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OIL MIST DETECTOR INSTRUCTION MANUAL MD-SX II

(Sensor type for 4 stroke engines)

Safety Precautions on Operation of Oil Mist Detector

This Manual describes cautionary items for installation and operation of the oil mist detector for sake of safe use.
Please operate the equipment adequately while following the cautionary items.

The degree of hazard and damage likely to result from wrong use, neglecting the indicated cautions, is explained in this Manual using symbol marks shown below.
The symbol marks mean as follows.



..... **CAUTION** State likely to cause damage of light or middle degree is indicated, unless the state is avoided or prevented.



1. Caution for electric shock

- (1) Voltage is left in the internal terminal block, even if the body POWER turned OFF.
- (2) Please switch off the controller every time when sensor is replaced or disconnected from sensor connector, otherwise, it may cause not only the electric shock but the breakdown of the equipments.
- (3) Especially, when 100 V AC is used for signal output contacts, please be careful for electric shock from the terminal block.



2. Caution against current leakage

- (1) To prevent electric leakage, please be sure to ground the equipment.

* The specification may be changed for improvement with no advance notice.

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1. OVERVIEW

This equipment consists of “sensor units” that are directly mounted through the wall on the crankcase side of a diesel or gas engine and a “controller” that collectively controls the units by communication means.

This equipment was developed by applying new techniques and ideas based on our long-term accumulated techniques related to detection of oil mist density. For detection of mist by the sensor units, the equipment uses a natural diffusion system that does not require mechanically moving parts, such as a suction mechanism, driving air or piping. Compact design, improved reliability and easy maintenance are realized by the use of the light scattering system for detection of mist density.

The maximum number of detection points is 9. Except for the ship engine with classifications approved. The system is very flexible for controller layout and installations.

Since the controller has key switches and an LCD, the operability is improved, and the conditions of the whole equipment including the sensor units can be monitored by the self-diagnostic function.

The oil mist density in the crankcase is constantly monitored. When the oil mist density exceeds the setting owing to overheated bearings, an alarm will be given, and a signal will be output to the outside. Not only on middle -speed 4 stroke engines, but also on high-speed 4 stroke engines, serious failures can be found early or predicted.

2. FEATURES

- (1) For mist detection by the sensor units, a natural diffusion system is used.
This eliminates the necessity of such fan suction mechanism, piping and driving air that the conventional systems required.
- (2) The mist detection section consists of a light emitting element (LED) and a light receiving element (PD: photodiode). The use of the light scattering detecting technique reduced the equipment size and realized high-sensitivity detection excelling in stability.
- (3) The sensor units do not have mechanically moving parts. They are light and excel in durability and vibration resistance.
- (4) Output variations due to changes in temperature are automatically corrected.
In addition any adjustment is not necessary for the sensitivity deterioration by contamination. It can be used for the long term by cleaning sensor hood.
(Please refer to 16.3 sensor cleaning procedure)
- (5) The use of a single-chip microcomputer ensures high-performance stable detection.
- (6) The use of data communication techniques realizes daisy chain wiring-saved connection for power supply lines and communication lines between sensor units and between the controller and each sensor unit.
- (7) The mist indicator on the controller consists of 16 LEDs in three colors and is clear. For alarm detection, a two-stage system (pre-alarm and high-alarm) is used.
- (8) The controller is provided with key switches and an LCD to improve the operability.
- (9) It is possible to connect an external output unit for an external monitor. (Option)
- (10) Since the connector is used for wiring connection of the sensors, wiring work is easy.
(Connector type)

3. CONSTITUTION

It is possible to install MD-SX II oil mist detection system for 4 stroke engine.
(For ship: refer to IACS UR M10.12)

(1) In case of standard install MD-SX II system.

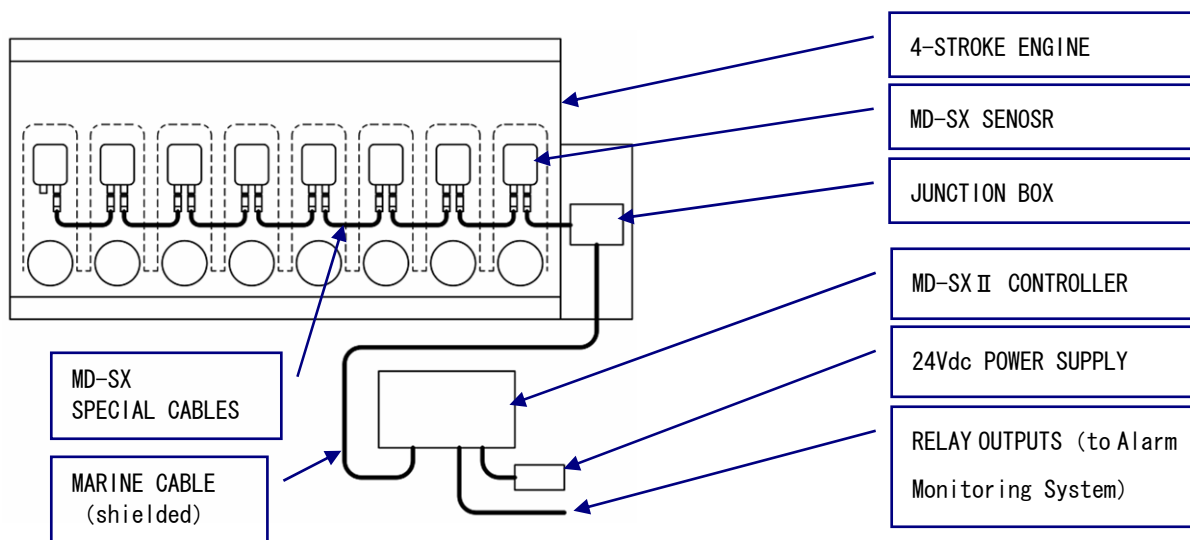


Fig. 1 Install of all cylinders

- **9 sensors** can be installed for one engine at the maximum.*
- Wire the sensors in daisy chain system (connection-in-a-row system) for each engine.
- Limit the total length of the telecommunication cable from the sensor of an end to a controller is less than **150 m** (for use of Daihatsu option cables). In case of the total wire length exceed 150 m, please ask the wiring method to Daihatsu.
- The wiring between sensors and controller shall be used Daihatsu option cables (the cable with connectors).
- (Note: When installing a junction box between a controller and sensors, a general cable for ships can be used between the controller and the junction box.)
- Mount the sensor directly on the engine frame.
- Use the specified wire cushions to isolate the controller from vibration if it is directly mounted on the engine body.

Please refer to [16.2 Anti-vibration bracket mounting drawing (OPTION)].

- Before using the mounting method described above, please contact us.

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- For ship use, it may be limited by the shipping classification society with one oil mist detector system 1 formula per engine. Please follow the rule of each shipping classification society.
 - For sensor wiring method, The loop wiring also applicable other than daisy chain method (Please refer to 16.4 Attention of using LOOP wiring for sensor cable routing)

(2) In case of special install MD-SX II system.(Example 1)

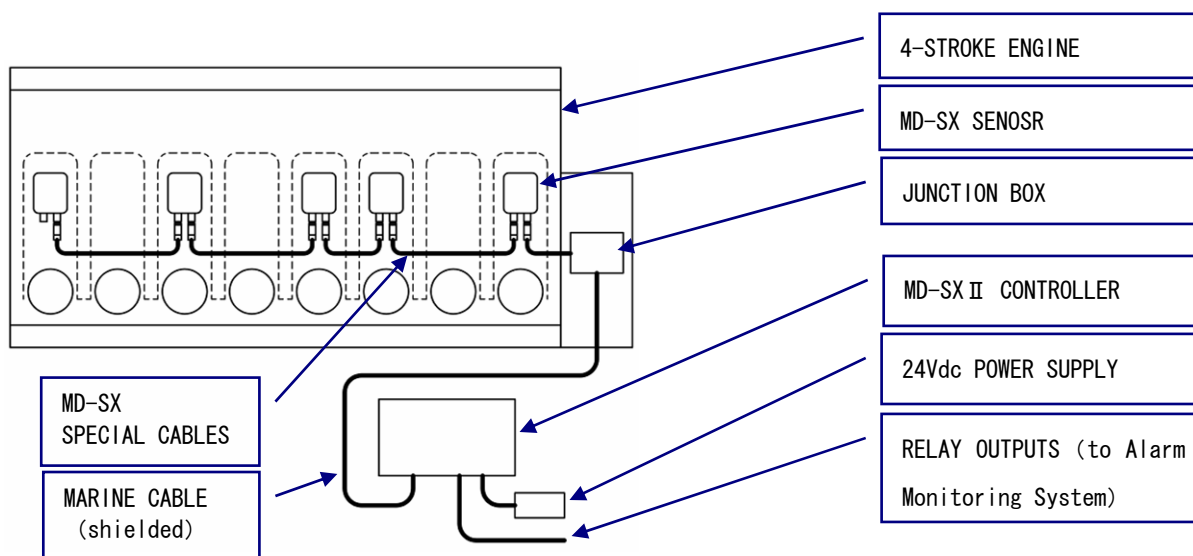


Fig. 2 Install of cull cylinders

Installation example when it is guessed from the sensor detection density of both sides Automatically.

	sensor detection point								
	No. 1 Cyl	No. 2 Cyl	No. 3 Cyl	No. 4 Cyl	No. 5 Cyl	No. 6 Cyl	No. 7 Cyl	No. 8 Cyl	No. 9 Cyl
3-Cyl. Eng.	○	—	○						
4-Cyl. Eng.	○	—	○	○					
	○	○	—	○					
5-Cyl. Eng.	○	—	○	—	○				
6-Cyl. Eng.	○	—	○	○	—	○			
7-Cyl. Eng.	○	—	○	—	○	—	○		
8-Cyl. Eng.	○	—	○	○	—	○	—	○	
	○	—	○	—	○	○	—	○	
9-Cyl. Eng.	○	—	○	—	○	—	○	—	○

(3) In case of special install MD-SX II system. (Example 2)

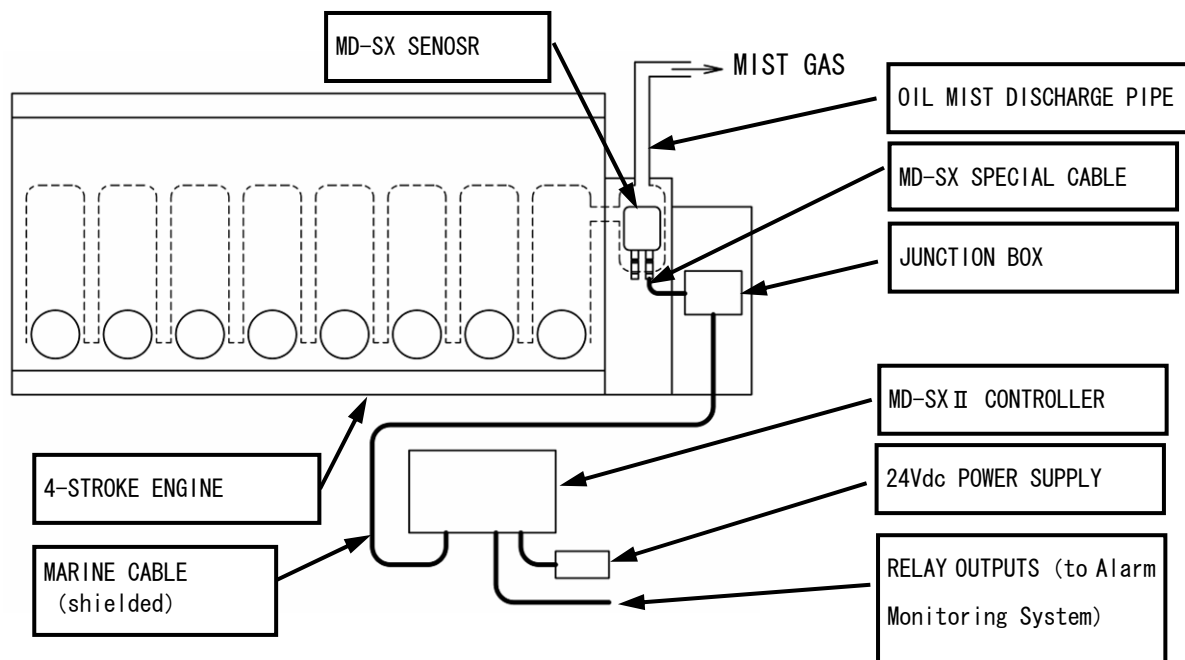
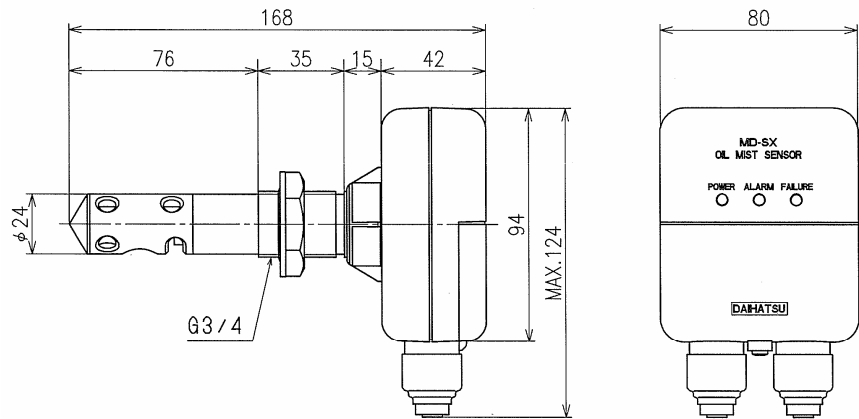


Fig.3 Install of Oil mist discharge pipe

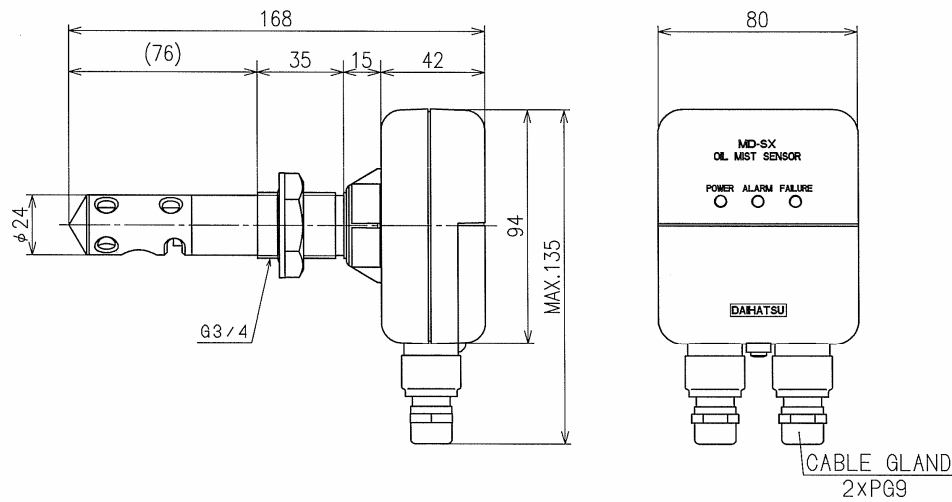
4. OUTLINE

(1) SENSOR UNIT

Standard type (connector type)



Cable gland type



Fling-lead type

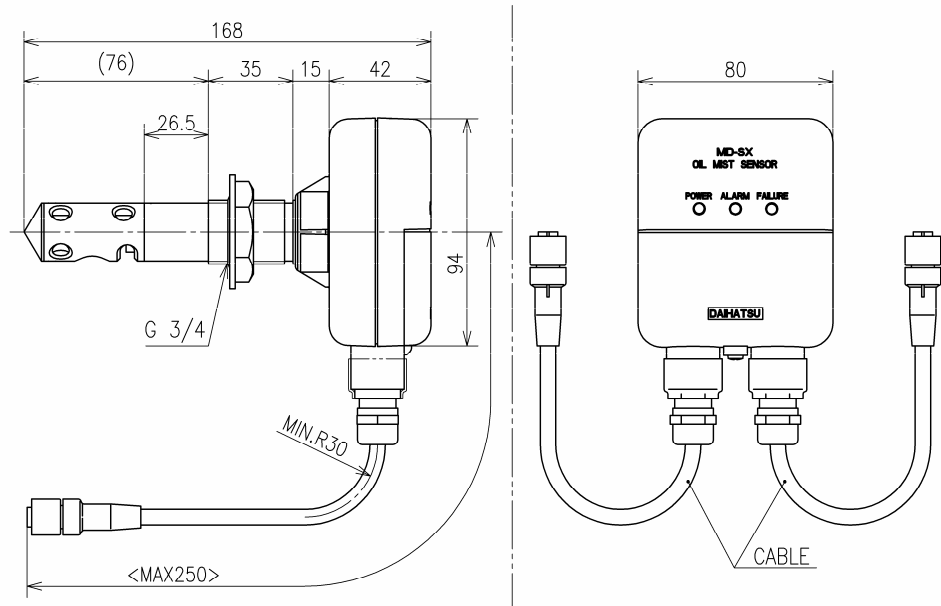
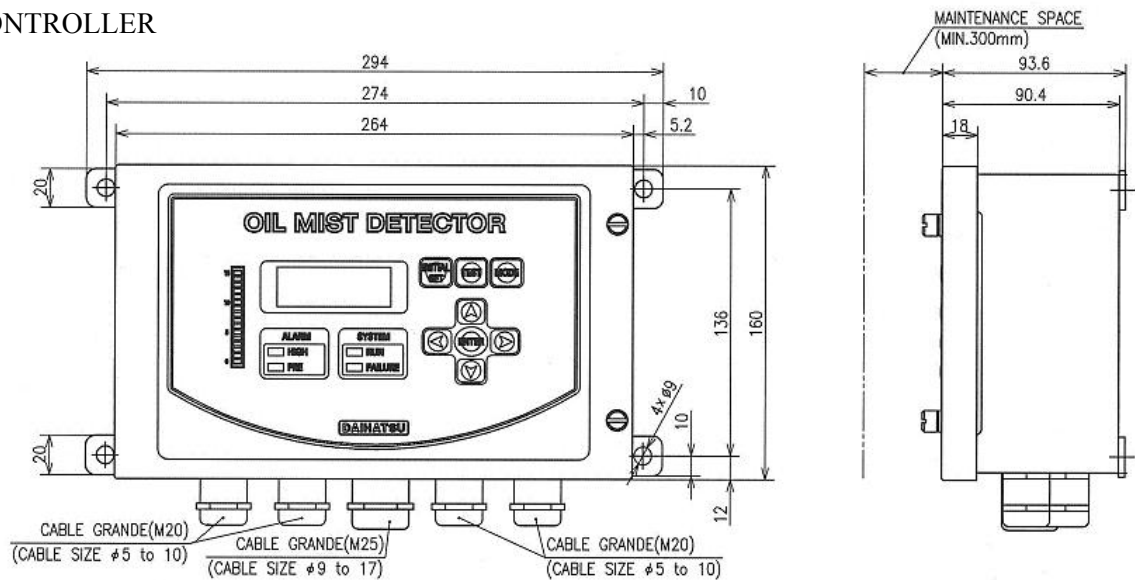
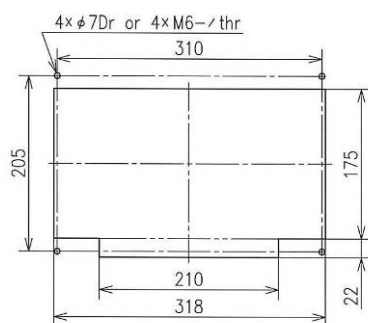
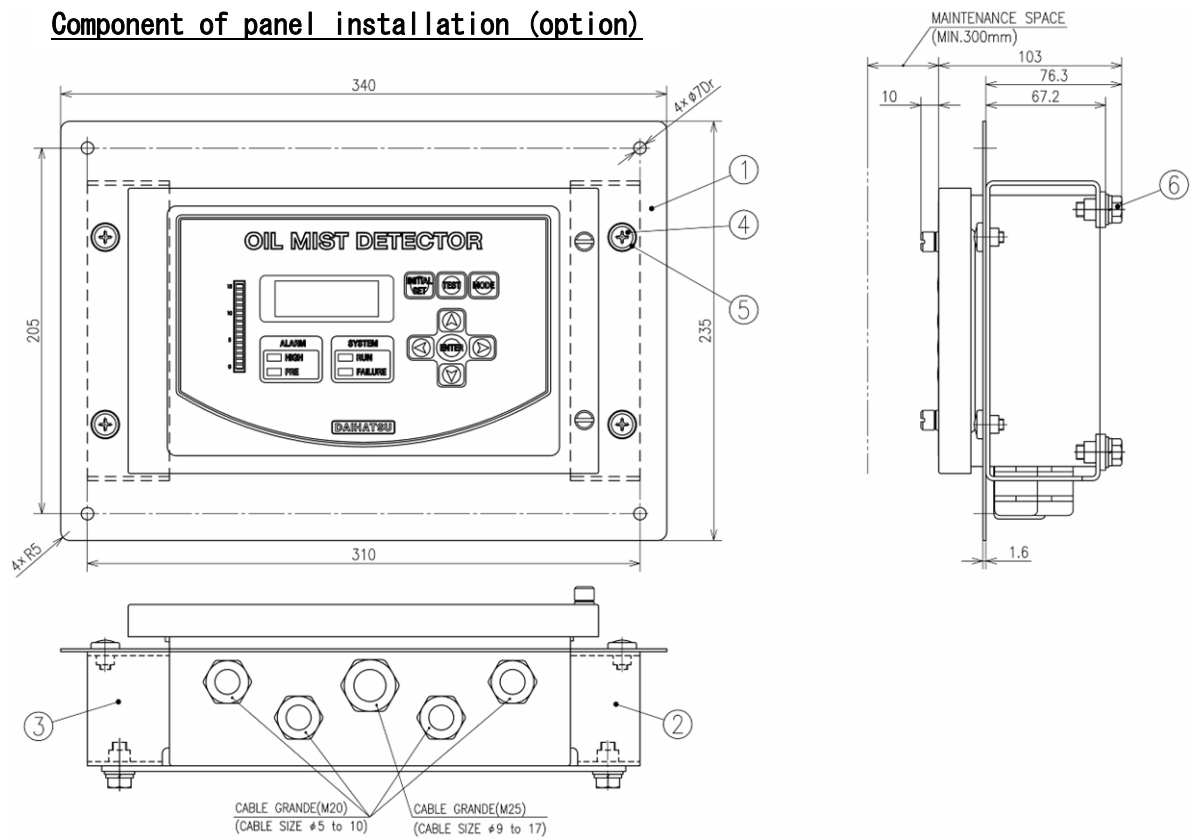


