting an ON signal to DI1 (under maintenance).

7.2.3 Leakage test

*You can carry out the test during warm-up (for two hours after starting energization).

1. Connect your PC and the Ethernet terminal of the interface box with a LAN cable.
2. Start the parameter loader.
3. Click the “Monitor” checkbox to open the Monitor window.

(3) Click the “Monitor” check box.

The screenshot shows the 'Detection Setting' window with the following details:

- Relay Box:** Monitor
- Navigation:** Common | Graph | measured Value | WaveForm Data | Execution | ZQS共通 | ZQS LD1 | ZQS LD1 LD Temp | ZQS LD2 | ZQS LD2 LD Temp | ZQS Graph
- Parameter Tables:**

item	CSV	item	CSV
Dry conv. gas conc. moving average[conc.×100]	<input checked="" type="checkbox"/>	Gas conc. moving average[conc.×100]	<input checked="" type="checkbox"/>
Zero gas conc.[conc.×100]	<input checked="" type="checkbox"/>	Dry conv. gas conc. moving average[conc.×100]	<input checked="" type="checkbox"/>
Span gas conc.[conc.×100]	<input checked="" type="checkbox"/>	Zero gas conc.[conc.×100]	<input checked="" type="checkbox"/>
Zero calibration coefficient[%FS×100]	<input checked="" type="checkbox"/>	Span gas conc.[conc.×100]	<input checked="" type="checkbox"/>
Span calibration coefficient[%×100]	<input checked="" type="checkbox"/>	Zero calibration coefficient[%FS × 100]	<input checked="" type="checkbox"/>
TDM-5000 Temperature meas. value[°C×100]	<input checked="" type="checkbox"/>	Span calibration coefficient[%×100]	<input checked="" type="checkbox"/>
TDM-5000 Current meas. value[A×100]	<input checked="" type="checkbox"/>		
- Laser1:** trans. light(%) 95.89, zero coefficient, span coefficient
- Laser2:** trans. light(%) 95.51, zero coefficient, span coefficient
- Graph:** SO2(ppm) on the left y-axis (0 to 350), CO2(vol%) on the right y-axis (-2 to 14). X-axis shows time from 15:43:45 to 15:47:45.
- Buttons:** LD1, LD2, ZQS, All Export, Export, All Import, Import, Measured Value, Update stop
- Status:** LD1 Status, LD2 Status, Loader Status, Reading on TAB Change, SO2(ppm) / CO2(vol%), PD Ver. 105, LD1 Ver. 105, LD2 Ver. 105, LD1 Combi ---, LD2 Combi ---

(1) Click the “ZQS” radio button.

(2) Check that the button displays “Stop update”. (This means the measurement value is being updated)

Fig. 7-11 PC loader startup screen

item	value
Gas temperature[°C×10]	-50
/[purge gas pressure[kPaG]	-35
▶ Sample gas flow rate[mL/min]	1
Collection section Hot Zone temperature[°C]	-250
Collection section Zone Temperature[°C]	-250
Gas cell temperature[°C]	70
A11 Gas temperature AD value	-50
A12 Unused AD value	-50
A13 purge gas pressure AD value	-50
A14 Sample gas flow rate AD value	8
AO1 SO2 concentration DA value[-3276~3276]	0
AO2 CO2 concentration DA value[-3276~3276]	-1
AO3 SO2/CO2 DA value[-3276~3276]	0
AO4 Proportional valve control DA value[-3276~3276]	3276
DI1 Under maintenance[0:OFF 1:ON]	0
DI2 not used[0:OFF 1:ON]	0
DI3 not used[0:OFF 1:ON]	0
DI4 not used[0:OFF 1:ON]	0
DI5 EGCS operation/stop[0:OFF 1:ON]	1
DI6 not used[0:OFF 1:ON]	0
DI7 not used[0:OFF 1:ON]	0
DI8 not used[0:OFF 1:ON]	0
DO1 LED2[0:OFF 1:ON]	0
DO2 LED3[0:OFF 1:ON]	0
DO3 LED4[0:OFF 1:ON]	1

Fig. 7-12 Sampling gas flow rate monitor screen

4. If the “sample gas flow rate” reading is 0 or 1 mL/min (0.5% of normal flow rate of 500 mL/min) or less, or if the flowmeter reading is 2.5 mL/min or less, the leakage test is successful. A reading of 2 mL/min or higher indicates that the leakage test was unsuccessful, and countermeasures will be required. Refer to “10. Troubleshooting” for details on countermeasures.

* The sample gas flow rate can also be checked by Modbus communication.

7.2.4 Restoring the analyzer after the leakage test

1. Turn off the analyzer, and open the front panel of the extraction unit to cool down inside the unit.
2. After 10 minutes, remove the tube cap (A) shown in Fig. 7-7.
3. Put the nut around the tube.
4. Put the tube end into the fitting.
5. Turn the nut clockwise with a monkey wrench or the like to fasten the nut onto the fitting. Screw the nut $\frac{1}{8}$ or $\frac{1}{4}$ turns more than the original position.
6. Pull out the tube cap (B)1 shown in Fig. 7-9.
7. Connect the air tube to the joint in the lower left of the inside of the extraction unit as shown in Fig. 7-8. Insert until it will go no further.
8. Close the front panel of the extraction unit.
9. Supply instrument air to the extraction unit.
10. Disconnect the flowmeter and pump connected to the detection unit exhaust port.
11. Pull out the tube cap (B)2 shown in Fig. 7-10. Connect the instrument air tube to the instrument air inlet at the bottom of the detection unit.
12. Supply instrument air to the detection unit.
13. Input an OFF signal to DI1 (under maintenance).