Fig. 4 Sensor unit outside

(2) CONTROLLER



Component of panel installation (option)



PANEL CUT

No.	Parts No.	Name of Parts	Qty.
1	NN00548016A	MD-SX:CONTROLLER-2 FLUSH MOUNT PARTS	1
1-1	NN00548007A	PLATE:MD-SX:CONTROLLER-2 FLUSH MOUNT	(1)
1-2	NN00548008A	BRACKET:MD-SX:CONTROLLER-2 FLUSH MOUNT RIGHT	(1)
1-3	NN00548009A	BRACKET:MD-SX:CONTROLLER-2 FLUSH MOUNT LEFT	(1)
1-4	NN00548010A	PCHS:MD-SX:DRESSING SCREW M6X5	(4)
1-5	NN00265031A	PCHS:WASHERS:C-1029-S-M6	(4)
1-6	X208008020Z	PLUS BOLT ASSY.:M8X1.25X20	(4)

Fig.5 Controller outside

5. SPECIFICATIONS

5.1 Sensor unit

No.	MODEL MD-SX SENSOR UNIT	
(1)	Function	Oil mist concentration detection Mist level signal conversion and output
(2)	Detection point	1 point/1 unit
(3)	Mist detection	Natural diffusion system
(4)	Detection system	Optical system (Optical dispersion system)
(5)	Detection interval	Continuous
(6)	Display	3 LEDs “POWER” (Green) : Power status (Lighting) “ALARM” (Red) : PRE ALARM (Blink) HIGH ALARM (Lighting) “FAILURE” (Yellow) : Comm. and Sensor failure (Lighting)
(7)	Data communications	Serial interface: RS-485 (Half Duplex) conformity (Sensor unit - controller)
(8)	Initial-setting operation	Rotary switch: Communication node (16CH) “0” - “F” Dip switch : Terminator “ON”/“OFF”
(9)	External connection (Sensor unit - Controller)	Sensor line : MD-SX option cables (Daisy chain) Total length: 150 m max. Connection method : Connector (Standard type) Clamp-type terminal (Cable gland type)
(10)	Power supply	24 V DC (+30% to -25%) (supply from controller)
(11)	Power consumption	60 mA (max.)/1 unit
(12)	Outline dimensions	80 W × 124 H × 168 D mm (Standard: connector type) 80 W × 135 H × 168 D mm (Cable gland type)
(13)	Installation	Screw size: G 3/4 (with a seal washer) Vertical direction : Level or less than 15° of facing down Rotation direction : Less than ±5°
(14)	Protection against dust and waterproofing	Protection class: IP 55
(15)	Weight	Approx. 450 g (Standard connector type, Cable gland type) Approx. 500 g (Fling - lead type)
(16)	Paint color	Munsell N1.0 (Black) (Case part)
(17)	Environmental conditions	Ambient temperature: (For operation) 5 - 55°C 5 - 80°C (Engine insertion part) (For storage) -20 - 80°C Humidity : Max. 80%RH (without dew condensation) Atmosphere : No corrosive gas Vibration : Amplitude: ±1.6 mm or less (2 to 25 Hz), 4 G or less (25 to 2 kHz)

5.2 Controller

No.	MODEL MD-SX II CONTROLLER	
(1)	Function	Mist level indication and alarm monitoring
(2)	Number of sensor unit connection	9 units (max.)
(3)	Detection time	Continuous (Response time: 1 sec or less/9 points)
(4)	Detection concentration	0 - 2.0 mg/L
(5)	Operation	Key switch input
(6)	Display	1) Mist level: 3-color bar-graph indication (16 LEDs) 2) 4 LEDs “RUN” (Green) : Detection (Lighting)/Mode set up (Blink) “PRE ALARM” (Red) : (On at mist level LED: “(10)” and over) “HIGH ALARM” (Red) : (On at mist level LED: “(15)”) “SYSTEM FAILURE” (Orange) 3) LCD: 60 × 22 mm 20 letters × 4 lines (with back light)
(7)	Contact outputs	1) Alarm (2 contacts for engine) “PRE ALARM”, “HIGH ALARM” 2) Failure output (1 contact) “SYSTEM FAILURE”
(8)	Contact specification	Relay contact output (1 form C) Contact capacity: 125 V AC 0.4 A / 30 V DC 2 A (Resistance load)
(9)	Data communications	Serial interface: RS-485 (Half Duplex) conformity (Sensor units and external unit)
(10)	External connection	Sensor line : Daihatsu option cables or specified cable for ships (To install a junction box: AWG15 × 4 cables) Contact output line : Cable outer dia. = 17 mm or less (for one engine) Power line : Cable outer dia. = 13 mm or less Connection method : Clamp-type terminal connection
(11)	Power supply	24 V DC (+30% to -25%)
(12)	Power consumption	1.5A (max.) (Internal: 0.5A, Sensor units supply: 1.0A)
(13)	Outline dimensions	294 W × 160 H × 93.6 D mm (Wall mount type) 340 W × 235 H × 102.7 D mm (Flush mount (option))
(14)	Protection against dust and waterproofing	Protection class: IP 55
(15)	Weight	Approx. 4.6 kg (Wall mount type with cable gland) Approx. 5.4 kg (Flush mount (option))
(16)	Paint color	Munsell N1.0 (Black)
(17)	Environmental conditions	Ambient temperature : (For operation) 5 - 55°C (For storage) -20 - 80°C Humidity : Max.80%RH (Without dew condensation) Atmosphere : No corrosive gas Vibration : 1 G or less (If vibration is more than 1 G, adopt a vibration-proof device.)

6. DISPLAY AND FUNCTIONS OF SENSOR UNIT

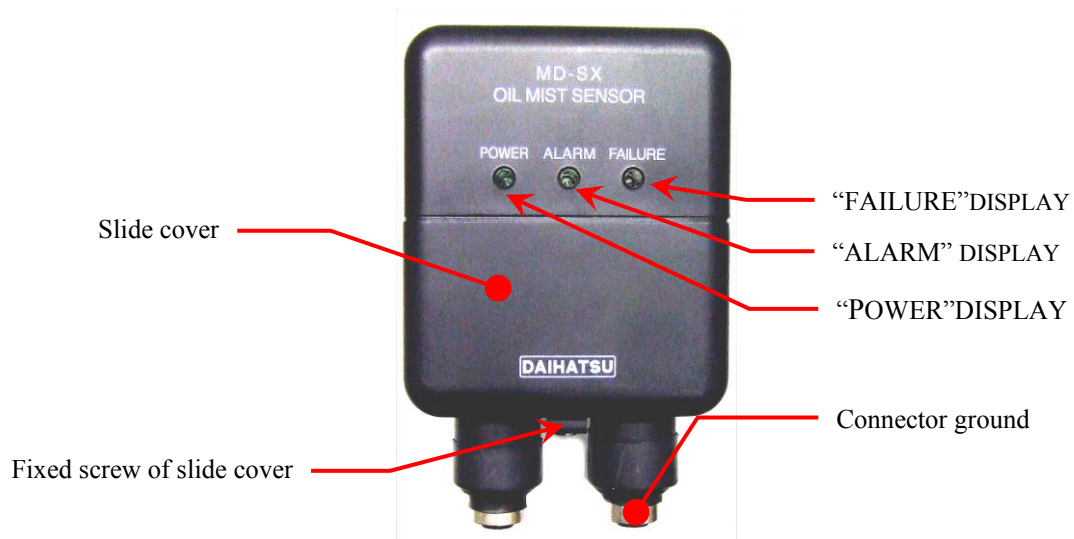


Fig. 6 Sensor unit

Each sensor unit has three status indicating lamps (LEDs); POWER (green), ALARM (red), and FAILURE (yellow).

6.1 Description of function

The light emitted from the LED of the sensor unit is diffused and reflected by the oil mist in the sensor hood, and then received by the photoreceiver diode (PD). After amplification and A-D conversion, the output from the photoreceiver is input to the CPU for arithmetic operation, and then transferred to the controller as the oil mist density data.

6.2 “POWER” LED

This lamp is located on the left of the surface of the sensor unit case. When the green LED is on, this means that power is being supplied from the controller and the CPU is working normally.

6.3 “ALARM” LED

The controller detects the alarm status based on the oil mist density detected by the sensor unit.

There are two alarm statuses, “PRE ALARM” and “HIGH ALARM”. Upon occurrence of any alarm, the red LED in the center of the case surface flashes (PRE ALARM) or lights (HIGH ALARM) according to the signal from the controller.

6.4 “FAILURE” LED

The sensor unit has a self-diagnosis function. If any trouble is found, the yellow LED on the right of the case surface will turn on.

Upon occurrence of a light receiving or emitting element output trouble, a CPU trouble, a thermistor trouble or a circuit trouble, the LED lights.

In addition, when the controller is set in the test mode, the LED of all sensor units becomes blinking.

7. DISPLAY AND FUNCTIONS OF CONTROLLER

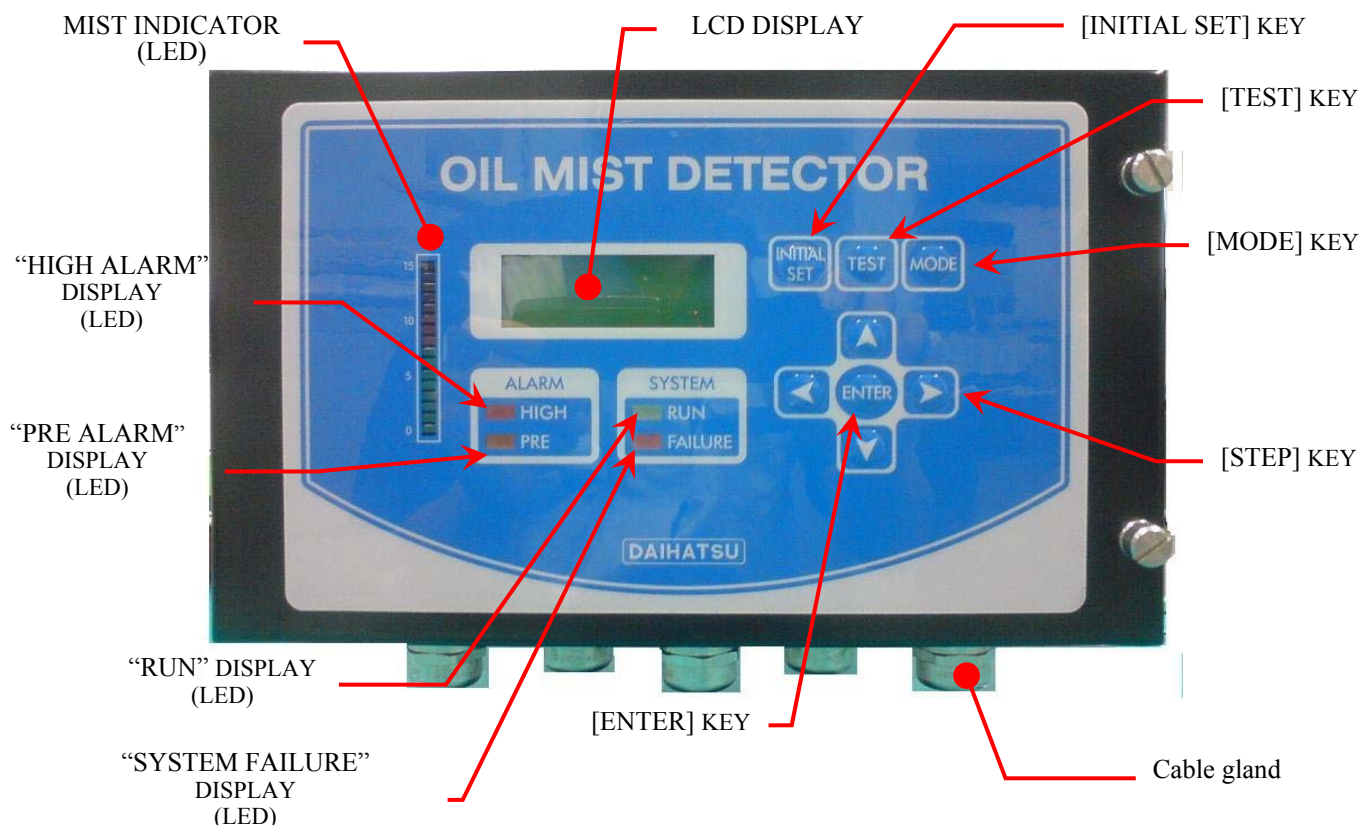


Fig. 7 Controller face of a board

The controller has not only operation key switches and an LCD indicator for displaying the status, but also a mist indicators that show the oil mist density level with 16 LEDs in three colors, green, orange and red.

It has also lamps (LEDs), "RUN" (green) and "SYSTEM FAILURE" (red), that indicate the system operation status and alarm indicating lamps (LEDs), "PRE ALARM" (orange) and "HIGH ALARM" (red). These devices have the following functions.

7.1 Mist indicator

The controller transfers oil mist density data with the sensor units (up to 9 units can be connected) and indicates the oil mist density levels based on the data with 16-level bar graph LEDs in three colors, green (No.0 to No.7), orange (No.8 to No.10) and red (No.11 to No.15).

When only the mist indicator LED No.0 (green) is flashing, this means that the controller has not been initialized (Full-load setting) as specified.

Initialize the controller as stated in [10.2 Initial setup of controller] or [11 Operation].

7.2 "RUN" LED

When this LED is on, the power supply is normal, and the controller CPU is working normally. If the controller has not been initialized as specified or is not in the normal mode, the LED is flashing.

Usually, when key operation does not have 10 minutes or more in the modes other than the mode, it usually returns to the mode automatically.

7.3 “SYSTEM FAILURE” LED

When a controller CPU trouble occurs, a hardware trouble is detected by the self-diagnostic function of any sensor unit or a communication trouble between the controller and a sensor, the LED will be turn on, and the “SYSTEM FAILURE” output relay will be activated.

- (1) After receiving a sensor unit trouble signal, the controller will turn off the LED Nos. 1 to 7 (green) of the mist indicator for the relevant sensor and make the LED Nos. 8 to 10 (orange) flash. Then, you can identify the defective sensor unit.
The defective sensor unit will be automatically excluded from the calculation of deviation (mean value).
- (2) When a cable is disconnected, a communication trouble will be detected on the sensor units in the downstream of the disconnected point. In this case, mist indicator LED Nos. 0 to 7 (green) will go out, and the LED Nos. 8 to 10 (orange) will flash. Then, you can identify the cable disconnection point.
- (3) After the communication recovers normally, “SYSTEM FAILURE” will be automatically restored.
Even after recovery, the error message will be continuously displayed on the LCD until the system is reset by the ENTER key.
System failures other than communication troubles are self-held. Turn off power with the power switch in the controller, and remove the cause of the trouble.
After recovery from the trouble, turn on the power switch in the controller to reset.
- (4) When a CPU trouble occurs, “SYSTEM FAILURE” will be output.
As for the details, see Section [15.Troubleshooting].

7.4 “PRE ALARM” and “HIGH ALARM” LEDs

There are two alarm statuses, “PRE ALARM” and “HIGH ALARM”. Upon occurrence of an alarm, the indicating lamp (LED) and the output relay function.

The status message is displayed on the indicating LCD.

The mist indicator lamps are in the following conditions when an alarm occurs and when the alarm is cleared.

	Operation point	Restoration point
“PRE ALARM”	No. 10 or above or At the time of deviation unusual generating	No. 8 or below or At the time of a deviation unusual return
“HIGH ALARM”	No. 15 (self-holding)	After mist density decreases Press the ENTER key for restoration.

Any deviation of the sensor level indicates the deviation alarm message of “PRE ALARM” when the level of the sensor in question deviates by more than 4 levels from the average level of all the sensors indicated on the mist indicator.

The “PRE ALARM” message is not continuously indicated, but automatically reset when the oil mist density level goes down.

The message indicator is automatically reset when the deviation goes below the level 4 from the average level.

“HIGH ALARM” is self-held, and all lamps (up to No.15) of the mist indicator are kept on.

When the mist density is lowered to the normal range, press the ENTER key to reset the “HIGH ALARM”.

As for the specifications for external output of the output relay, see Section [9.3 Wiring of the controller].

7.5 [STEP] keys and [ENTER] key

Use the arrow keys to move the cursor on the LCD or to increase or decrease the set values.

Use the ENTER key to reset the alarm to the normal mode.

In the setting status of each mode, also use the ENTER key to determine the set data at the cursor position.

7.6 [INITIAL SET] key switch

The [INITIAL SET] key switch is to (store the mist density data under the maximum load in the controller) when setting the full load. You can display the setting change screen by pressing the key long (for more than 3 seconds).

7.7 [TEST] key switch

You can select the test mode by pressing the [TEST] key switch.

The “FAILURE” message blinks for each of the sensor units as communication is disconnected between the sensor units and the controller when the test mode is selected. The “RUN” message on the controller also blinks.

The test mode has the following functions:

1. Alarm operation check
2. Function check
 - 1) LED/LCD ALL ON : To check that the LCD screen and LED lamps properly operate by turning all of them on.
 - 2) SWITCH CHECK : To check that the key switches properly operate
 - 3) OUTPUT CHECK : To forcibly turn the contacts on and off to check the function.

The 「1. ALARM OPERATION CHECK」 is to detect mist in the sensor and to check if the system properly operates. You can check the proper operation of the system by temporarily lowering the alarm setting-off level of one sensor unit to detect the “PRE ALARM” and “HIGH ALARM” set off at the density level of oil mist generated during the engine in operation. See the [11.5 ALARM OPERATION CHECK] for the detailed procedure.

The 「2. FUNCTION CHECK」 is to check if the individual displays and switches properly function.



The alarm output relays (external output) are operational in the test mode.

But avoid checking the functions in the test mode during the engine in operation. If there is no other way than to check in the test mode, take necessary actions such as disconnecting the wire for the external output or grounding the external output circuit.

(Always reconnect the wire after it is disconnected.)

7.8 [MODE] key switch

You can select the mode change screen for the modes of 「1. STATUS」, 「2. INITIAL RESET」, and 「3. CONFIGURE」 by pressing the [MODE] key switch.

1. STATUS
 - 1) CONTROLLER : To display the controller data on the LCD screen in a batch
 - 2) SENSOR : To display the current status of the connected sensor
 - 3) MIST/ALARM LEVEL : To digitally display the set mist quantity
 - 4) COM. LINK SETTING : To display the current setting for communication
 - 5) SOFTWARE VER. : To display the version of the software currently set in the system
 - 6) WORKING MODE : To display that the oil mist detector version is now used.
2. INITIAL RESET
3. CONFIGURE (A password must be input for the change.)
 - 1) CONTROLLER : To change the basic settings for controller display and communication, etc.
 - 2) SET ENG/SENSOR : To set the number of the engines and sensors
 - 3) ISOLATE SENSOR : To temporarily disconnect and connect a sensor when the sensor fails
 - 4) EXCEPTED FROM AVE. : To set a specific item to be excluded from the average computing
 - 5) INITIAL VALUE SET : To manually set the alarm setting-off level

The 「1. STATUS」 mode is to display the current status of the system, but does not change the setting.

The 「2. INITIAL RESET」 is to reset the initial setting (for the engine and sensor quantity and the exclusion from the average computing). The resetting procedure is in the same sequence as for the initial setting and in the interactive manner.

The 「3. CONFIGURE」 mode is to change the detailed setting for individual functions. A password “9999” must be input for the change. Do not make the password public to prevent changing by anyone. Do not change the settings unless definitely necessary.

8. INSTALLATION

8.1 Sensor unit

- (1) Use the sensor unit under environmental conditions meeting the following specifications

When mounting the sensor unit, select a place where vibration can be 4 G or less (2 Hz to 2 kHz).
When selecting the sensor mounting place, also check that the mist suction port of the sensor hood cannot be continuously blocked by a large quantity of oil.

By rotatory direction of a crankshaft and structure of the engine inside, the heavy splash of lubrication oil occurs, and there may be the case that the oil mist is hard to come in to a detecting element.
Please install it by a recommended method.

The recommended installation position of the MD-SX sensors is upper place from clank shaft and side of figure below.

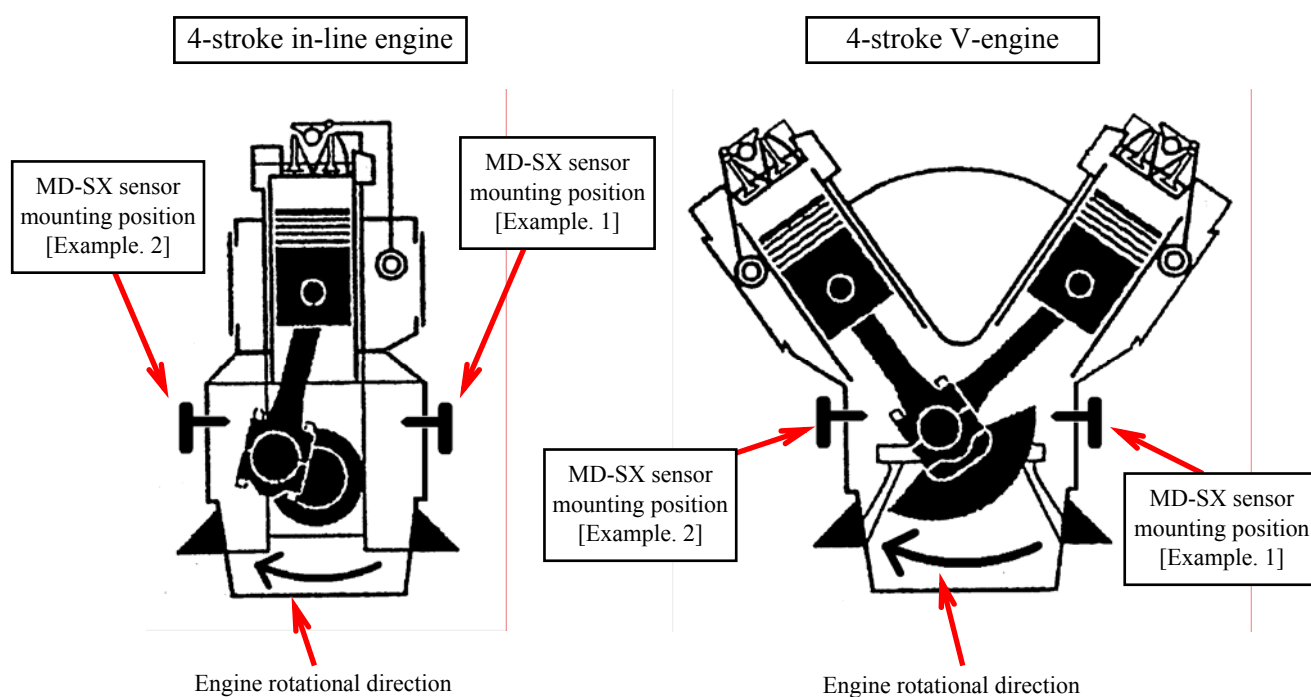


Fig. 8 Recommended attachment position of the sensor unit

(2) Mounting conditions

1) Horizontal or downward (front declined) within 15°

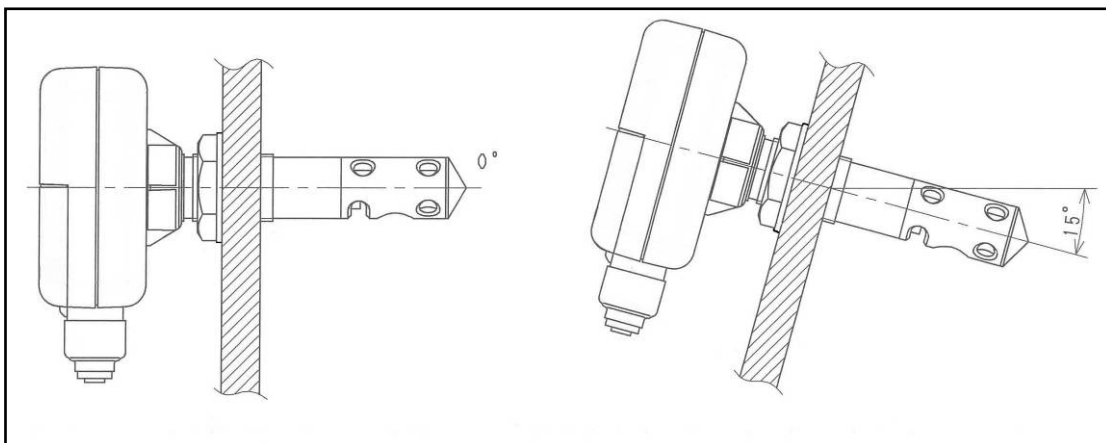


Fig. 9 Tilt tolerance for horizontal direction

2) Rotation direction within $\pm 5^\circ$

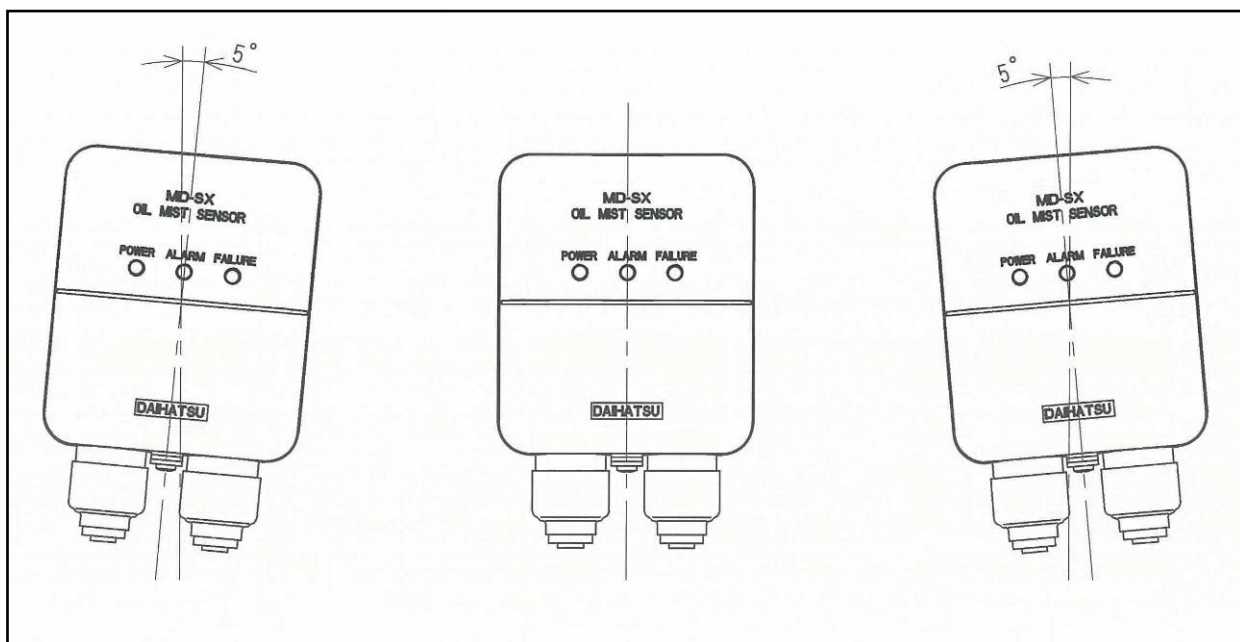


Fig. 10 Tilt tolerance for the rotation direction

- (3) Insert the hood of the sensor unit into the crankcase through the threaded portion (thread size: G3/4) of the engine frame, screw in the hood to the specified length (threaded portion length of 15 mm: 10 turns or more) after winding a sealing tape, and secure the hood with the lock nut through the supplied sealing washer.

Note: • If the screw part is not rolled up by seal tape, Oil leak will be occurred from screw part to engine outside.

- If you use the special sealing washer (optional), it is not necessary to wind the sealing tape. If you need this special sealing washer, please contact us

- (4) Although the threaded portion is made of stainless steel and has sufficient strength, the case and the front hood are made of plastics. When handling them, take care not to give undue force to them.
- (5) Please do not install an obstacle to a radius of less than 100 mm from an installation hole of a sensor. On sensor installation work, a sensor hits the obstacle, and there is the case that cannot screw.

(6) When MD-SX sensor unit install on engine with the following condition, MD-SX sensor should be avoided to install on these place.

- Oil comes from upper part like a waterfall continuously.
- Oil comes from lower part like a fountain continuously.
- Oil comes from the inside structure to reflect oil heavily.
- There is the structure like oil pool, and the sensor hood sinks.



In case the sensor is installed such a place, mist inlet holes of the hood may be blocked by oil and MD-SX may not detect mist density surely. Then, oil comes into mist detection area in hood from the mist inlet holes. As a result it may cause sensitivity abnormal or miss-alarms (HIGH and/or PRE- ALARM).

When MD-SX sensor unit can not install on the recommended place by the limit of engine design, Daihatsu recommend using the cover structure or the protection pipe to cover the hood part of MD-SX sensor from heavy scattering oil. Please refer to the below drawings for protection method or ask Daihatsu in the details.

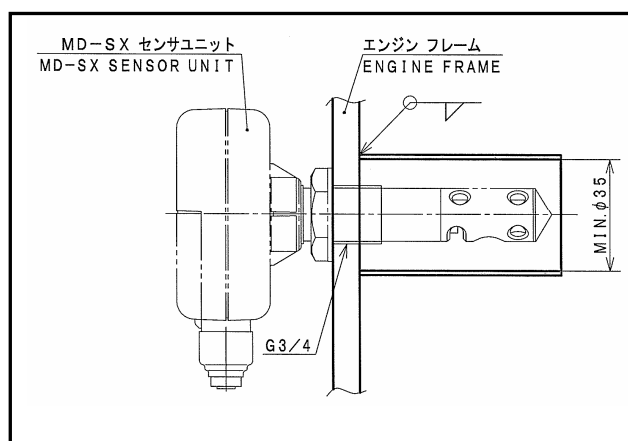


Fig.11 (Sample 1) Protection pipe

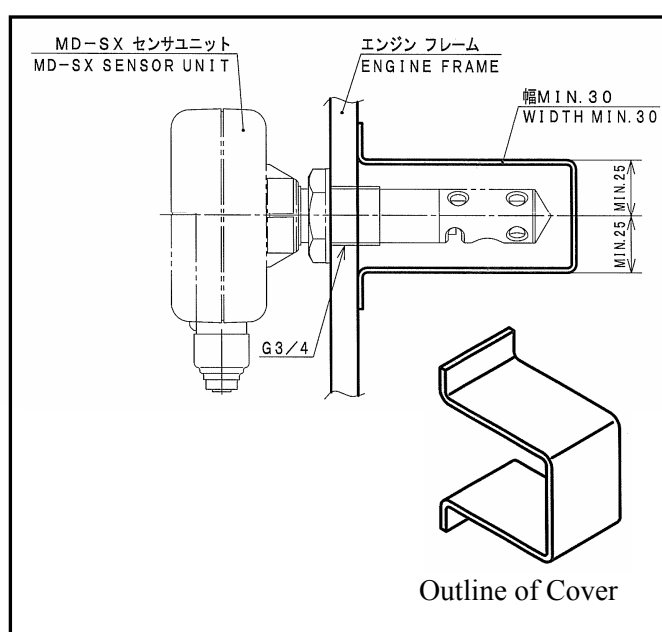


Fig.12 (Sample 2) Cover structure

(7) In case of fitting sensor to a gear case except the engine crankcase, a chain case, the part of fuel oil supply unit, please measure the vibration value of the sensor fitting part up to frequency 2KHz beforehand, then please fit the sensor after confirmed the specification is satisfied.

In case of exceeding the vibration value from the specified value of sensor, please fit the sensor after executed the anti-vibration measures.

If the sensor is fitted to the place the vibration value is large, or the space the engine outside is narrow where the external force seems to suffer from the sensor connector,

Please adopt the flying lead type sensor or the ground type sensor.

- ※ When the connection is not enough between the sensor connector and cable connector by the large Vibration or external force to the sensor, it may cause communication abnormal and/or the breakdown of sensors. Please fix the cable within 200mm from a sensor connection to avoid the above troubles.



8.2 Controller

- (1) Use the controller under environmental conditions meeting the following specifications.

The vibration acceleration applied to the mounting place shall be 1G or less.
If the acceleration exceeds 1G, mount the controller using the separately supplied antivibration bracket or equivalent brackets through the specified rubber vibration insulators.

Install the IACS M10 at a safe place far away from the engine room.

- (2) When the controller is mounted on a wall or a panel
When the controller is installed on a place where the vibration acceleration is low (1G or less), it is unnecessary to use antivibration means.
Install the controller directly on the wall or panel using the bracket mounting holes (9 mm in diameter) in the controller main body.
Or please apply a controller of a flush mount type.
- (3) When the controller is mounted on the engine main body

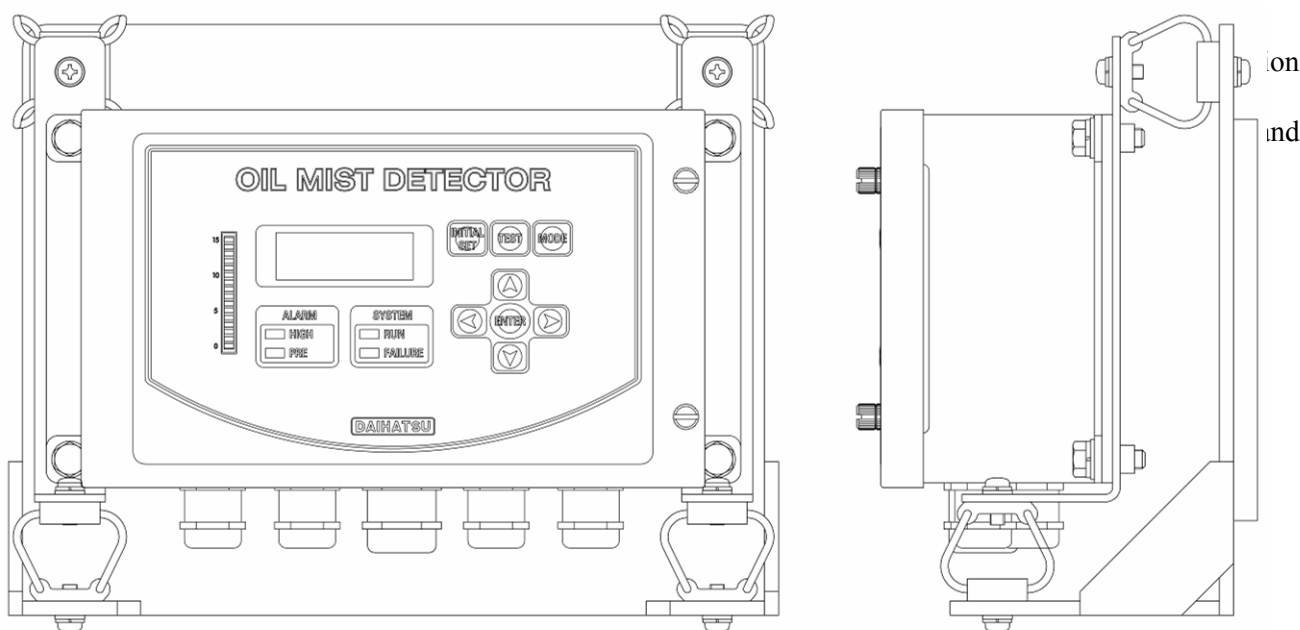


Fig. 13 Antivibration wire attachment outline

* Install the controller in such a way that the case vibration acceleration from the three directions indicated by the arrows (in the center of the case) is 1G or less.

- (4) The wire vibration insulators have been selected to ensure that the vibration acceleration becomes 1G or less on a low-speed engine (the vibration frequency caused by the rotational speed or the number of cylinders is approximately 30 Hz or less).

When exceeding 1G, or in installing in middle speed or high speed engine, please consult to our company.

9. WIRING

One MD-SX II oil mist detector.

Pay attention to the followings when wiring the detector.

Note) For ship use of oil mist detection system, IACS recommend the system institutions. (IACS UR M10.12 regulation : “Each engine is to be provided with oil mist detector.”) Please obey the rule of each shipping classification society.