8. MAINTENANCE

For proper functioning of the analyzer and keeping it in favorable condition, it is essential to perform maintenance periodically.

8.1 Maintenance by user

For proper functioning of the instrument and keeping it in favorable condition, a user shall perform regular maintenance work listed in Table 8-1. Do not extend the maintenance cycle. Any troubles resulting from failure to perform periodical maintenance are not covered by warranty.

Table 8-1

Item	Cycle	Action	Remarks
Interface box , DO or Modbus communication	Daily	Check LED sif any alarm or maintenance request are made.	If there are any alarms made, see "10. TROUBLESHOOTING". If a maintenance requests is made, see 8.1.1.
Instrument air	Daily	Check if the instrument air is supplied.	If not, turn off the analyzer and supply the instrument air.
Extraction unit	Monthly	Replace the filter element	Refer to 8.1.2.

8.1.1 Maintenance request

If the status indicators of the interface box or the DO6 delivers the maintenance request, at least any one of the incidents listed in Table 7-2 exists.

Table 8-2

Item	Check	Action
Sample gas flow rate low	Check the flow rate by using the parameter loader*. (See below the table.) If the value in the "sample gas flow rate" column is below 300 mL/min, it is deficient.	Replace the filter element. See 8.1.2. If the problem is not solved by replacing the filter element, refer to "10. TROUBLESHOOTING".
Instrument air pressure low	Check the pressure of the instrument air by using the parameter loader*. (See below the table.) If the value in the "instrument air pressure" column is below 0.3 MPa, it is deficient.	1. Turn off the analyzer. 2. Set the instrument air pressure to 0.3 MPa or greater. 3. Turn on the analyzer.
Light transmittance low	Check the light transmittance by using the parameter loader*. (See below the table.) If the value is 50% or below, the transmittance is deficient.	Contact us.

* Can also be checked by Modbus communication.

How to check the sample flow rate

1. Connect your PC and the Ethernet terminal of the interface box with a LAN cable.
2. Start the parameter loader.
3. Click the "Monitor" checkbox to open the Monitor window.
4. If the value in the "sample gas flow rate" column is below 300 mL/min, it is deficient. Carry out the maintenance work described in the Table 8-2.

How to check the instrument air pressure

1. Connect your PC and the Ethernet terminal of the interface box with a LAN cable.
2. Start the parameter loader.
3. Click the “Monitor” checkbox to open the Monitor window.
4. If the value in the “instrument air pressure” is below 0.3 MPa, the pressure is deficient. Carry out the maintenance work described in the Table 8-2.

How to check the transmittance

1. Connect your PC and the Ethernet terminal of the interface box with a LAN cable.
2. Start the parameter loader.
3. Check the “ZQS” option button below left, and then select the “ZQS Graph” tab.
4. Check the “LD1 transmittance (%)” and “LD2 transmittance (%)” values in the following diagram. If either one shows the value below 50%, the transmittance is deficient. Please contact us.