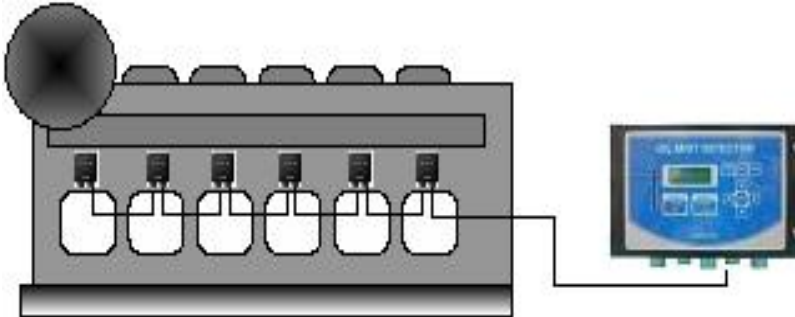


Fig. 14 Wiring layout to install one oil mist detecting system on one engine

- 9 sensors can be installed for one engine at the maximum.*
- Wire the sensors in daisy chain system (connection-in-a-row system) for each engine.
- Use the Daihatsu option cables for the wiring between sensors and a controller. For one engine, limit the total length of the wires within 150 m from the end sensor and the controller. Even if two engines are used, the total length of the cable should be within 150 m for each engine.
- A general cable for ships (batch shielded cable with 4 or more cores) can be used between the junction box (terminal box) and controller when the junction box is on the engine body. If the wire diameter is in the range of 1 to 1.5 mm² (AWG18 to AWG14), the total length of the wires can be extended within 200 m.
- Securely fix the wires for the sensors on the engine body to prevent its vibration.

It may be one of factor the communication abnormal.

- Connect only one end of the sensor wire with the controller.
- Set the termination setting DIP switch ON for the terminal sensor, and OFF for other sensors.
- Set the node setting switches in different settings from each other for sensors on a same engine.

9.1 CABLE

- (1) Use a “cable with both-ends connector” for wiring between sensor units (for standard type sensors). And use a “cable with a single-sided connector” between a sensor unit and a controller.

Minimum Bend Radius of cables : 30mm

- 1) Cable with both-ends connector ... Between a sensor and a sensor
(The lineup of wiring length: 1 to 10 m by 1 m, the lineup of wiring length: 15 to 50 m by 5 m.)

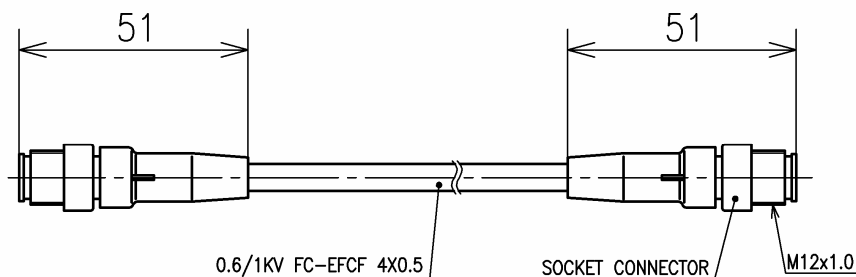


Fig. 15 Cable with both-ends connector

- 2) Cable with single-sided connector ... Between a sensor and controller
(The lineup of wiring length: 2 to 15 m by 1 m, the lineup of wiring length: 20 to 50 m by 5 m.)

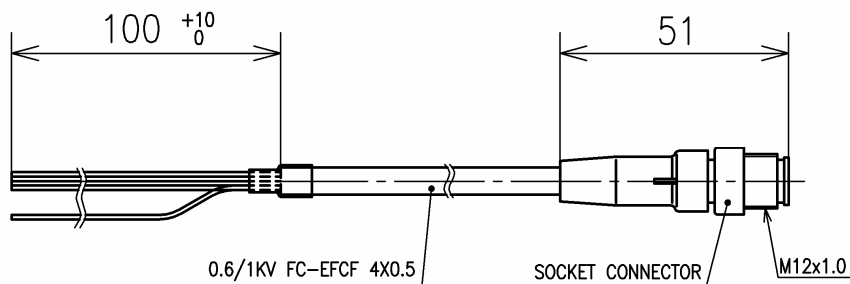


Fig. 16 Cable with single-sided connector

Notes) Daihatsu diesel can provide this special cable.
In the case of ordering, please specify necessary length.
When you need it anything other than normal length, please consult with Daihatsu.
Shape of a connector can be changed. But connection is compatible entirely.

- (2) A general cable for ships (batch shielded cable with 4 or more cores) can be used between the junction box (terminal box) and controller when the junction box is installed on the engine body.
But use a Daihatsu option cable for the wiring between sensor units, and between a sensor unit and a junction box.

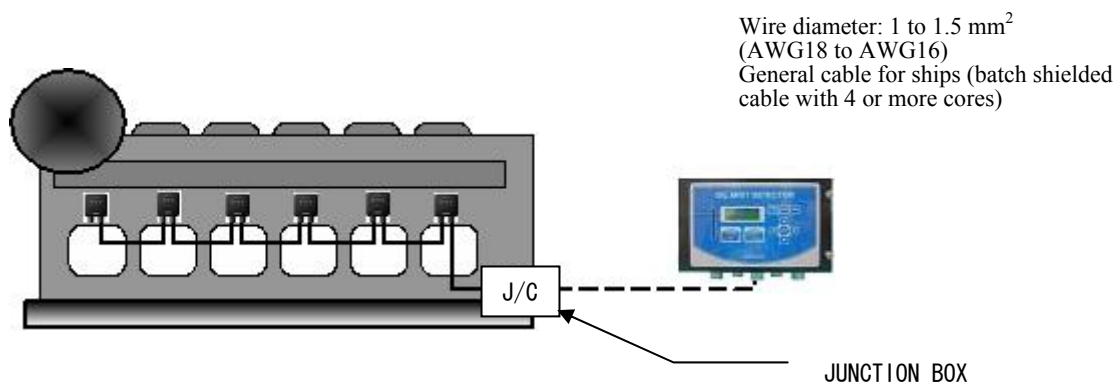


Fig. 17 In case of install the junction box between the controller and sensors on engine

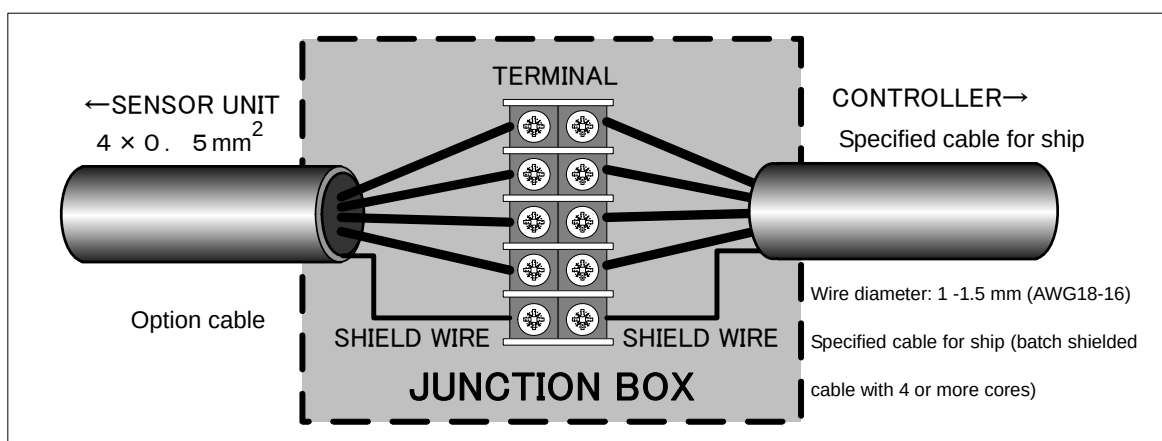


**Fig. 18 Specification for connection with the junction box
(Terminal box)**

Install 5 terminals in a same junction box for the engine control signal line and above wiring lines.

Caution) The shield wiring terminal in junction box connects only the shield of the cable and please do not be connected to other shield line terminals or the grounding terminal. It causes the misworking of the equipment by noises.

The color of cable jacket of Daihatsu optional cables are shown at this table.

When you connect the Daihatsu optional cable to the general cable for ships, distinguish the power supply lines and the communication lines with a color of cable jacket, and connect it without wrong.

Table) Relation between Wire Colors and Corresponding Functions

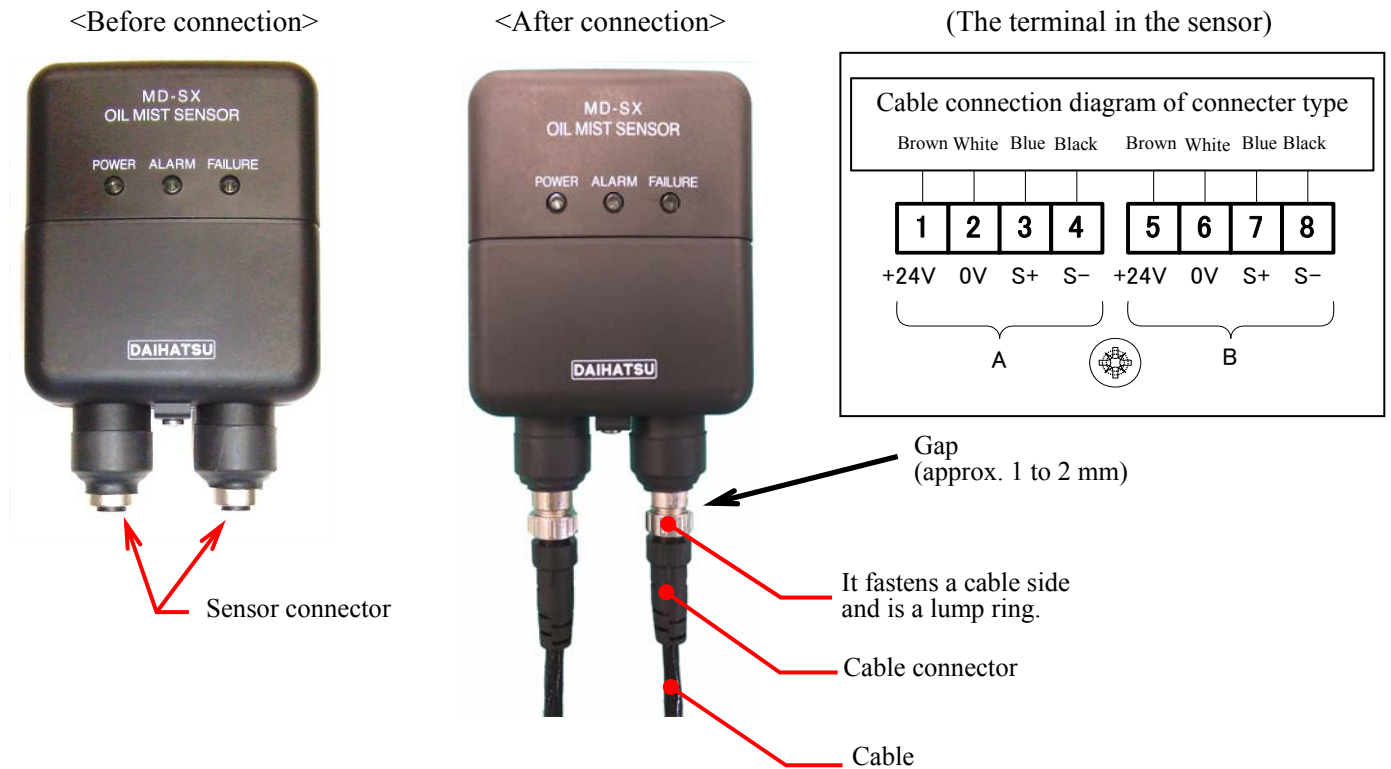
Daihatsu option cable (RTFRO 4×0.5)		
Wire color	Name	Signal type
Brown	+24 V	Power supply line
Blue	0 V	
Gray	S+	Communication line
Black	S-	
Shield wire		Shielded wire



※ When the equipment is installed, replaced works or during wiring, cabling works, please execute not only the switching off the controller but also the switching off the outer terminal of the controller and the power supply all together

9.2 Wiring of the sensor

- (1) Cable for connection : Daihatsu option cables
[Cable with both-ends connector] or [Cable with single-sided connector]
- (2) Connection topology : Daisy chain
- (3) Connection method : Connector - Connector



Cable connection diagram of connector type

Fig. 19 Connection of sensor and wiring (Connector)

- (4) Connection method of connectors
The connectors have polarity.
The sensor side is female connector.
The wiring side is male connector.

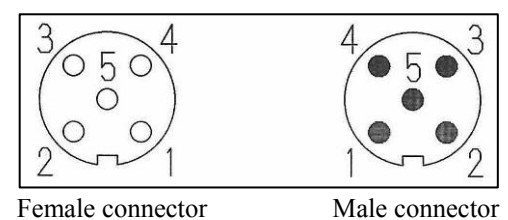


Fig. 20 CONNECTOR FORM

- 1) The connectors have a position to fit.
Connect the cable connector to the sensor connector while checking that the inner pins of the cable connector can be inserted into the holes of the sensor connector.
Notes) Please do not look for the fit position after putting connectors together.
The connector pins may be broken, and the broken pins may cause imperfect contact.
- 2) Tighten a cable side fixing ring with your hand enough.
After tightening, there will be a gap of approximately 1 to 2 mm between the sensor connector and the cable connector. This gap will not cause any problems.
Notes) Please set the termination and node settings to the sensors necessarily after wiring work was over.
And attach a dust cover (option) to an unused connector of a sensor unit of end.

9.3 Wiring of the controller

(1) Wiring: Use the following cables for wiring.

- Grounding line : 1.5 mm² (AWG14) 1 wire
- Power supply (24 V DC) : 1.5 mm² (AWG14) 1 wire
- Communication line:
 (Between the sensor units and controller) Daihatsu option cable (4 × 0.5mm²) 4 lines
 (When a junction box is installed) 1.5 mm² (AWG15)
- For contact outputs : In case of one engine : 3 contacts

(2) Terminal connection: Clamp type terminal block

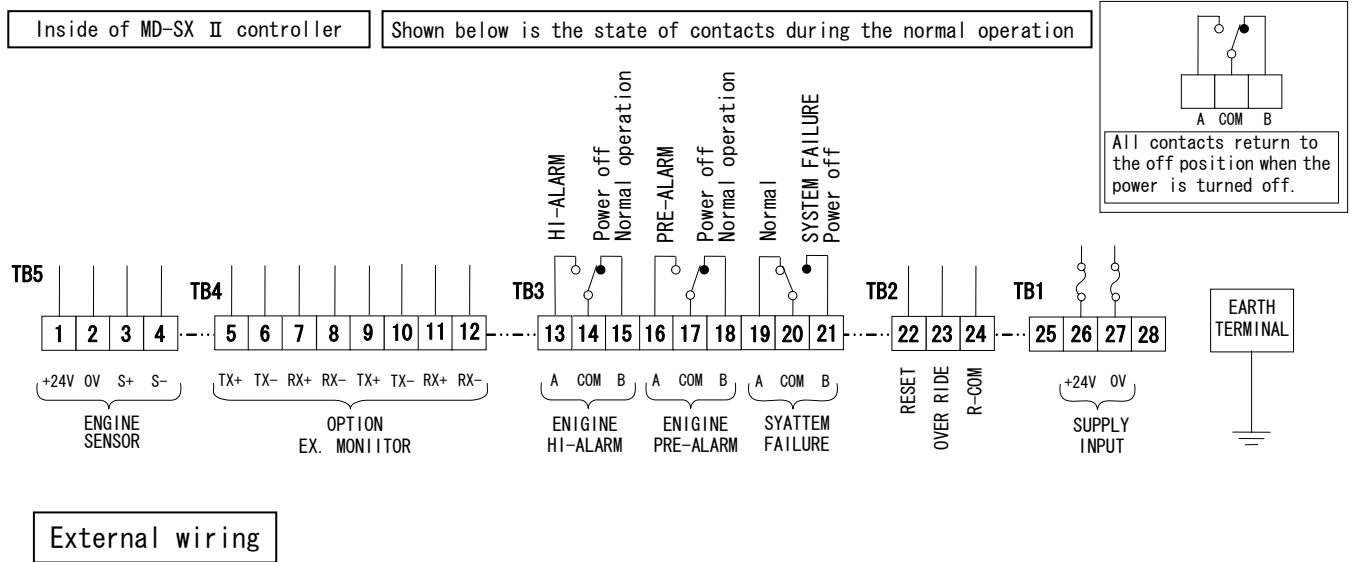


Fig. 21 Drawing of the controller terminal block

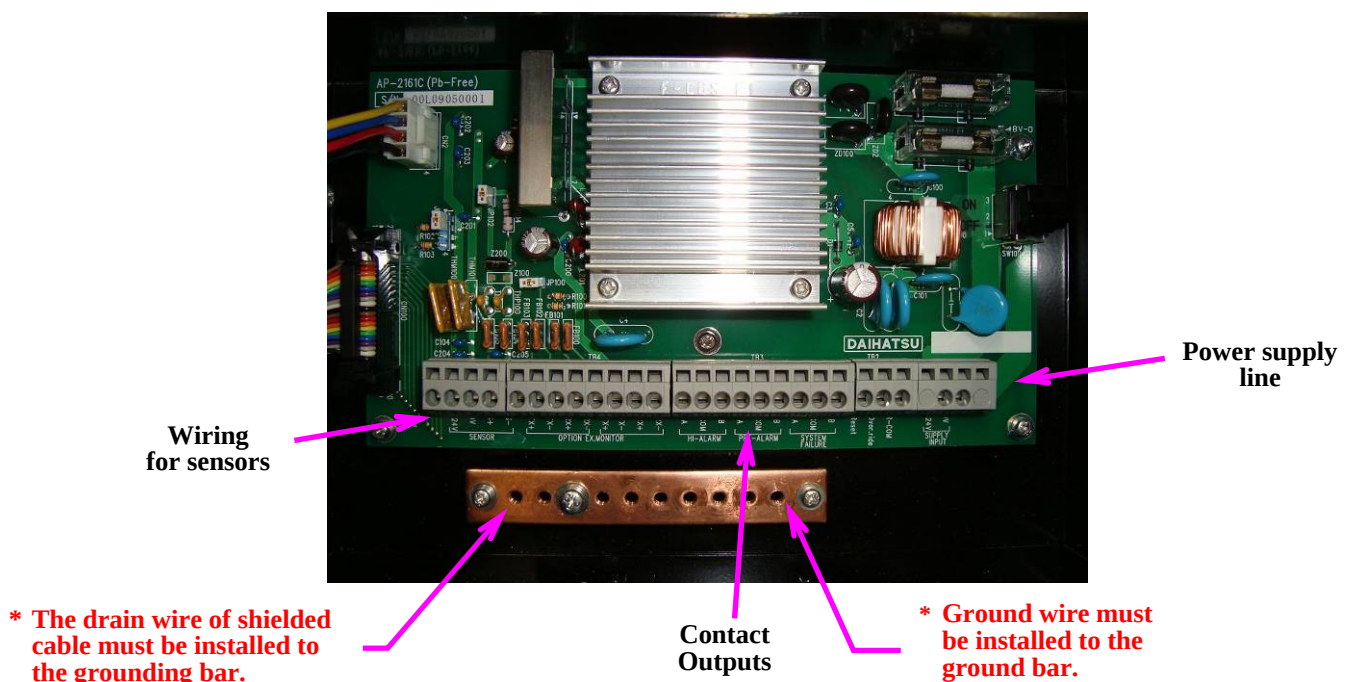


Fig. 22 Schematic drawing of the controller external wiring connections

- Connect the sensor wires on the [ENGINE SENSOR] side.
- Always pull the shielded-conductor cable out and connect it with the grounding bar installed in front of the terminal block inside the controller for sensor wires.
- Always connect the grounding wire with the grounding bar.
- The terminal block is of the clamp type. See the wiring instruction manual to correctly wire the controller.
- Do not connect to the [OPTION EX. MONITOR] and the [OPTION] terminals.
- Isolate wires for the controller from those for the motor, and solenoid valves and for the power supply lines to prevent noise impacts.
- As various sizes of marine use gland packing suitable for the wiring are supplied with the detector, use the correct size gland packing.
- Refer to the next chapter to set the wire disconnection detecting resistor if the resistor is required to detect disconnection in the alarm setting off wire as the wire disconnection detecting resistor is installed in the control unit.