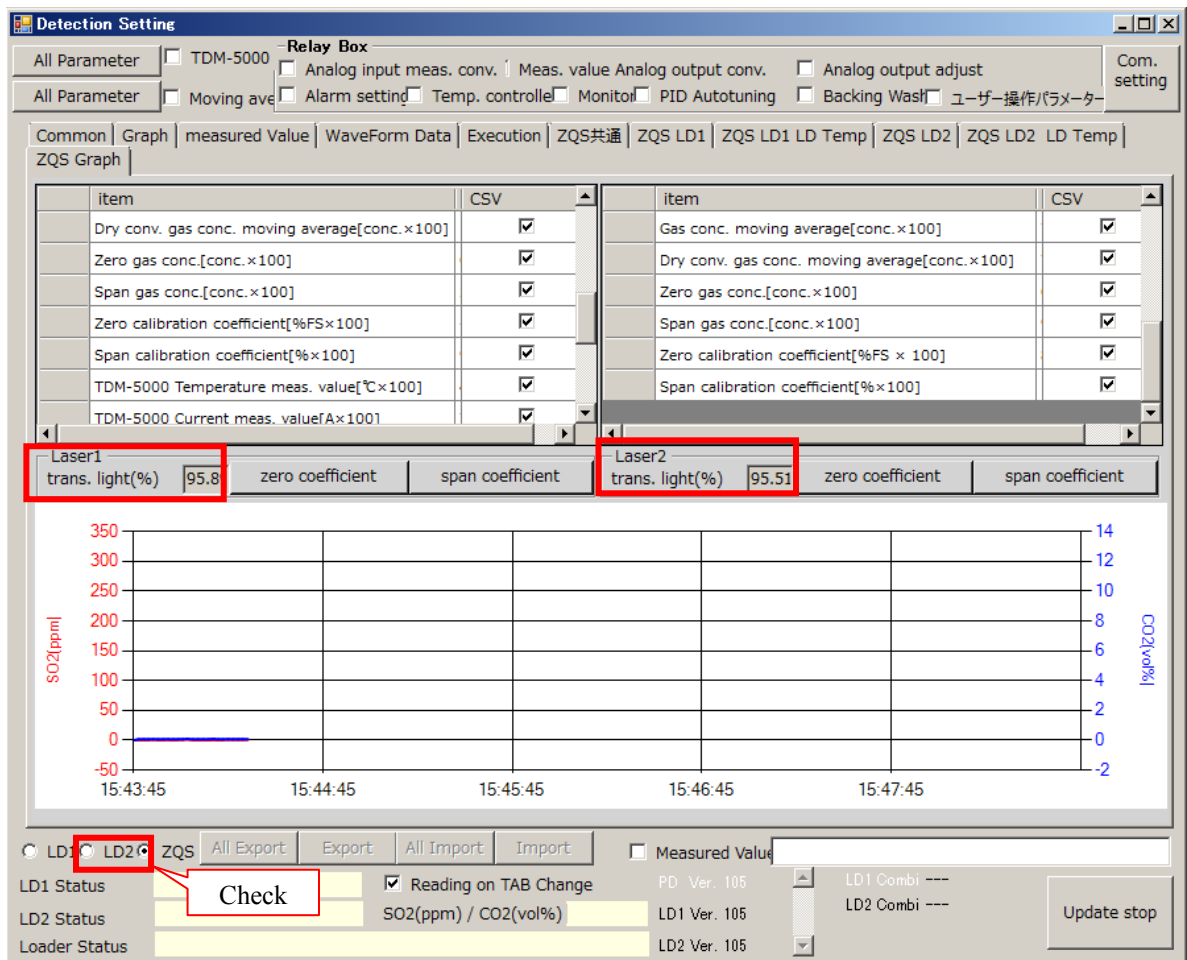


Fig. 8-1

8.1.2 Replacement of the filter element

Replace the filter element every month and when a maintenance request is made due to sample gas flow rate low.

1. Turn off the analyzer, and open the front panel of the extraction unit to cool down inside the unit for 10 minutes.

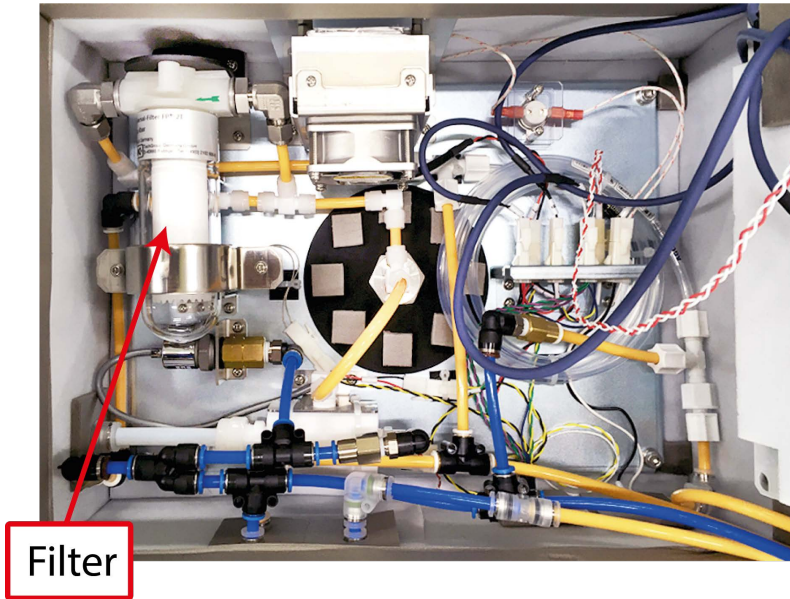


Fig. 8-2

2. Loosen the two screws shown in Fig. 8-3, and then remove the cover.

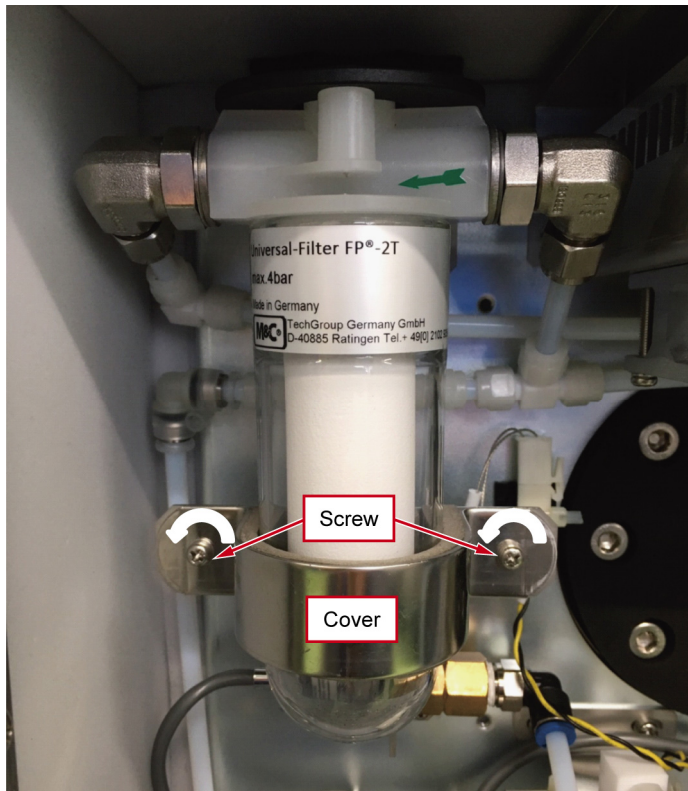


Fig. 8-3

3. Remove the filter glass.


The filter glass is a screw-in type. Grip the glass by hand and rotate in the direction indicated by the arrow in Fig. 8-4 to loosen. Apply more force a little at a time, and rotate the glass until it comes free.



Fig. 8-4

When the glass comes free, lower it to remove.

By the removing the glass, the clamp and filter element will be exposed.

 CAUTION	<ul style="list-style-type: none">• You will need the panel after the replacement of the filter element. Keep the panel in a place where has no risk of break.• The filter panel is made of glass. Handle the panel slowly and with care not to drop or hit it to other parts. If the panel gets damaged, it causes leakage and the accurate measurement becomes unavailable.
--	--

4. Remove the clamp and filter element.

The filter element is supported by the clamp. The clamp is a screw-in type. Grip the clamp by hand and rotate in the direction shown in Fig. 8-5 to loosen. Apply more force a little at a time, and rotate the clamp until it comes free.

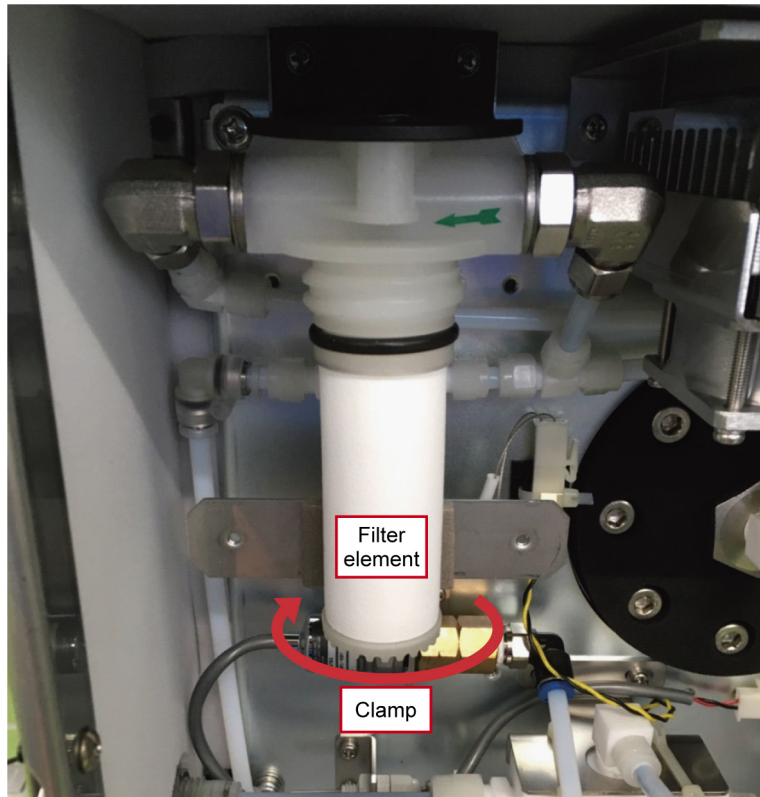


Fig. 8-5

5. Remove the dirty filter element from the removed clamp.
Reuse the clamp.
6. Fit a new filter element to the clamp.
7. Rotate the clamp and new filter element in the opposite direction to that in step (4), and screw in tightly.
8. Rotate the filter glass in the opposite direction to that in step (3), and screw in tightly. Tighten until the glass contacts the filter unit and stops rotating.
9. Tighten the two screws shown in Fig. 8-3, and reattach the cover (tightening torque: 1.5 N·m).
10. Close the front panel of the extraction unit. Filter element replacement and equipment repaneling are now complete.

8.2 Maintenance by service engineer

For proper functioning of the instrument and keeping it in favorable condition, periodical maintenance work listed in Table 8-3 shall be performed by a service engineer. Only qualified personnel who has been trained by Fuji Electric should perform maintenance works.

Do not extend the maintenance cycle. Any troubles resulting from failure to perform periodical maintenance are not covered by warranty.

The detection unit needs to be overhauled every five years. Remove the detection unit and send it to our factory.

Table 8-3

Name	Cycle	Action	Remarks
Detection unit	1 year	Zero calibration and span calibration	Refer to 7.1
All units	1 year	Leakage test	Refer to 7.2
Detection unit	1 year	O-ring replacement	Refer to the service manual
Extraction unit	1 year	Gas sampling probe inspection	
	2 years	Gas sampling probe replacement	
All units	5 years	Overhaul	

9. Returning and Disposing of the Product

9.1 Returning the Product

If returning the product to Fuji Electric for repair, pay attention to the following.

1. Clean the surface of the equipment.
2. Pack the detection unit, the extraction unit, and the interface box with bubble wrap. In particular, wrap the extraction unit fan with double packing.
3. Pack the detection unit, the extraction unit, and the interface box in durable outer boxes (example: double wall cardboard cartons). Fill the gaps with buffer material.
4. Pack to withstand any shocks (acceleration of 150 m/s²) anticipated during transport.
5. Pack in such a way as to protect the equipment from direct exposure to water droplets, and to protect it from corrosive gas.