Note) The drain wire of shielded cable for communication line to the sensors must be connected the grounding bar. The ground wire for power line must be connected to ground bar. Otherwise the detecting performance may be deteriorated.

(3) Cable gland and selection of the correct type gland

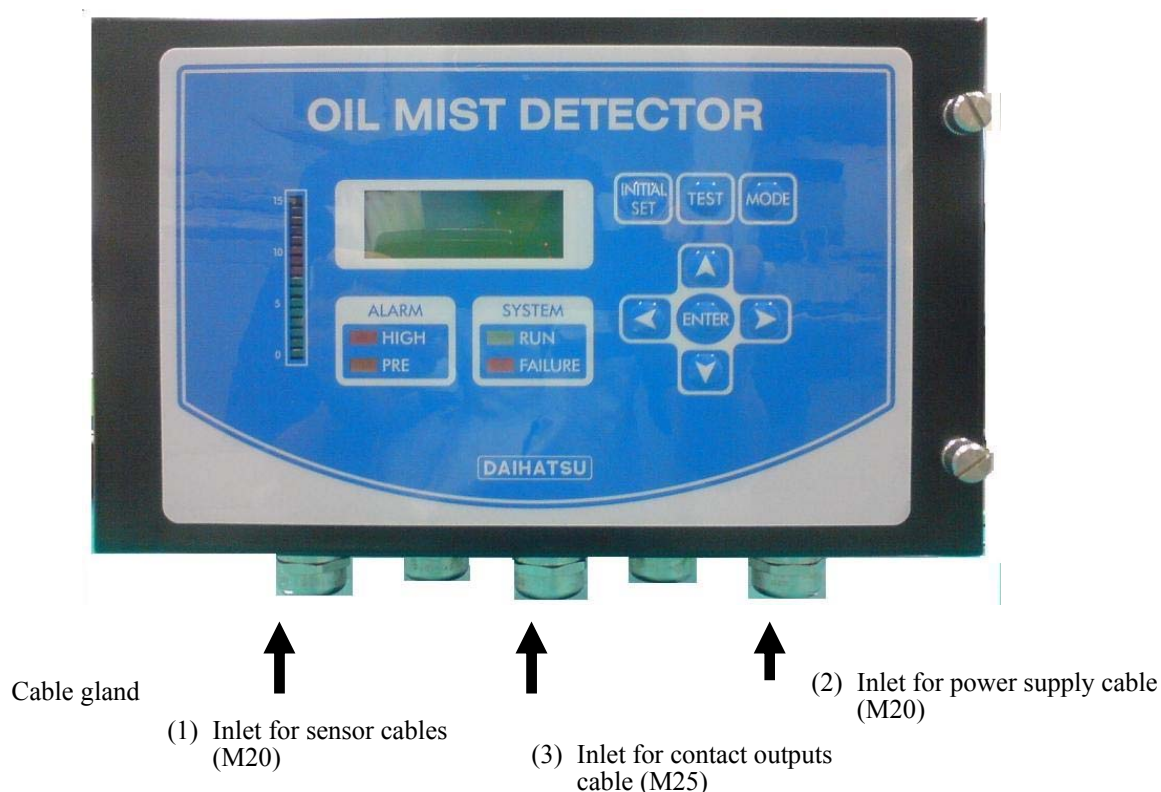


Fig. 23 Controller cable inlet hole

Cable gland : For sensor units	: Cable gland M20 × 1 set
For power supply	: Cable gland M20 × 1 set
For contact outputs	: Cable gland M25 × 1 set
For option communication	: Cable gland M20 × 2 set

The rubber packing of the cable gland should be different in size depending on the wire diameter to be connected with the controller.

As suitable sizes of the rubber packing are supplied with the detector, select the correct size when replacing as follows.

- 1) For sensor units line: Gland size M20
 - Option cable “4x0.5mm²” : Change the packing to the supplied packing (φ 5mm~10mm).
 - Cable for ships : Installed packing (φ 7mm~13mm)
- 2) For power supply line: Gland size M20
 - A packing with the bore diameter 13 mm should be incorporated in the wiring gland.
- 3) For contact outputs line: Gland size M25
 - A packing with the bore diameter 17 mm should be incorporated. Or a packing with the bore diameter 18 mm is supplied with the controller.
- 4) For option communication line: Gland size M20
 - Cable for ships : Installed packing (φ 7mm~13mm)

9.4 Setting of resistance for detecting disconnection

The setting of the resistance for detecting disconnection of the controller safety circuit (High-alarm) can be changed by changing the specified jumper positions on the board.

The jumper has been normally fitted to the pins 1 and 2 (open) before shipment.

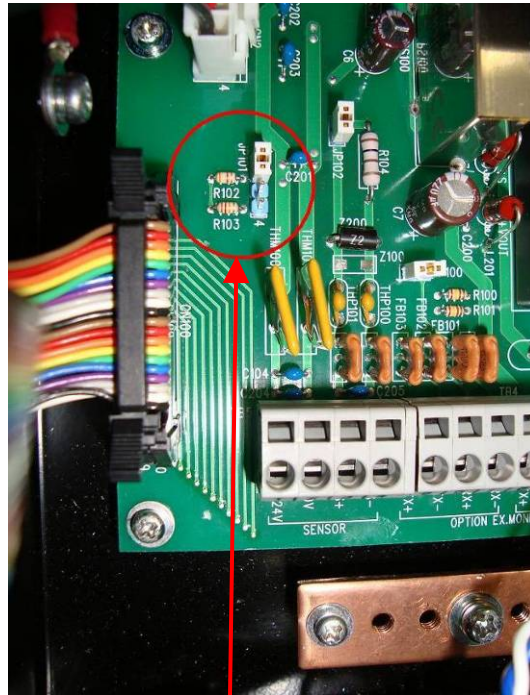


Fig. 24 Resistance for disconnection detection (The mounting part of a jumper setup)

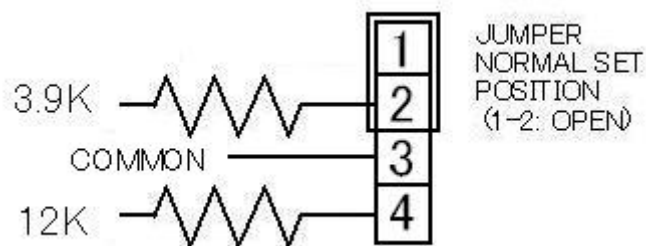


Fig. 25 The circuit of resistance for disconnection detection

The jumper settings are shown below. Set the jumper according to the specified resistance value.

JP101 (ENGINE HIGH ALARM)
Jumper between 1 and 2: Open
Jumper between 2 and 3: 3.9 k Ω
Jumper between 3 and 4: 12 k Ω

9.5 Wiring of the gland type sensors

Using the sensor of “gland type”, connection work for “Terminal Block” is necessary. The connection and method of wiring work for Terminal Block, please refer to [9.6 Cautions in wiring].

- (1) Loose screw fastening the slide cover and slide the slide cover to reveal the terminal block.
- (2) Wiring connection refer to Figure 26 [SENSOR TERMINAL BLOCK LAYOUT].
- (3) Set the termination and node settings to the sensors necessarily after wiring work was over.

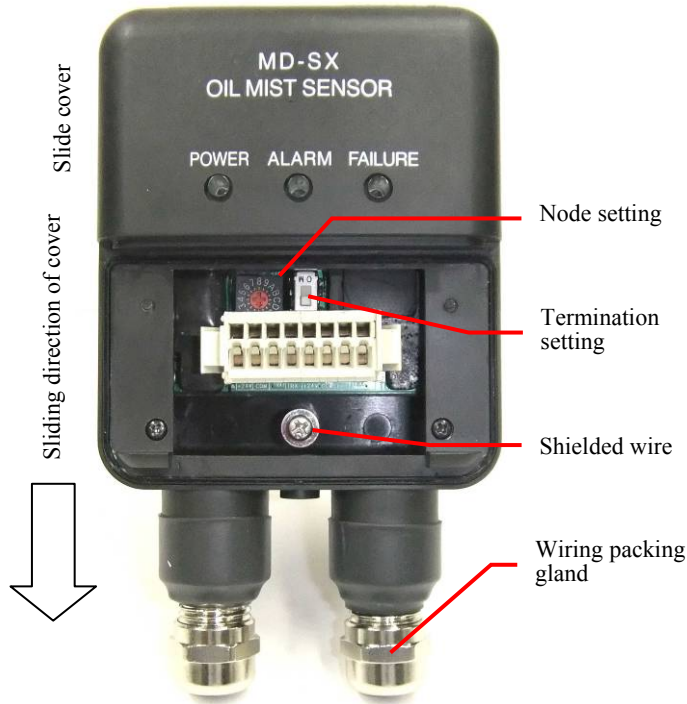


Fig. 26 Cable connection diagram (gland type)

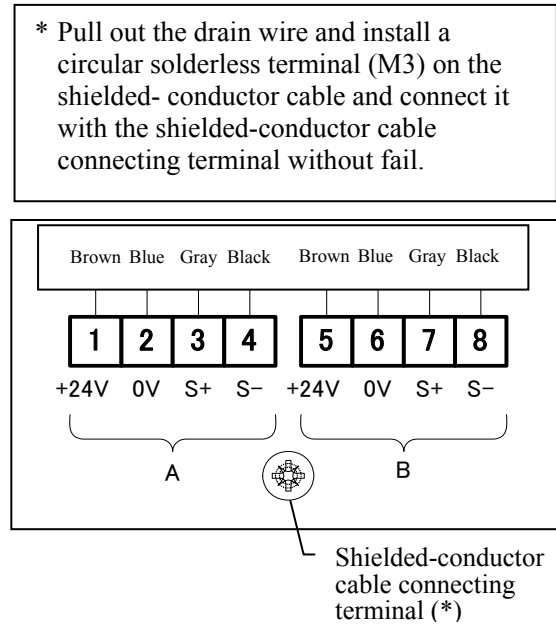


Fig. 27 Sensor terminal block layout

9.6 Cautions in wiring

The solderless terminal is not required for other connection terminal blocks as the clamp type (no screw) terminal blocks are used for them. See the wiring instruction for correct wiring as follows.

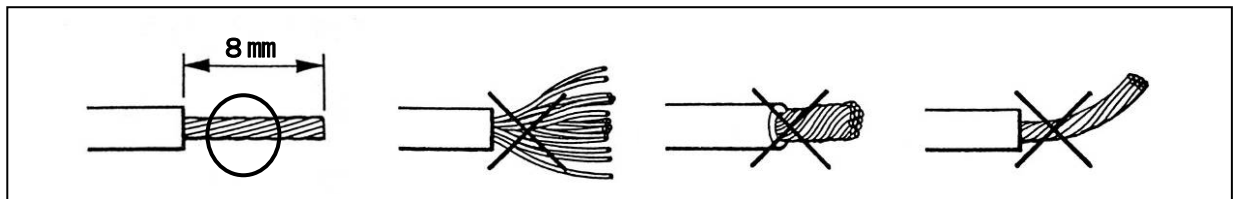
As connectors are equipped with the sensor unit terminal blocks, remove the connectors by pinching the locking devices on both ends of the connector and pulling the connector out if they make wiring difficult.

Connect the shielding wire to a “shielded-conductor cable connecting terminal” in a sensor unit with circle solderless terminal.

- (1) Wire end treatment for cables to be connected with the control unit and sensor terminal block:

Always bare wiring cable ends in correct length.

Bare the wiring cable end again if the core wires loosen, too tightly twisted, or bent.

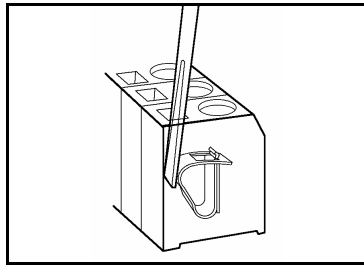


- Wire size to be used
 - Sensor cable: $4 \times 0.5 \text{ mm}^2$

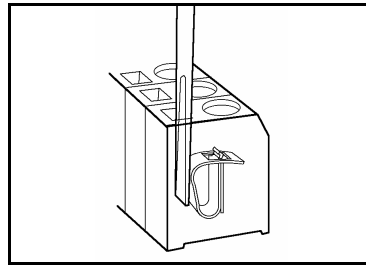
Fig. 28 Wire terminal treatment

(2) Wiring procedure

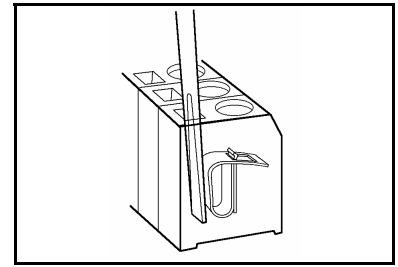
Use the supplied special tool or 2.5 to 3.5 mm wide flat tip screwdriver.



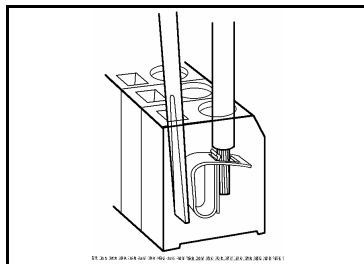
1) Insert the screwdriver at an angle in the setting slot (square hole).



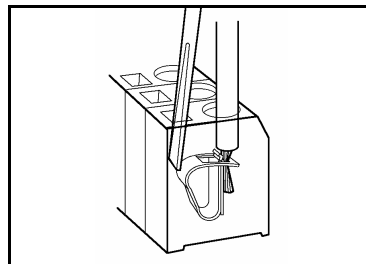
2) Straighten up and insert the screwdriver to the full depth.



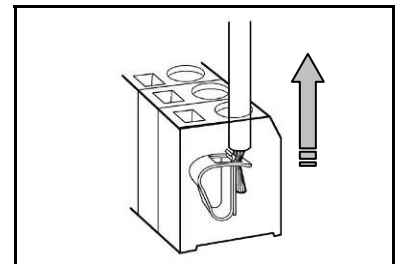
3) If properly inserted, the screwdriver can stay straight in the slot when hand is take off.



4) Insert a properly bared cable in the cable hole (round). You can smoothly insert the cable by sliding it along the edge of the hole.



5) Insert the cable until it hits the bottom, and pull the screwdriver.



6) Lightly pull the cable to check it is securely installed. (Do not pull it too hard.)

Fig. 29 Connector wiring point figure

* Insert a screwdriver in the same way as to install the wire if the wire must be pulled out.

Cautions in use

1. Always bare the cable end in the specified length with care not to damage the core conductor. Using the cable bared in the wrong length at the end or with the core damaged may cause insulation defect, poor contact, or wire disconnection.
2. Lightly pull the cables one by one to check they are not easily pulled out after wiring. Using the system without making sure the cables are tightly connected may cause poor contacts or wire disconnections.
3. Be careful the cable tension (twisting stress) is not directly applied to the cable conductor and contact points of the terminal block. If the cable tension is directly applied, cable poor contacts or disconnection may result.
4. Use correct bore diameter cable gland packing to securely tighten the packing to fix cables in place. Loosely tightened packing may cause damage and disconnection in the cables by vibration during use, resulting in poor wire connection.
5. Do not apply excessive force when loosening the spring, otherwise the housing may be damaged.

10. INITIAL SETUP

10.1 Initial setup of sensor units

After fitting the sensor units on the engine, initialize the units while the controller power is off. Remove the lid of the sensor unit case, and operate the internal setting switches.

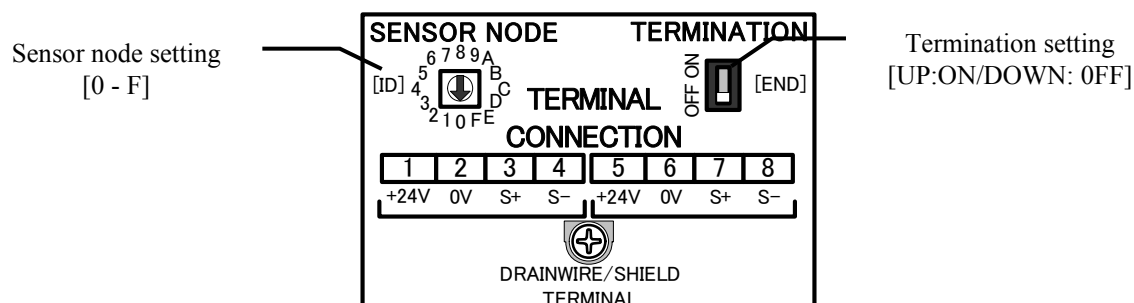


Fig. 30 Sensor terminal outline

- (1) Sensor (communication) node setting:
Setting necessary for the controller to recognize each sensor unit.
Set the rotary switch (16 channels) in the sensor unit to the specified position ("0" to "F").
Please set the node number from "0" sequentially from a No. 1 cylinder not to overlap.

When one engine is connected

Controller channel	1	2	3	4	5	6	7	8	9
Rotary switch setting position (Node No.)	0	1	2	3	4	5	6	7	8

- (2) Termination (terminator) [ON/OFF] setting:
Set the DIP switch in the sensor unit at the end to ON.

* After the completion of setting of the internal switches, fit the slide cover to the sensor unit case.

10.2 Initial setup of controller

After the completion of the initial setup of the sensor units, initialize the controller with power on the controller. Refer to [11. OPERATION] for the operation procedure of the controller from initial setup to run. Initial setting menu is displayed interactively on the Liquid Crystal Display (LCD). Please set it up in order.

(1) **Initial setup:**

Set the following parameters for conditions of connection of the sensor units using the key switches.

- 1) Number of connected sensor units
- 2) Sensor units to be excluded from calculation of mean values

(2) **Full-load setting:**

By the full load setting during operation of the engine(s) under the maximum load, you can adjust the maximum mist density during normal engine operation to the standard value (No. 3 on the mist indicator). The alarm value will be optimized by this setting.

If the full load is not set, the No. 0 mist indicator lamp of each channel will flash.

* About Full load setting

The oil mist concentration in crankcase of a diesel engine varies significantly depending on the difference of the engine type, each cylinder and operating conditions.

Therefore, normally, the full-load setting is performed based on the maximum mist concentration during normal operation of the engine, such as the engine running under the maximum load. Some engines might be occurred between 75% and 100% load, so that “PRE ALARM” is detected at about three times higher mist concentration and “HIGH ALARM” is detected at about five times higher mist concentration.

The alarm setting values are automatically set the optimal value by the “Full load setting” operation for all sensor units.

* The full load of the controller is set to the default value before delivery from our plant.

(When the digital value is “100”, the “PRE-ALARM” value will be set to approximately 0.6 mg/L, and the “HIGH ALARM” value will be set to 1.0 mg/L.)

※ After full load setting of the controller at maximum load, please do the full load setting of the controller on the operating condition again in case of indicating more than 3rd position out of 15th position of the mist indicator on the controller without engine abnormal.

11. OPERATION

Described in this item are steps from the first power ON, initial setting, and full load setting to the actual operation.

11.1 Checks before turning the power on

Always check the followings before turning the power on for the first time.