If returning the product to Japan from overseas, please append documentation indicating that the purpose of export is for repair. Please provide us with a certificate indicating that the equipment includes no restricted substances (substances stipulated by Ship Recycling Convention or laws and regulations of the exporting country)

Fuji Electric shall not be held liable in cases where export is not possible when re-exporting equipment from Japan due to document (certificate indicating that equipment does not contain substances subject to Ship Recycling Convention, document indicating purpose of export) discrepancies.

9.2 Disposing of the Product

If disposing of the product, comply the laws and regulations of the applicable region.

10. TROUBLESHOOTING

If any alarms occur or the analyzer does not work properly, refer to the troubleshooting below.


	<p>CAUTION</p>	<p>If you cannot figure out how to fix the problem even if you read the troubleshooting, or troubleshooting does not solve the problem, please contact us. Improper handling or disassembling may cause electric shock or injury.</p>
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Table 10-1 Troubleshooting

Problem	Where to check	What to check	Recommended actions
The analyzer won't start. The green LED on the interface box does not light.	Power supply	Does the power supply voltage meet the specification?	Supply the power that meets the specification.
	Power cable	Is the power cable wired appropriately?	Wire it as instructed.
Sample gas flow rate is too low	Filter of the extraction unit	Is the filter clogged?	Replace the filter element in reference to "8.1.2 Replacement of the filter element".
	Sample gas tube between the extraction unit and the detection unit	Is the tube clogged? Is the tube bent?	Replace the sample gas tube.
	Tube fittings for sample gas tube	Is the fitting clogged?	Clean the inside of the fitting.
	Tube inside the extraction	Is the inside of the tube clogged with dirt?	Contact us.
	Tubes from exhaust ports	Is the inside of the tube clogged with dirt?	Clean the tube, or replace it with a new one.
Is the tube longer than 500 mm?		Change the tube length to 500 mm or shorter.	
The instrument air pressure is low.	Filter of the extraction unit	Is the filter clogged?	Replace the filter element in reference to "8.1.2 Replacement of the filter element".
	Sample gas tube between the extraction unit and the detection unit	Is the tube clogged? Is the tube bent?	Replace the sample gas tube.
	Tube fittings for sample gas tube	Is the fitting clogged?	Clean the inside of the fitting.
	Tube inside the extraction	Is the inside of the pipe clogged with dirt?	Contact us.

Problem	Where to check	What to check	Recommended actions
The concentration reading is too low	Tube and fittings between the extraction unit filter and the sampling probe	Is the tube connection loose or is the tube disconnected from the fitting?	Connect the tube to the fitting firmly.
	Sample gas tube between the extraction unit and the detection unit	Does the tube has any cracks or holes?	Replace the sample gas tube.
	Tube fittings for sampling gas tube	Is the sample gas tube disconnected from the fitting?	Connect the tube to the fitting firmly.
	Exhaust gas temperature	Is the gas temperature beyond the allowable range?	Use the air backflush function that makes the instrument air pass through the gas cell of the detection unit. This causes the reading to be around zero.
	Under maintenance	Is an “Under maintenance” signal being input?	The air backflush works while “Under maintenance”. The air backflush function makes the instrument air pass through the gas cell of the detection unit. This causes the reading to be around zero.
The concentration reading is too high	PC loader or Ethernet communication	Is the transmittance too low?	Contact us.
The concentration reading does not change.	PC loader or Ethernet communication	Is the transmittance too low?	Contact us.
The air backflush does not end. (The measurement won't start.)	PC loader or Ethernet communication	Is the instrument air pressure too low?	Increase the pressure of the instrument air.
	The front panel of the extraction unit	Is the front panel open?	Close the panel.
	Exhaust gas temperature	Is the gas temperature beyond the allowable range?	The air backflush works while gas temperature is out of range
	Warm-up	Is the analyzer warming up?	The air backflush works during warm-ups.
	EGCS on / off signal	Has the EGCS on signal not been input?	Input an EGCS on signal with DI5 or Modbus communication.
Analyzer error (DO7)	PC loader or Ethernet communication	Check the detail of error.	<ul style="list-style-type: none"> • If the error is a) the sample gas flow rate is too low, b) instrument air pressure is too low, or c) abnormal temperature of the extraction unit, take actions described in above columns. • For other errors, contact us.

Problem	Where to check	What to check	Recommended actions
Modbus communication is not possible, or the interface box status indicator indicates a “PLC error”	Interface box internal CPU module indicator	Does only the green LED light?	The communication module (PLC) is in failure. Contact us.
Leakage test failed	Tube cap(A) nut attachment	Was the tube cap tightened by hand?	Use a tool to retighten.
	Joint dirt	Is there any dirt or foreign material adhesion on the joint?	Use a blower or cloth to eliminate any dirt or foreign material.
	Scratches, dirt on end of sample gas tube between the extraction unit and the detection unit	Are there any scratches, or is there any dirt on the end of the sample gas tube?	If scratches are found, cut the end with a tube cutter to leave a new end portion free of scratches. If dirty, eliminate the dirt with a cloth.
	Midway point in sample gas tube between the extraction unit and the detection unit	Does the tube have any cracks or holes?	Replace the sample gas tube.
Transmittance is too low (during commissioning)	Detection unit mounting wall	Is there a gap between the detection unit mounting surface and the wall?	Eliminate the gap as described in “4.3 Installation of the detection unit”.