- If the system is correctly wired according to the specification
- If the sensors and controller are correctly installed
- If the required 24 V DC power is properly supplied
- If the sensors are correctly set for node and termination

11.2 Steps from the first power ON to practical operation

Shown below is the flow diagram for settings to be made from the power ON to the actual operation

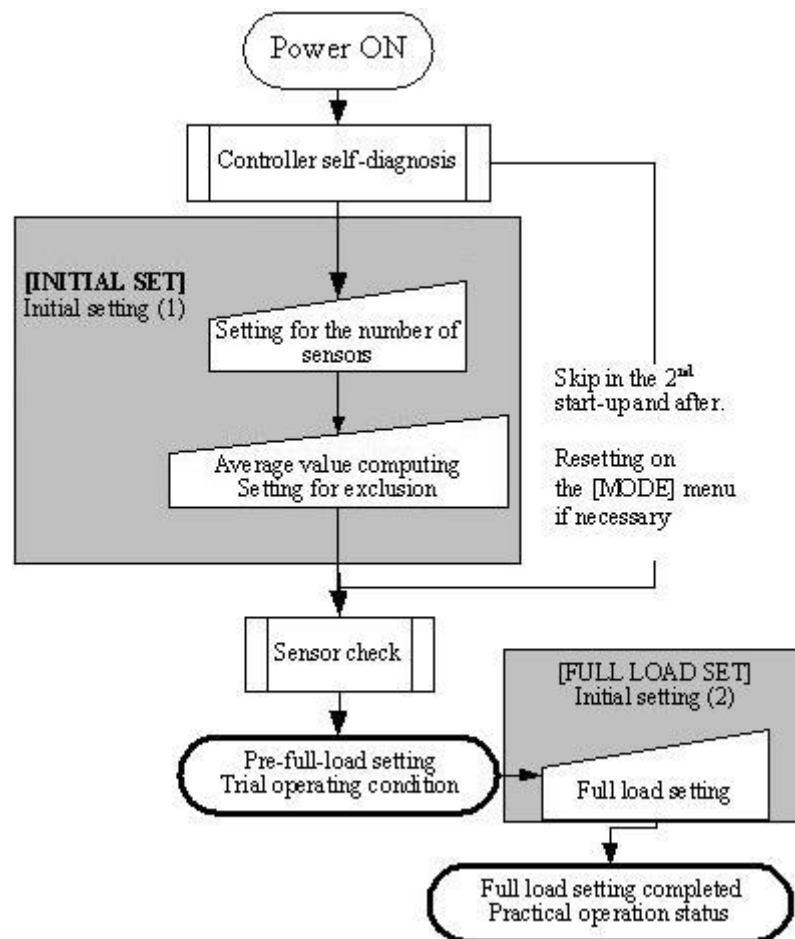


Fig. 31 The flow of steps when starting

(1) Power ON

Unlock the snap type lock or the knurled lock on the right side of the controller, and then open the panel front side toward the left side.
Turn the power switch on.

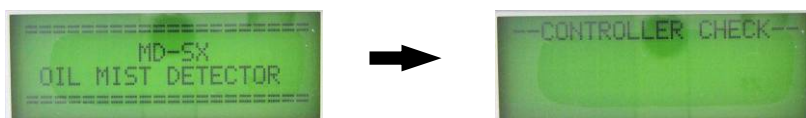
The power is supplied to the system and the controller begins the self-diagnosis after the power switch is turned on.

All the LED lamps are lighted for 3 seconds during the controller check (self-diagnosis).

The initial setting screen is displayed on the LCD unit. Proceed with settings as the setting screen progressively indicates.

(2) Controller check

The controller checks itself (controller self-diagnosis) after the power is turned on.

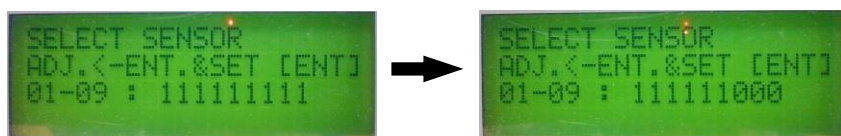


(3) Initial setting: To set the number of sensors

After the power is turned on for the first time, the initial setting must be carried out (the initial setting screen is displayed).

After the completion of initial setting, the initial setting process is skipped and the system jumps to the trial or normal operating condition when the power is turned on next time and after as the initial setting is not repeatedly required.

1) Defining the selected number by pressing the [ENTER] key.



(4) Initial setting: To select a sensor to be excluded from the average value computing

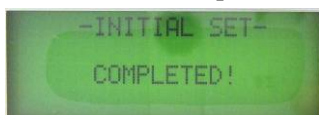
To select a sensor to be excluded from the average value computing

If it is necessary to monitor the chain case, the corresponding sensor should be excluded from the average value computing. This is because the mist density of the chain case may differ from that of the crankcase, and in this case, the deviation alarm may not be activated correctly.

1) Use the arrow key to move the cursor to the sensor to be excluded from the average computation, and press the [ENTER] key to turn [0][1] dark. The [0] represents the item to be excluded from and [1] represents the items to be included in the average computing. Turn the [0] dark for the sensor to be excluded, move the cursor to the [ENT] position, and press the [ENTER] key to define the selection.



2) Move to the next process when the initial setting complete message is displayed.



(5) Sensor check

Try to communicate with the sensors set on the controller, and one of the following messages is displayed.

[*] : Sensor in trouble

[1] : Sensor in normal condition. The sensor is recognized.

[-] : No sensor is connected.

Move to the screen showing the troubling location if any of the sensors is in trouble. If not, move to the next process.



<= a sensor is in trouble



<= a sensor is in normal

(6) Full load setting is yet to be carried out and the system is in the trial operating condition.

The MD-SX detector can properly operate only when [full load setting] is carried out for the mist density under the full load. If the screen as shown below is displayed, it indicates [full load setting] is yet to be carried out and the system is operating with the alarm setting-off value set as the initial value. The alarm condition can be detected in this condition, but always apply full load on the system to properly set for the full load.



11.3 Full load (mist density level) setting

The full load misty density level must be set in practical operation mode to properly operate the detector.

Operate the installed engines under full load for a certain time. When the operation is stabilized, set the full load.

If the engines are not to be operated steadily under full load, set the mist density level under the highest load in normal operation.

- 1) Press the [INITIAL SET] key for 3 seconds or longer under the full load running.



- 2) Select the SET item and define the selection by pressing the [ENTER] key, and the “setting complete” message is displayed. If the CANCEL item is selected, the setting screen is closed and the detector returns to the trial operating mode.



The full load mist density level setting is necessary for each engine when two engines are involved.



When the mist density is set under full load as the last setting item, the detector becomes operational in practical condition.

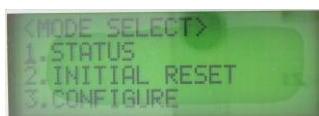
* You can repeatedly set the full load.

Operate the installed engines under full load. When the engine operation is stabilized, set the full load.

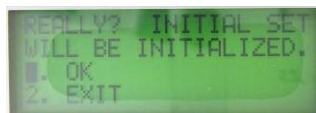
11.4 Initial reset

This is the function to repeat the initial setting carried out when the MD-SX II is turned on for the first time. For instance, when the initial setting is improperly carried out, the number of sensors or of engines must be changed, or the computed average value must be changed, you can carry out the initial setting again from the beginning with this function.

- (1) Press the [MODE] key to display the menu below.
Select the 「2. INITIAL RESET」 item.



- (2) Select the “OK” twice and now you can carry out the initial setting from the beginning (setting of the number of engines.)



- (3) Set the number of engines, number of sensors, and items to be excluded from average value computing according to the displayed menu.



11.5 Alarm operation check

This is the function to check if the MD-SX II properly detects mist and if the system properly operates. You can check if the system properly operates by temporarily setting one sensor unit at the alarm setting-off level lower than normal to force the system to set off “PRE ALARM” and “HIGH ALARM” with the normal oil mist density during the engine in operation.

The alarm operation check can be carried out also during an engine stop. Unite a setting value with the same value as a current value. (An alarm comes out instantly.)

The display automatically returns to the normal operation screen if the system is not operated for 10 minutes after the start of the ALARM OPERATION CHECK.

- (1) Press the [TEST] key to display the following menu.
Select the 「1. ALARM OPERATION CHECK」 and press the [ENTER] key to define the selection.



- (2) Select a sensor to temporarily lower the setting value by scrolling the screen with the upward and downward arrow keys.

Select the sensor and press the [ENTER] key to define the selection.



- (3) Set the HIGH ALARM level for the selected sensor.
The value currently detected is displayed (5 is displayed as an example here), and the value of about 10 above the currently displayed value (15 as an example here) is automatically set as the HIGH ALARM level.
Increase or decrease the automatically set value as required with the upward and downward arrow keys and press the [ENTER] key to define the final value.



- (4) The currently detected value and set value are displayed. Select the 「1. CHECK」 and press the [ENTER] key to start the test.



- (5) The 「ALARM OPERATION OK」 message is displayed during the test process, showing the detector is in the test process.
Press the [ENTER] key to suspend the test process if the process must be stopped.



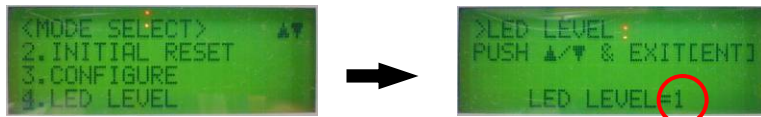
- (6) Check the 「PRE ALARM」 and 「HIGH ALARM」 messages are displayed if the mist density exceeds the set level at the specified sensor.
Press the [ENTER] key to return to the normal operating screen.



11.6 LED_LEVEL

The mist indicator displays the data of each sensor at a constant interval time.

Press the [MODE] key to display the menu below. Select the 「4.LED LEVEL」 item.



Set the number of sensors , the sensor' s data display to the mist indicator displays.

11.7 The function to guess the mist level

In case of middle-speed engines, it has the function that the point which is not fitted sensor can be guessed the mist level by the density value of the adjoining sensors.

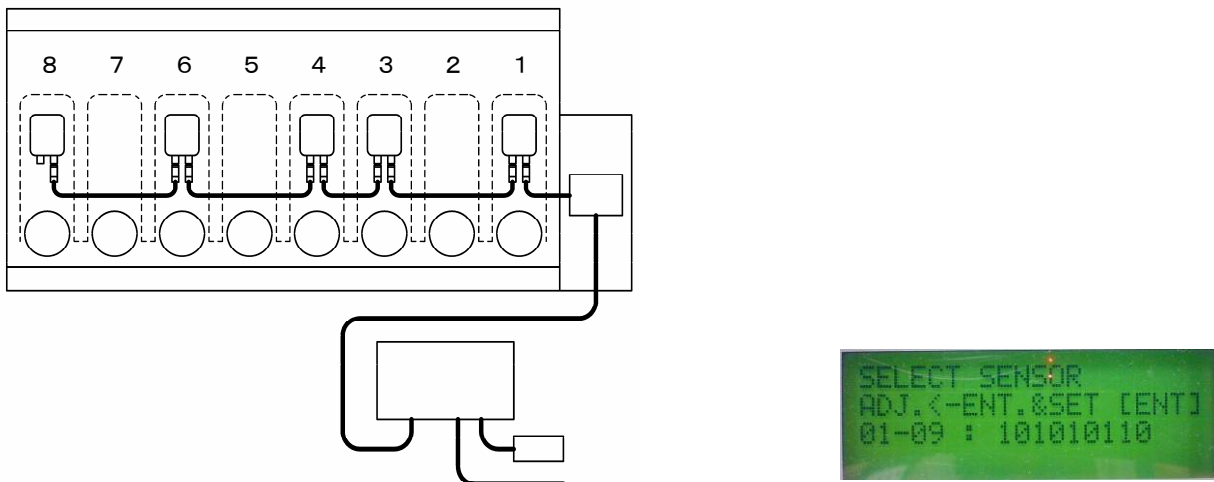


Fig. 32 Installation for cull cylinders

Example for selecting sensor

- 1) For example, this function can be guessed no. 2 mist level by the actual value of sensors both no. 1 and no. 3 cylinders.
As same as the above, no. 5 mist level can be guessed by the actual value of sensors both no. 4 and no. 6 cylinders, no. 7 mist level can be guessed by the actual value of sensors both no. 6 and no. 8 cylinders.
It is not necessary to fit sensors to no. 2, no. 5, and no. 7 cylinders by this function.
- 2) In case of applied the function, both sensors must be fitted next to the cull cylinder.
For example, the value of cylinder no. 2 and 3 without sensors cannot be guessed with sensor on between no. 1 and 4 cylinders.
Addition to that, the sensor must be fitted to the first cylinder and the last cylinder.
If not, the function of cull cylinder can not be worked.
- 3) In case of the above 1), the mist level of cylinder no. 2, no. 5 and no. 7 is not displayed to the mist indicator because the sensor no. 2, no. 5 and no. 7 are not fitted.
When the pre-alarm or high-alarm situation occurs at the cylinder no. 2, no. 5 or no. 7, the message will be on LCD in accordance with guessed mist value.
- 4) When the pre-alarm or high-alarm occurs at no. 2, no. 5 or no. 7 cylinder, please check the applicable cylinder and both adjoining cylinders of the engine.

12. TEST METHOD AND OPERATION CHECK (FOR IACS M10.13)

To check the HIGH ALARM and PRE ALARM functions or to check operation of sensors, refer to Section [11 OPERATION].

Sensors are calibrated before delivery from our plant. So the scales will not be changed.

At starting and stopping the engine during daily operation, check whether the mist levels indicated by the controller are increased. By this check, you can judge whether the sensors are operating properly.

When the engine can not be operated, the working condition of the sensor can be confirmed by the density difference between lubrication oil priming pump works and stops.

It can be checked the change of the mist level on the controller LCD when the engine working and stopped in daily operation check. If the mist level of engine working is increased more than that of engine stop, the oil mist detector can be judged normal.

However, if you have to check a sensor only without operating the engine, remove the sensor, correctly connect the cable, and then turn on the power of the controller.

After that, using the spray type smoke tester, directly spray the smoke to the removed sensor. Check whether the sensor can correctly detect the smoke.

In that work, sensor can be reacted earlier by reducing smoke leaving from sensor inside when all holes of sensor hood, except for the hole smoke is inserted are blocked by hand like photo34.



Photo 33 Spray test

13. APPROXIMATE VALUE OF MIST DENSITY

(1) Mist density

- 1) The oil mist density is expressed as the weight (mg) of oil contained in 1 liter of air.
It has been experimentally verified that 50 mg/L is the lower explosion limit of oil mist.
- 2) The oil mist density of an engine considerably varies depending on the engine type and operating conditions.
The specified “full-load setting” operation is performed to automatically set the sensitivity based on the maximum mist density during normal operation.
- 3) The oil mist detector is provided to detect overheat of bearings that can cause explosion of the crankcase at an early stage rather than to alert workers to the danger of the explosion.
Normally, the alarm can be given at 1.5 to 2.0% of the lower explosion limit density. The alarm is given in the early stage when the mist density starts increasing abnormally from the oil mist density during normal operation.

(2) Confirmation of mist density

The controller can indicate the mist density of 0 to 2 mg/L in the level of 「0」 to 「1023」 to inform you of the approximately calculated oil mist density besides indicating the oil mist level.

Some types of controllers can directly indicate the mist density in mg/L.

[Digital value of density / mg/L converted value / temperature of sensor fitted] can be displayed as follows;

- ① Press MODE key
 - ② 1. Chose STATUS
 - ③ 1. Chose MIST/ALARM LEVEL
 - ④ 1. Chose MIST/ALARM LEVEL : Display the digital value
「Value」×0.002=mg/L (Approximately)
2. Chose CONVERT TO [MG/L] : Display the mg/L converted value
3. Chose TEMPERATURE : Display temperature of sensor fitted part
- ※④ Function 2,3 may not be displayed if the version of controller is old version.

14. MAINTENANCE



Since the sensor unit is the maintenance-free type. After installing and starting operation of the sensor unit, it is not necessary to provide maintenance services for 3 years basically.

MD-SX sensor does not need the renewal parts.

Regarding the contamination of the lens surface, it is necessary to be cleaned the sensor hood section when the error code 17 which means the sensitivity decreased occurred and daily operation check.

Please refer to [16.3 Sensor cleaning procedure].

During engine operation, if the sensor unit is removed for maintenance or inspection, the alarm will be activated, and the engine protective relay may trip.

And please switch off the power of controller whenever the sensor is removed

To prevent activation of the alarm, disconnect the external output line from the controller, or take the other measures.

When disconnect the external wires from the terminal block, record the wire numbers so that they will be reconnected correctly. If necessary, mark the wires with the terminal block numbers.

If any problem is found as the result of inspection, see Section [15. Troubleshooting,] and take necessary measures.

(1) Checking for abnormalities (Check as needed.)

- 1) Check that excessive vibrations are not applied to the sensor units and they are fitted securely.
If the sensor unit is vibrated or loose, tighten the sensor unit.
- 2) Check for oil leak from the sensor unit mounting screws. If the oil leaks, reinstall the sensor unit while referring to Section [8 INSTALLATION].
- 3) Check that the controller main body does not show abnormal heat generation, vibrations or noises.
If a problem is detected, check the wiring conditions of the terminals and the input power supply voltage.

(2) Confirmation of indication of mist indicator LEDs (Check as needed.)

- 1) Periodically check the engine load factor at the start of the engine and during normal operation and the correlation between the load factor and the mist indicator LEDs.
- 2) Check that the mist indicator indicates “2” to “3” while the engine is operating at the rated conditions.
If the indication is improper, particularly if the indication of the mist indicator is remarkably high (in the yellow range), the engine may be disordered. In this case, check the engine.
If the engine is not defective, operate the engine with the full load, and check the engine again with the full load. In addition, set the full load again.

(3) Loosing of screws of various parts (Check every six months.)

- 1) Check for loosening of the rubber vibration insulators (if the rubber is fitted), and bolts for mounting the controller. If the rubber or the bolts are loose, tighten them.
- 2) Check for loosening of wire connections on the terminal block in the controller.
Check for loosening of the board mounting screws and wire connectors.
If screws or connectors are loose, tighten them.

(4) Check of operations of alarm LEDs and output relay (Check every six months.)

- 1) Check the operations of the alarm output relay according to 11.5 [Alarm operation check.]
In the test mode, you can check the indications of the mist indicator LEDs and the operations upon occurrence of PRE ALARM and HIGH ALARM.
- 2) Since noise, etc. can activate the HIGH ALARM function. To prevent such an alarm activation error, the HIGH ALARM function will be activated after confirmation and then held.

(5) Check of operations of “SYSTEM FAILURE” LED and output relay (Check when necessary.)

It is unnecessary to check the operations of these devices during normal handling. If the external output must be checked, its operation can be checked by simulating a nonconforming state as stated below.

- 1) Turn off the power switch in the controller, and temporarily disconnect the input wire on one side of the communication line to a sensor unit (No. 4 of terminal block CN203: TRX-).
- 2) Turn on the power switch, and a “System failure” will occur.
- 3) The “SYSTEM FAILURE” LED will light, and the output relay will function.
The mist indicator LED Nos. 10 to 12 will flash to indicate the system failure status.
- 4) The output relay is held. It can be restored by turning off power.
Turn off the power switch, and reconnect the disconnected wire correctly to restore the relay.

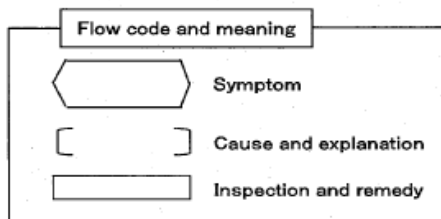
(6) Other check and maintenance

- 1) The sensor units vary in service life depending on working conditions and environment (temperature and humidity). To obtain stable output, it is recommended to replace them with new ones every three years.
- 2) If a sensor unit is used for 3 years or more, clean the unit using the cleaning agent specified by Daihatsu, and then check the alarming operation of the sensor unit using a smoke tester.
- 3) The power switch shall be kept on to keep them in working state.
- 4) Watch out for the places where the sensor units and the controller are stored. If they are stored for a long term or during construction period, put vinyl sheets, or the like, over them to protect them from water, dust, and dirt.