11. SPECIFICATIONS

11.1 General specifications

- (1) Principle : Non-dispersive infrared laser
- (2) Measurement method : Gas extraction method
- (3) Measuring object : SO_x scrubber outlet flue (dedicated) for marine engine exhaust gas
- (4) Components and ranges : SO₂ and CO₂

Gas	Concentration
SO ₂	0 to 300 ppm
CO ₂	0 to 10.0 vol%

- (5) Light source : Semiconductor laser
- (6) Laser class : Class 1 (laser devices are Class 1 and Class 3B)
- (7) Dimensions (W × D × H) : Detection unit: 330 (W) × 880 (H) × 255 (D) mm
mm Extraction unit: 400 (W) × 300 (H) × 323.4 (D) mm
*Depth varies with diameters of the stack.
Interface box: 500 (W) × 400 (H) × 166 (D) mm
- (8) Weight : Detection unit: approximately 30 kg
Extraction unit: approximately 18 kg
Interface box: approximately 20 kg
- (9) Enclosure : Indoor use, IP44 (totally enclosed, splash-proof)
Only the extraction unit fan: IPX4.
- (10) Materials : Detection unit: Stainless steel
Extraction unit: Stainless steel
Interface box: Stainless steel
- (11) Materials of gas-contacting parts : SUS316L, CaF₂, FKM, Silicone, PTFE, Glass, PVDF
- (12) Air purge connection : Rc¹/₄ (for 6 × 4 mm tube)
- (13) Box finish color : Detection unit: No finish
Extraction unit: No finish
Interface box: No finish
- (14) Power supply : Rated voltage: 100 V AC
Operating voltage: 90–115 V AC
Frequency: 50/60 Hz
- (15) Power consumption : Max. rated power: Approximately 1000 VA
- (16) Calibration interval : 1 year

- (17) Display : None
- (18) Cable length : Between the receiver unit and the transmitter unit: 1 m
 Between the detection unit and the interface box: ≤ 15 m
 Between the extraction unit and the interface box: ≤ 20 m
- (19) Sample gas tube length : Between the detection unit and the extraction unit: ≤ 10 m
- (20) Analog output : 4–20 mA DC, 3 points
 Insulated from the grounding line and the internal circuit. Not insulated between signals.
 Load resistance: $\leq 300 \Omega$
 Output contents: SO₂ concentration, CO₂ concentration, SO₂/CO₂ ratio
 Output is held at 0% during maintenance and during suspension of scrubber.
- (201) Analog input : 4–20 mA DC, 1 point
 Insulated from the grounding line and the internal circuit. Not insulated between signals.
 Input contents: gas temperature
- (22) Digital output : SPST-NO relay contact, 4 points
 Contact capacity: 30 V DC, 1A (resistive load)
 Insulated from the internal circuit. Contacts are not insulated each other (shared COM).
 Output contents: maintenance, warm-up, sampling suspension, maintenance request, analyzer error (extraction unit error, detection unit error), power interruption
- (23) Digital input : Voltage contact input, 4 points
 Contact ON at DC18 to 25 V input
 Insulated from the internal circuit. Contacts are not insulated each other (shared COM).
 Input contents: maintenance, EGCS on/off
- (24) Communication input and output : Ethernet 10/100BASE-T RJ45 connector Modbus/TCP
 Concentration value output, parameter setting, RAS information, zero and span calibration command
- (25) Status display : Status indicator lamps

11.2 Installation environment

Installation environment

- (1) Operating environment: Ambient temperature:
Detection unit: 0°C to 55°C
Extraction unit: 0°C to 65°C
Interface box: 0°C to 45°C
Ambient humidity: ≤ 90%RH (no condensation)
- (2) Storage environment: Ambient temperature: -20°C to 70°C
Ambient humidity: ≤ 100%RH (no condensation)
- (3) Vibration: ≤ 0.2 G (1.9 m/s²)
- (4) Standard flange: JIS 5K65A

Gas requirements

- (1) Gas temperature: 5°C to 60°C
- (2) Mist: There should be none.
*Even if mist production is unavoidable, measurement is possible. However, the higher the mist concentration is, the higher the likelihood of adverse effects are such as extraction unit piping corrosion and premature filter clogging.
- (3) Water vapor: ≤ 20 vol% (below the level that saturation occurs at 60°C)
- (4) Pressure: -10 kPa to +10 kPa
- (5) Gas composition: SO₂: ≤ 300 ppm
CO₂: ≤ 10 vol%
NO_x: ≤ 1000 ppm
CO: ≤ 2000 ppm
O₂: 1–21 vol%
CH₄: ≤ 50 ppm
NH₃: ≤ 10 ppm
Balance N₂ and H₂O

11.3 Performance

- | | |
|---|---|
| (1) Accuracy: | Not more than $\pm 2.0\%$ rdg. or $\pm 0.3\%$ FS whichever is larger |
| (2) Precision: | 2.5 times the standard deviation of 10 repetitive responses:
$\leq \pm 1.0\%$ FS |
| (3) Noise: | $\leq \pm 2.0\%$ FSp-p |
| (4) Zero drift: | $\leq \pm 2.0\%$ FS for 6 months |
| (5) Span drift: | $\leq \pm 2.0\%$ FS for 6 months |
| (6) Response time
(90% FS response): | ≤ 180 s |
| (7) Warm-up time: | ≤ 120 min |
| (8) Cross interference | Error when the following interference gas exists: $\leq \pm 2\%$ FS
500 ppm NO
200 ppm NO ₂
2000 ppm CO
10 ppm NH ₃
50 ppm CH ₄
H ₂ O below the level that saturation occurs at 60°C
Diluent gas shall be N ₂ |

12. CODE SYMBOLS

12.1 Analyzer

Digit	Specification	Notes	Digit →							
			1	2	3	4	5	6	7	8
			Z	Q	S	S	M	E	0	1
4	<Measuring range of 1st component> SO ₂ 0 to 300 ppm					S				
5	< Measuring range of 2st component > CO ₂ 0 to 10 vol%					M				
6	<Flange> JIS 5K65A							E		
7	—								0	
8	<Revision code>									1

12.2 Gas sampling probe

Digit	Specification	Notes	Digit →							
			1	2	3	4	5	6	7	8
			Z	Q	Z	A		0	0	1
4	<Accessories : gas sampling probe>					A				
5	<Length of gas sampling probe of extraction unit> 300 mm 400 mm 500 mm 600 mm 700 mm 800 mm	Notes 1						3 4 5 6 7 8		
6	—							0		
7	—								0	
8	< Revision code >									1

Note 1: Select the gas sampling probe length so that the end of the probe comes as near as possible to the center of the exhaust pipe in radial direction.

12.3 Sample gas tube

Digit	Specification	Notes	Digit →	1	2	3	4	5	6	7	8
				Z	Q	Z	B	0		0	1
4	<Accessories:sample gas tube>						B				
5	—							0			
6	<Length of tube between extraction unit and detection unit> 2 m 5 m 10 m	Notes 1							2 5 A		
7	—									0	
8	< Revision code >										1

Note 1: Select a sufficient length for sample gas tube to connect the extraction unit and detection unit.

12.4 Cable 1 (between the detection unit and the interface box)

Digit	Specification	Notes	Digit →	1	2	3	4	5	6	7	8
				Z	Q	Z	C	0		0	1
4	<Accessories:cable>						C				
5	—							0			
6	<Cable length> 2 m 5 m 10 m 15 m	Notes 1							2 5 A B		
7	—									0	
8	< Revision code >										1

Note 1: Select a sufficient length for cable 1 (detection unit - interface box) to connect the detection unit and the interface box.

12.5 Cable 2 (between the extraction unit and the interface box)

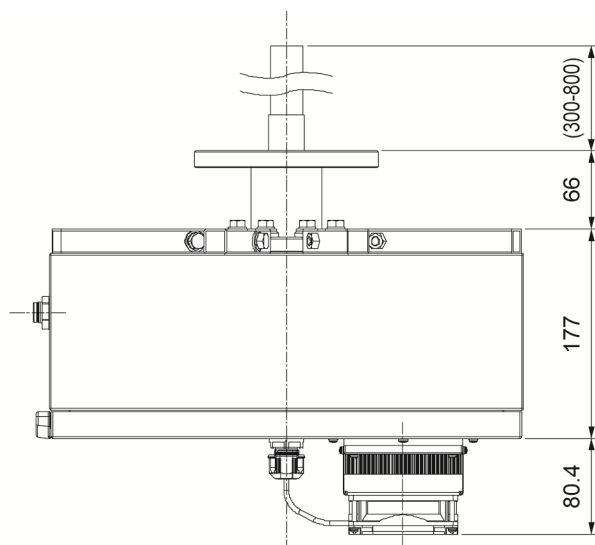
Digit	Specification	Notes	Digit →							
			1	2	3	4	5	6	7	8
4	< Accessories:cable >		Z	Q	Z	D	0		0	1
5	—					D				
6	< Cable lenght > 2 m 5 m 10 m 15 m 20 m	Notes 1						0		
7	—								0	
8	< Revision code >									1

Note 1: Select a sufficient length for cable 2 (extraction unit - interface box) to connect the extraction unit and the interface box.

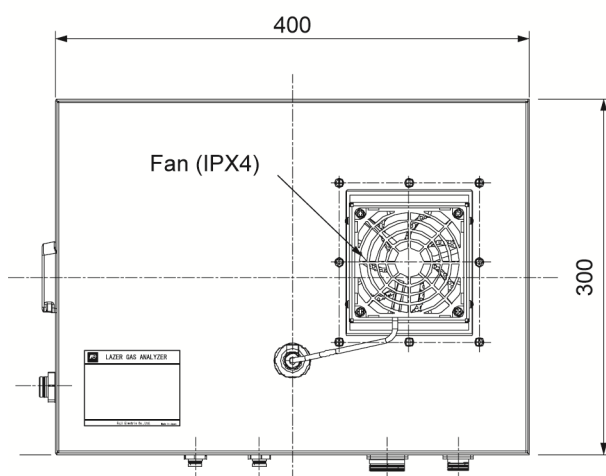
13. DIMENSIONS

13.1 Extraction unit

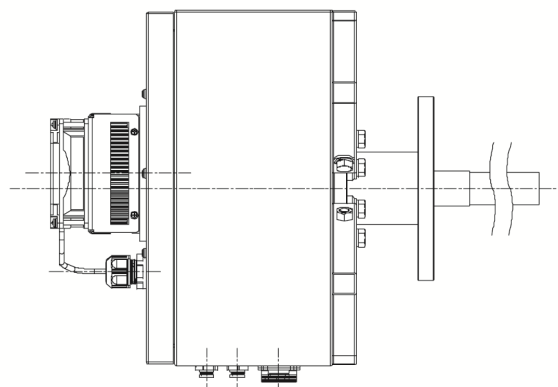
(in mm)