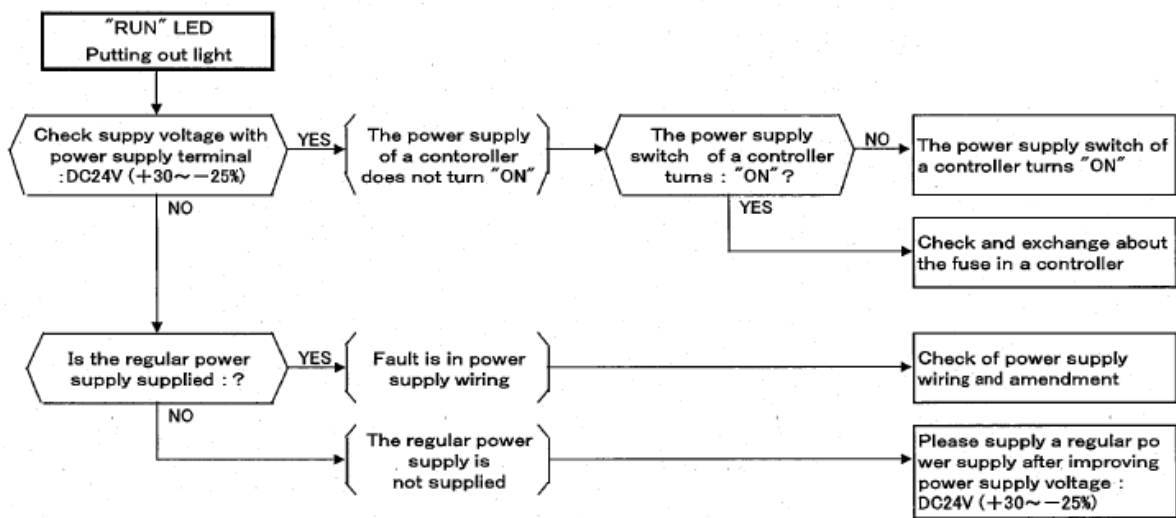
Note) When use of the MD-SX oil mist detecting system becomes it over eight years, you should ask DAIHATSU for system operation check and maintenance by Daihatsu engineer.

15. TROUBLESHOOTING

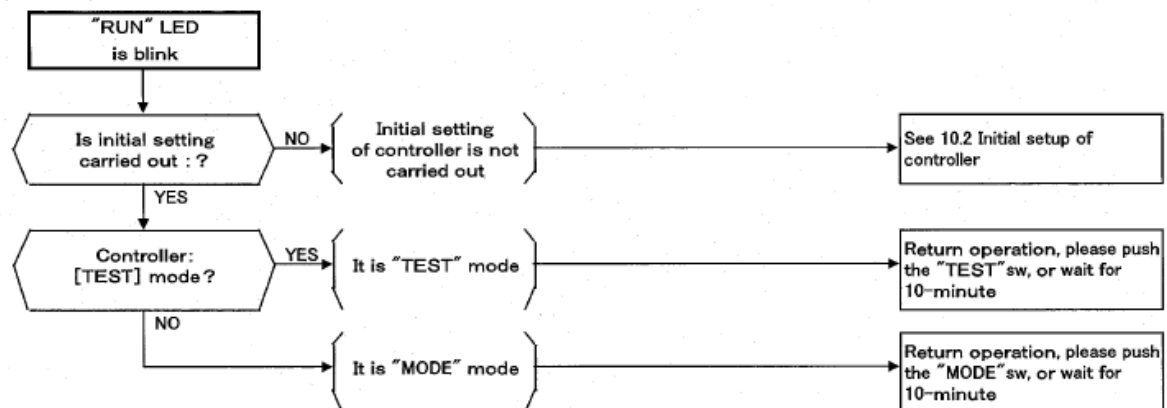
15.1 TROUBLESHOOTING by controller indicate



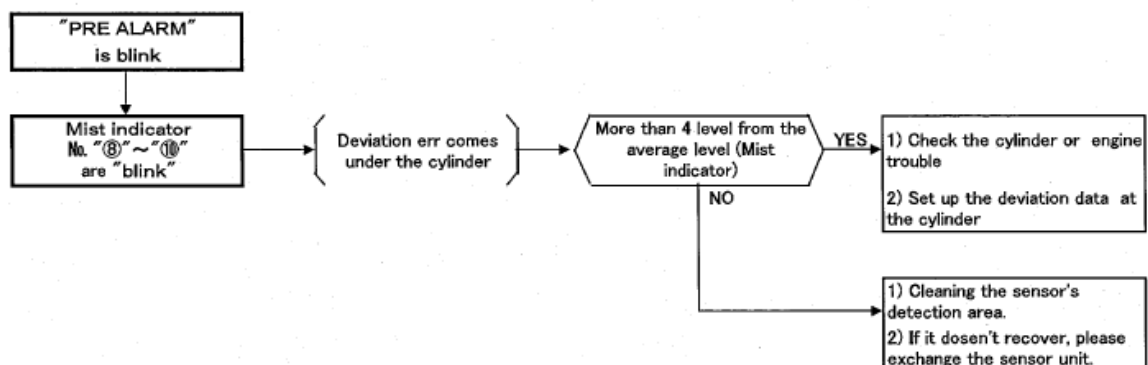
(1). In the case of "RUN" LED putting out light



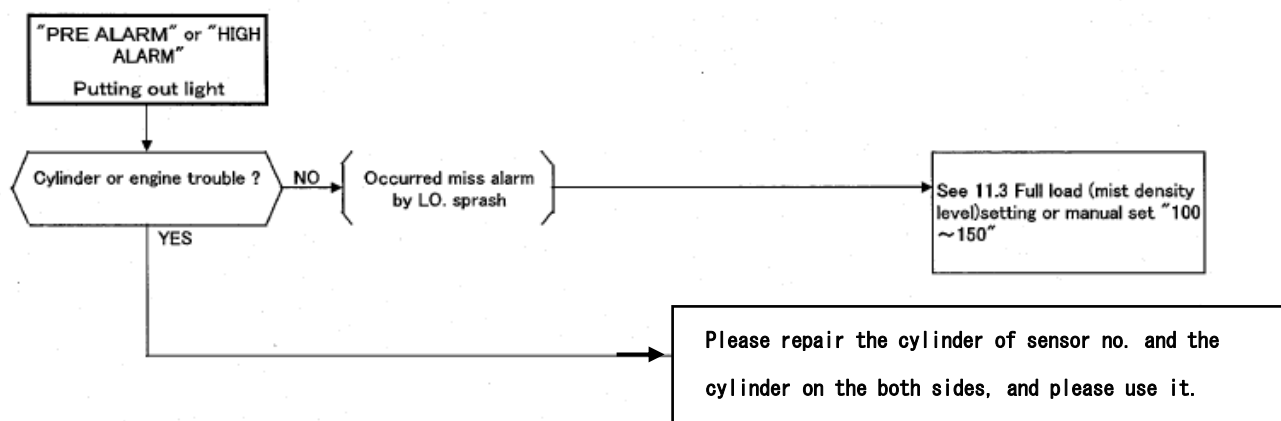
(2). In the case of "RUN" LED is blink



(3). In the case of "PRE ALARM" LED is blink LED

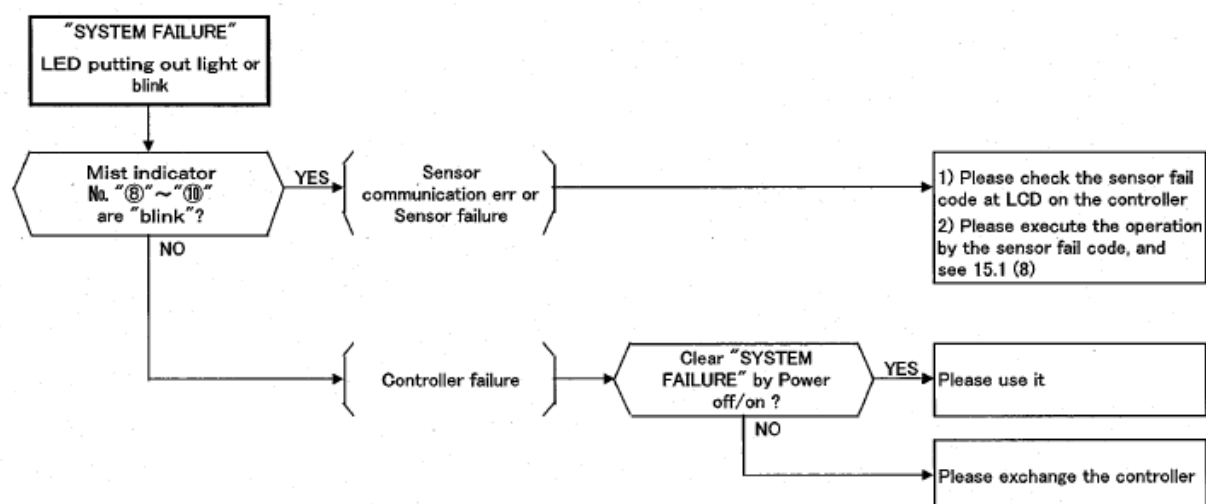


(4). In the case of "PRE ALARM" or "HIGH ALARM" LED putting out light

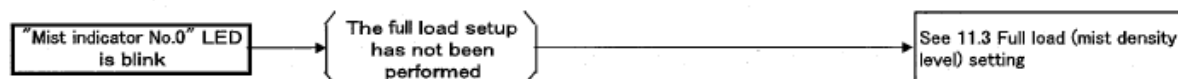


(5). In the case of "SYSTEM FAILURE" LED putting out light or blink

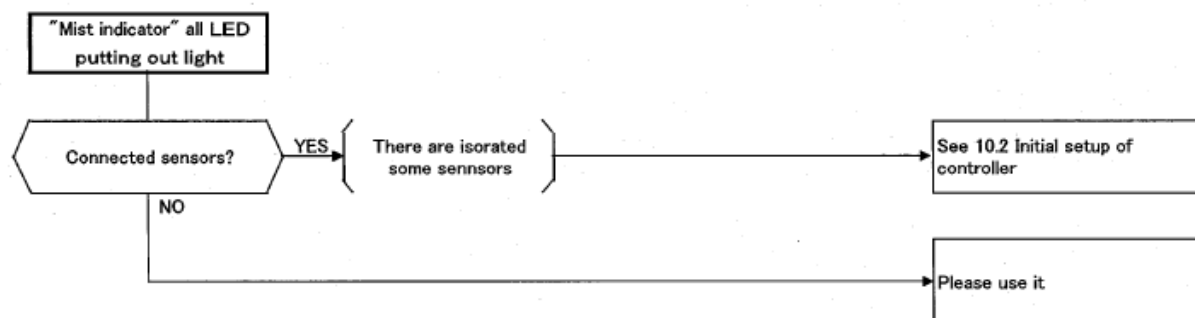
※ Please check the sensor fail code at LCD on the controller.



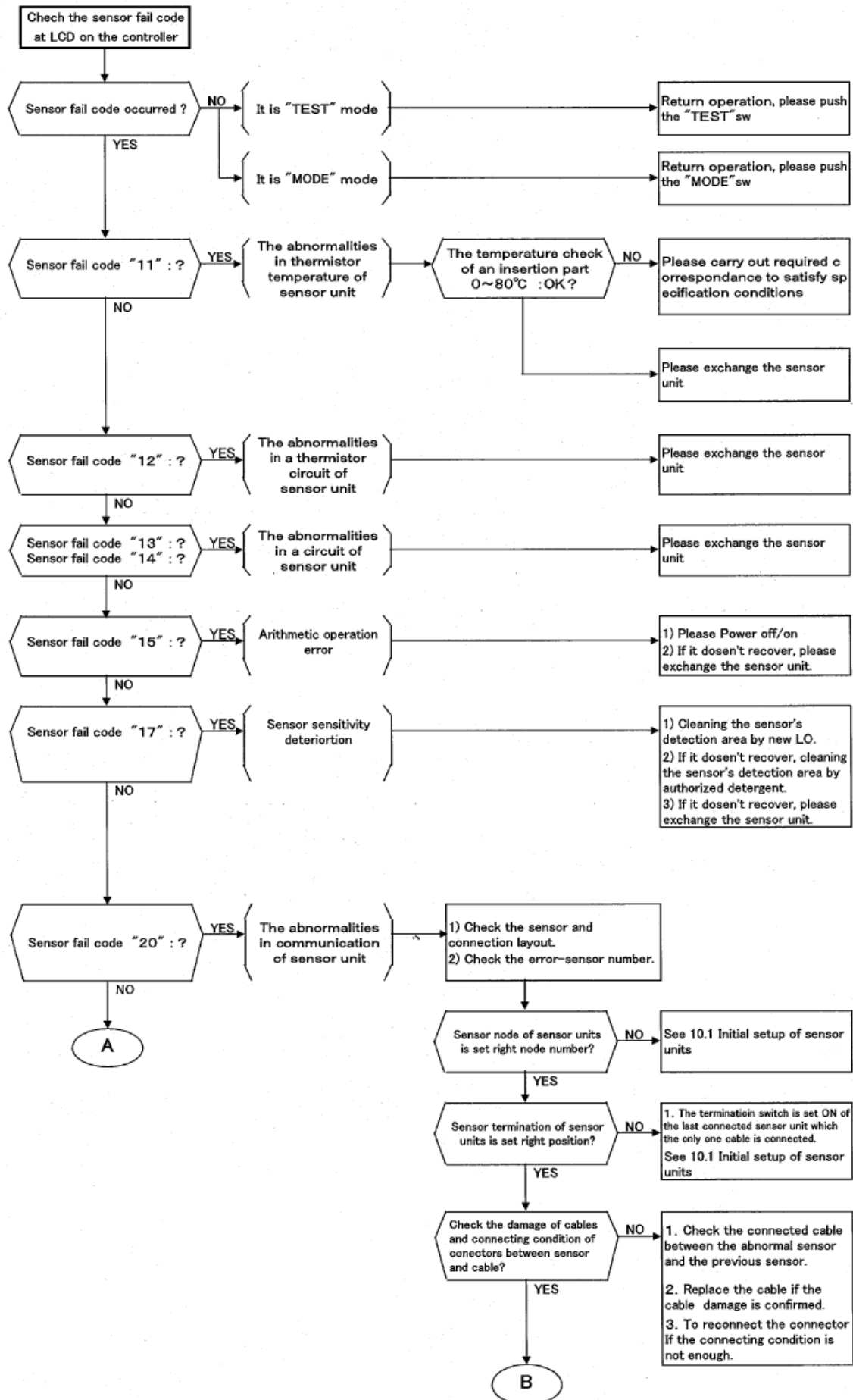
(6). In the case of "Mist indicator No.0" LED is blink

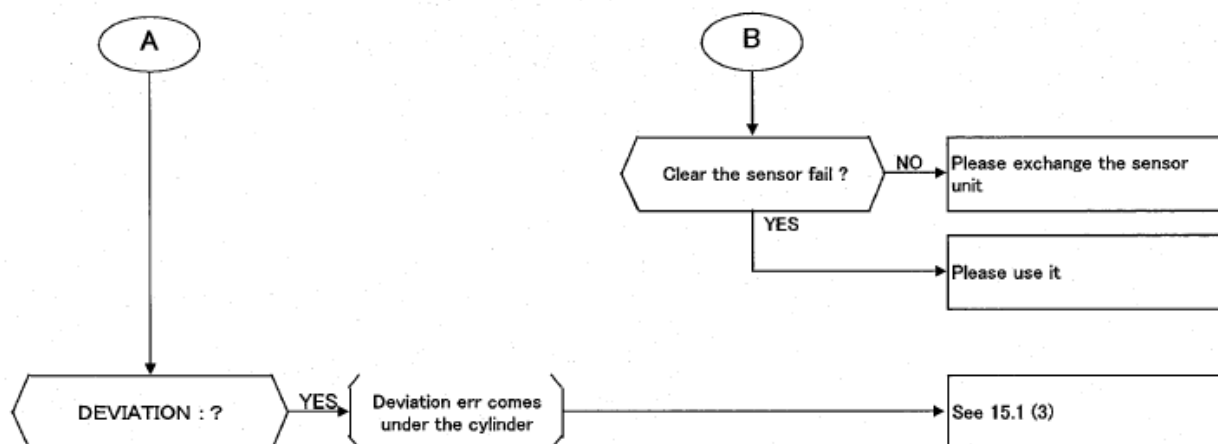


(7). In the case of "Mist indicator" all LED putting out light



(8). In the case, occurred "sensor fail code" at LCD on the controller





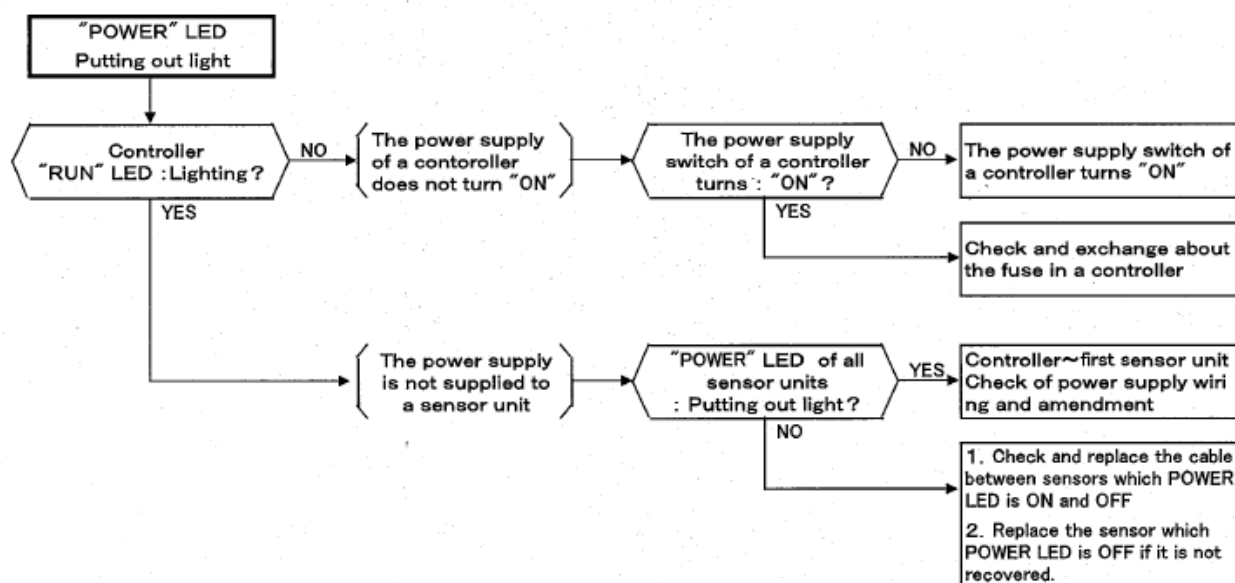
15.2 Sensor fail code at LCD on the controller

No.	Outline	Remedy
11	The abnormalities in thermistor temperature of sensor unit	Please check the temperature of an insertion part. If it has no problem of an insertion part, please exchange the sensor unit.
12	The abnormalities in a thermistor circuit of sensor unit	Please exchange the sensor unit.
13	EEPROM error	Please exchange the sensor unit.
14	The abnormalities in a circuit of sensor unit	Please exchange the sensor unit.
15	Arithmetic operation error	Please exchange the sensor unit.
17	Sensor sensitivity deterioration	Cleaning the sensor's detection area. If it doesn't recover, please exchange the sensor unit.
20	The abnormalities in communication of sensor unit	Check the cable condition and connecting condition between sensor and cable. Replace the sensor unit if it is not recovered.