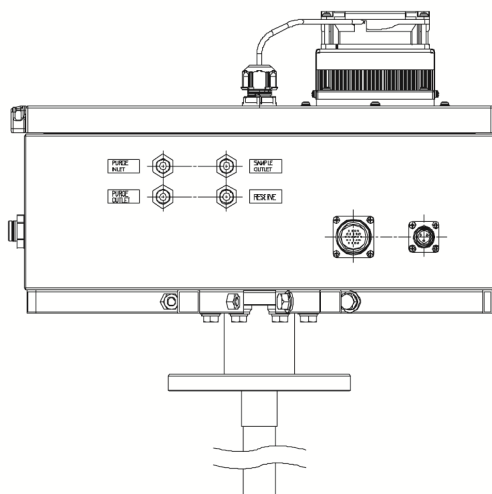
Top view



Front view

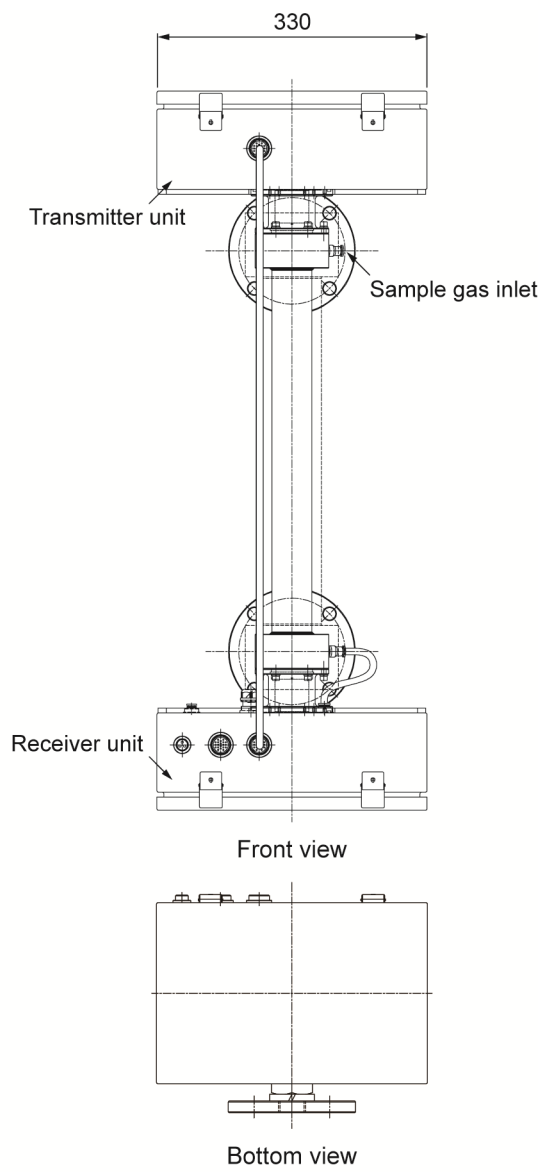
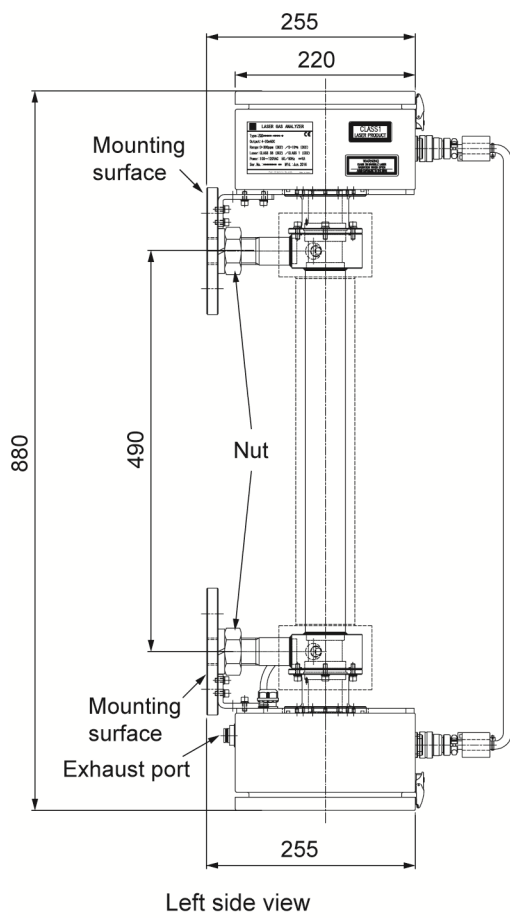


Right view



Bottom view

13.2 Detection unit





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