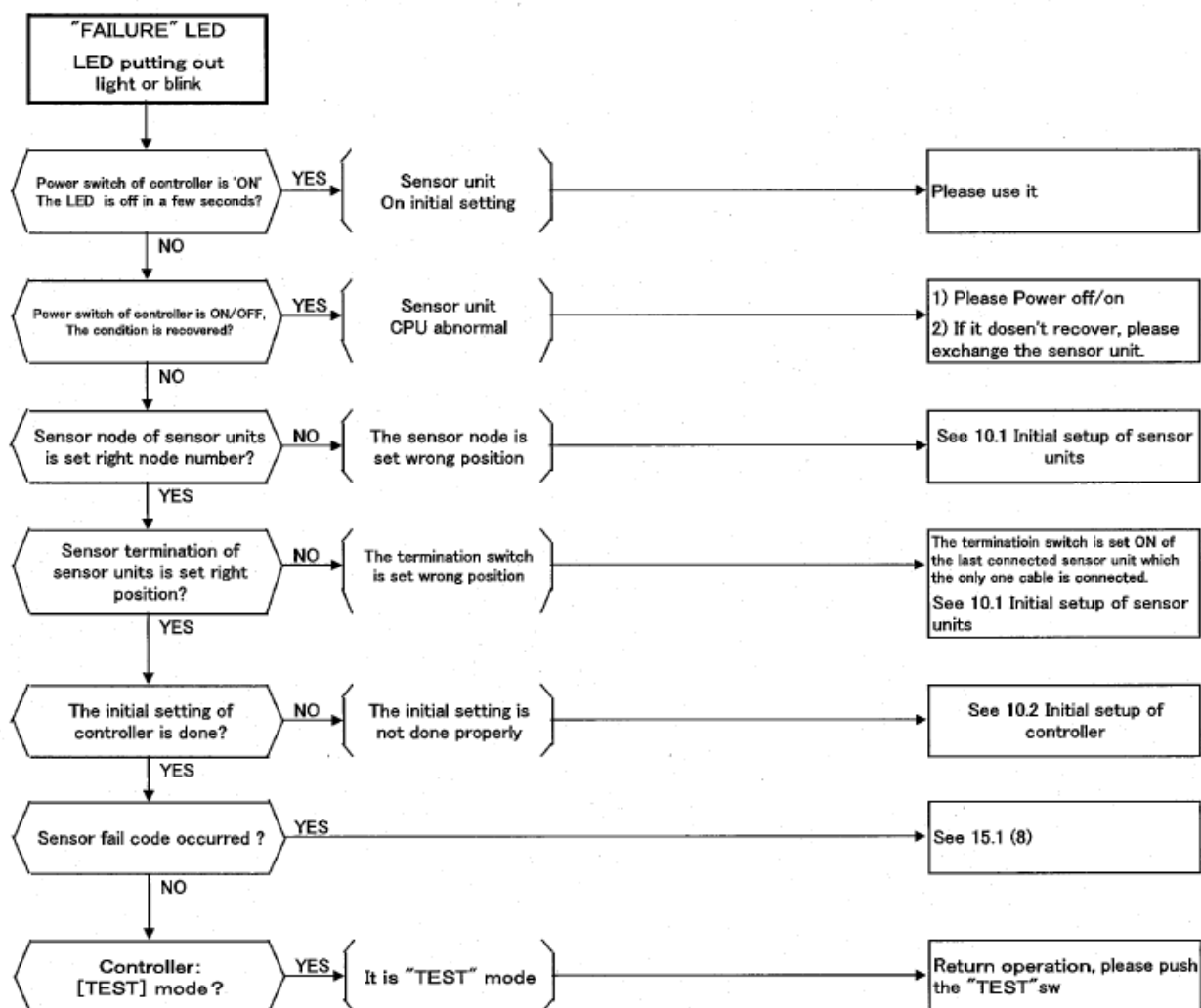
15.3 TROUBLESHOOTING by sensor unit indicate

First, please observe the sensor unit and check whether the damage is found or not.
If the damage is found, please replace the new sensor.
Next, please follow the below trouble shooting flow after checking whether cabling is done properly from the controller and abnormal sensor.

(1). In the case of "POWER" LED putting out light



(2). In the case of "FAILURE" LED putting out light or blink



16. APPENDIX

16.1 Parts list

1) SENSOR UNIT (Standard : Connector type)

Number	Parts Number	Name of Parts	Quantity
1	NN00465001C	ASSY.: MD-SX: SENSOR UNIT (CONNECTOR TYPE)	*

SENSOR UNIT (Gland type)

2	NN00465002B	ASSY: MD-SX: SENSOR UNIT (GRAND TYPE)	*
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SENSOR UNIT (Fling - lead type)

3	NN00465007B	ASSY: MD-SX: SENSOR UNIT (FLYING LEAD TYPE)	*
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2) Standard spare parts/Accessories for SENSOR UNIT

1	NN00465009A	PCHS: SEAL WASHER (Special type , use without seal tape)	*
2	NN00264003A	NUT: MD-SX SENSOR	

3) Option parts / Accessory for SENSOR UNIT

1	NN00264060A	PCHS: MD-SX: SEALING CAP	*
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4) CONTROLLER (Wall mount type with cable gland)

Number	Parts Number	Name of Parts	Quantity
1	NN00548001A	ASSY.: MD-SX II : CONTROLLER	1

5) Parts for Flush mount installation (option)

Number	Parts Number	Name of Parts	Quantity
1	NN00548016A	MD-SX:CONTROLLER-2 FLUSH MOUNT PARTS	1
1-1	NN00548007A	PLATE:MD-SX:CONTROLLER-2 FLUSH MOUNT	(1)
1-2	NN00548008A	BRACKET:MD-SX:CONTROLLER-2 FLUSH MOUNT RIGHT	(1)
1-3	NN00548009A	BRACKET:MD-SX:CONTROLLER-2 FLUSH MOUNT LEFT	(1)
1-4	NN00548010A	PCHS:MD-SX:DRESSING SCREW M6X5	(4)
1-5	NN00265031A	PCHS:WASHERS:C-1029-S-M6	(4)
1-6	X208008020ZB	PLUS BOLT ASSY::M8X1.25X20	(4)

※ NN00548016A is a blanket order cord of 1-1 to 1-6.

6) Standard tool for CONTROLLER

Number	Parts Number	Name of Parts	Quantity
1	NN00265002A	PCHS: DRIVER: 210-119S	1

7) Standard spare parts for CONTROLLER

Number	Parts Number	Name of Parts	Quantity
1	NN00265003A	PCHS: FUSE 20L: 6A-125V	2

8) Standard attachment parts/Accessories for CONTROLLER

Number	Parts Number	Name of Parts	Quantity
1	NN00548015A	PCHS:MD-SX:CONTROLLER-2 GLAND M20(Φ5-10)	1

9) Antivibration attachment parts (Option)

Number	Parts Number	Name of Parts	Qty.
1	NN00548011A	BRACKET:MD-SX:CONTROLLER-2 V-INS. MOUNT	1
2	NN00548012A	BRACKET:MD-SX:CONTROLLER-2 V-INSULATION	2
3	NN00548013A	PLATE:MD-SX:CONTROLLER-2 V-INSULATION	1
4	NN00548014A	PCHS:WIRE ISOLATOR:CR4-100-DM	4
5	X208008025ZB	PLUS BOLT ASSY : : M8X1.25X25	4
6	X249006016ZB	PLUS BOLT ASSY : : M6X1.0X16	8
7	—	BOLT M8 (preparations in a user)	4

10) Wiring material (Specification article: Option)

Number	Parts Number	Name of Parts	Qty.
1	NN00646001A	CABLE.: MD-SX:BOTH SIDES CONNECTOR 1M	*
2	NN00646002A	CABLE.: MD-SX:BOTH SIDES CONNECTOR 2M	*
3	NN00646003A	CABLE.: MD-SX:BOTH SIDES CONNECTOR 3M	*
4	NN00646004A	CABLE.: MD-SX:BOTH SIDES CONNECTOR 4M	*
5	NN00646005A	CABLE.: MD-SX:BOTH SIDES CONNECTOR 5M	*
6	NN00646006A	CABLE.: MD-SX:BOTH SIDES CONNECTOR 6M	*
7	NN00646007A	CABLE.: MD-SX:BOTH SIDES CONNECTOR 7M	*
8	NN00646008A	CABLE.: MD-SX:BOTH SIDES CONNECTOR 8M	*
9	NN00646009A	CABLE.: MD-SX:BOTH SIDES CONNECTOR 9M	*
10	NN00646010A	CABLE.: MD-SX:BOTH SIDES CONNECTOR 10M	*
11	NN00646011A	CABLE.: MD-SX:BOTH SIDES CONNECTOR 15M	*
12	NN00646012A	CABLE.: MD-SX:BOTH SIDES CONNECTOR 20M	*
13	NN00646013A	CABLE.: MD-SX:BOTH SIDES CONNECTOR 25M	*
14	NN00646014A	CABLE.: MD-SX:BOTH SIDES CONNECTOR 30M	*
15	NN00646015A	CABLE.: MD-SX:BOTH SIDES CONNECTOR 35M	*
16	NN00646016A	CABLE.: MD-SX:BOTH SIDES CONNECTOR 40M	*

Number	Parts Number	Name of Parts	Qty.
17	NN00646017A	CABLE.: MD-SX:BOTH SIDES CONNECTOR 45M	*
18	NN00646018A	CABLE.: MD-SX:BOTH SIDES CONNECTOR 50M	*
19	NN00646019A	CABLE.: MD-SX: ONE SIDE CONNECTOR 2M	*
20	NN00646020A	CABLE.: MD-SX: ONE SIDE CONNECTOR 3M	*
21	NN00646021A	CABLE.: MD-SX: ONE SIDE CONNECTOR 4M	*
22	NN00646022A	CABLE.: MD-SX: ONE SIDE CONNECTOR 5M	*
23	NN00646023A	CABLE.: MD-SX: ONE SIDE CONNECTOR 6M	*
24	NN00646024A	CABLE.: MD-SX: ONE SIDE CONNECTOR 7M	*
25	NN00646025A	CABLE.: MD-SX: ONE SIDE CONNECTOR 8M	*
26	NN00646026A	CABLE.: MD-SX: ONE SIDE CONNECTOR 9M	*
27	NN00646027A	CABLE.: MD-SX: ONE SIDE CONNECTOR 10M	*
28	NN00646028A	CABLE.: MD-SX: ONE SIDE CONNECTOR 11M	*
29	NN00646029A	CABLE.: MD-SX: ONE SIDE CONNECTOR 12M	*
30	NN00646030A	CABLE.: MD-SX: ONE SIDE CONNECTOR 13M	*
31	NN00646031A	CABLE.: MD-SX: ONE SIDE CONNECTOR 14M	*
32	NN00646032A	CABLE.: MD-SX: ONE SIDE CONNECTOR 15M	*
33	NN00646033A	CABLE.: MD-SX: ONE SIDE CONNECTOR 20M	*
34	NN00646034A	CABLE.: MD-SX: ONE SIDE CONNECTOR 25M	*
35	NN00646035A	CABLE.: MD-SX: ONE SIDE CONNECTOR 30M	*
36	NN00646036A	CABLE.: MD-SX: ONE SIDE CONNECTOR 35M	*
37	NN00646037A	CABLE.: MD-SX: ONE SIDE CONNECTOR 40M	*
38	NN00646038A	CABLE.: MD-SX: ONE SIDE CONNECTOR 45M	*
39	NN00646039A	CABLE.: MD-SX: ONE SIDE CONNECTOR 50M	*

* Order your nearest distributor specifying the necessary length.

16.2 Anti-vibration bracket mounting drawing (OPTION)

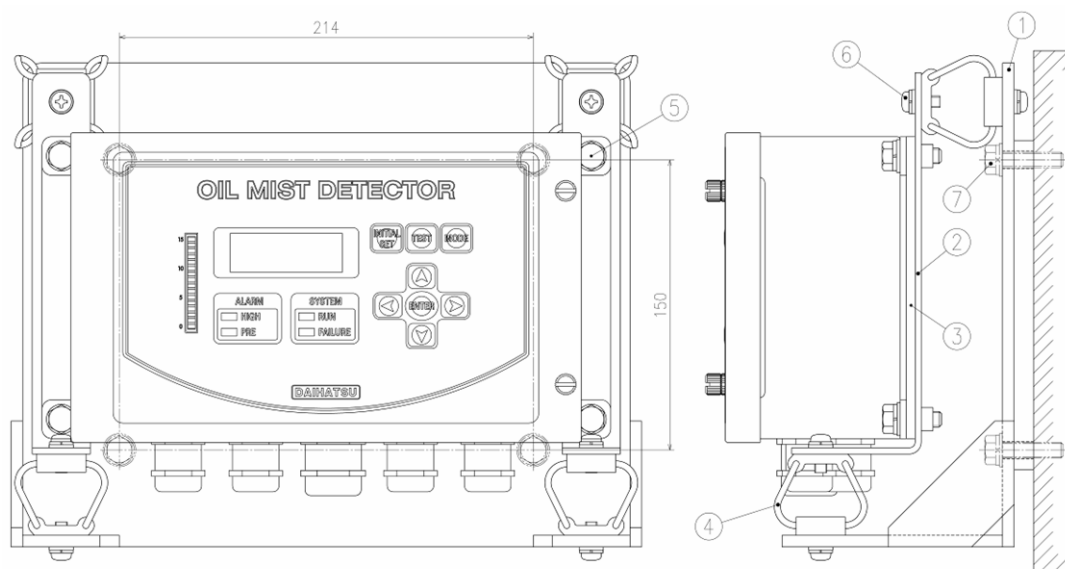


Fig. 34 Antvibration wire attachment outline (OPTION)

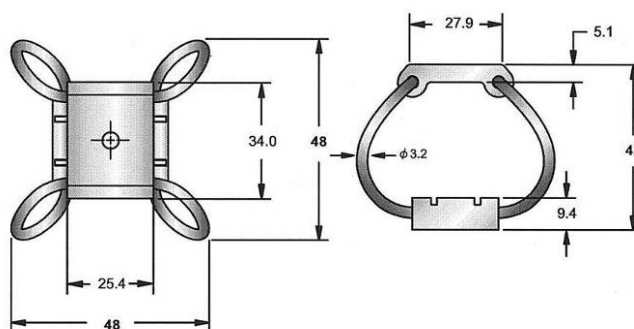


Fig. 35 Wire vibration insulator

Number	Parts Number	Name of Parts	Qty.
1	NN00548011A	BRACKET:MD-SX:COTROLLER-2 V-INS. MOUNT	1
2	NN00548012A	BRACKET:MD-SX:CONTROLLER-2 V-INSULATION	2
3	NN00548013A	PLATE:MD-SX:CONTROLLER-2 V-INSULATION	1
4	NN00548014A	PCHS:WIRE ISOLATOR:CR4-100-DM	4
5	X208008025ZB	PLUS BOLT ASSY : : M8X1.25X25	4
6	X249006016ZB	PLUS BOLT ASSY: :M6X1.0X16	8
7	—	BOLT M8 (preparations in a user)	4

16.3 Sensor cleaning procedure

The sensor and the internal lens surface can be cleaned automatically by replacing to the new oil from the existing system oil.

Please replace the system oil periodically in following to the system oil control of engine.

Regarding purchasing Daihatsu Diesel designated cleaning liquid. Please purchase the cleaning liquid (SAFE CARE SC-1000) from the cleaner manufacturer (GEMTEC Product (USA) or Infinity Enterprises Inc) directly.

If you can not find the contacted information of the cleaner manufacturer, please contact us.

Regarding the function of sensitivity decreased, the sensor manufactured before July 2008 does not have the function in order not to be required by Classification. By replacing the sensor manufactured after July 2008, the function will be effective.

Cleaning Procedure for Oil Mist Sensor MD-SX

Cleaning and Operation Control of MD-SX Sensor

In daily checking, change of mist density level between engine running and engine stopping has become extremely small (check by digital value on LCD), or for sensors which have detector function for sensitivity deterioration, when SENSOR FAIL 17 is shown on LCD, practice cleaning. (Refer to attached "Judgment standard for sensor cleaning".) After cleaning, make sure to confirm digital value on LCD goes up to 1023 in testing by smoke spray or a strip of white paper.

For sensors which have detector function for sensitivity deterioration, make sure "SENSOR FAIL 17" is not shown.

In case the sensor would not recover after cleaning some times, replace with new one. If the sensor which is used for 2~3 years in normal operation, please consult with us.



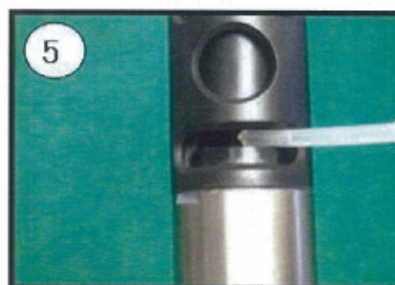
- ① Cleaning tools (Photo is one example)
 1) New lubricating oil (or Cleaning liquid)
 2) Syringe 3) Cleaning vessel (Cup etc.)



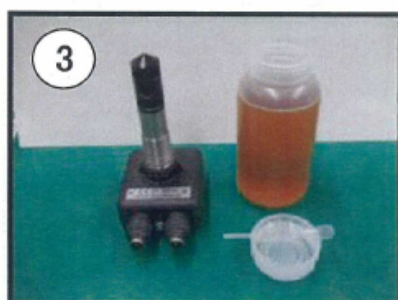
- ④ Sucking new lubricating oil or cleaning liquid with syringe.



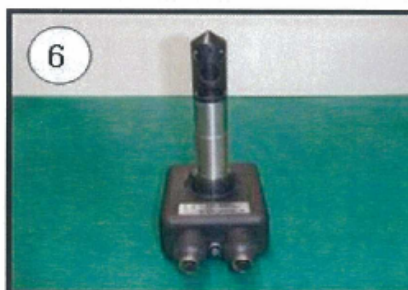
- ② Cleaning liquid
 1) New lubricating oil or Cleaning liquid designated by Daihatsu Diesel.
 (In case of heavy contamination)
 (Product Name: SAFE CARE SC-1000 Aqueous Cleaner Concentrate)
 Supplier: GEMTEC Product (USA)
 Infinity Enterprises, Inc (Japan)



- ⑤ From oval hole on probe, drop approx. 2ml of new lubricating oil or undiluted cleaning liquid onto lens surface using syringe.



- ③ Preparation for cleaning sensor lens
 Place the sensor on the table like photo.



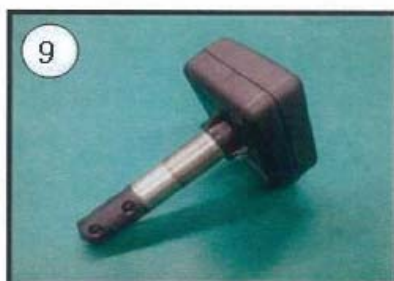
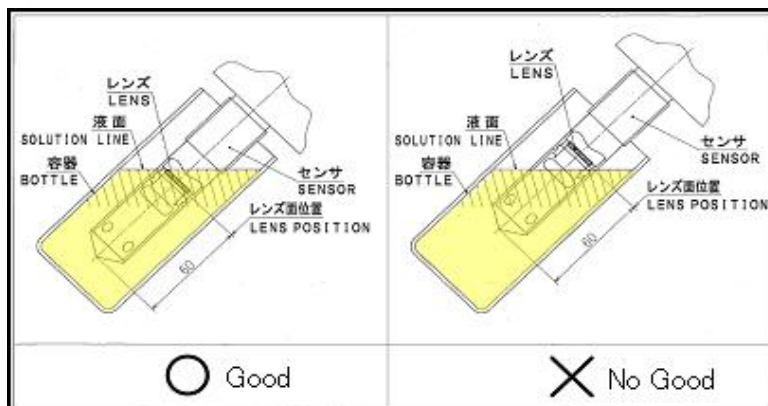
- ⑥ After dropping cleaning liquid, leave for several hours (In case of heavy contamination, leave for more than 24 hours.)



- ⑦ Preparing approx.10cm depth of new lubricating oil or approx. 5% concentration solvent of cleaning liquid in a clean vessel.



- ⑧ Slanting the vessel like photo, soak the probe in a way to release air in the probe, shake the probe right and left about 10 times. Soak the probe until the lens is soaked in solution.



- ⑨ After drying or air blow, leave the sensor like photo for approx.30 minutes for the solvent to flow out.



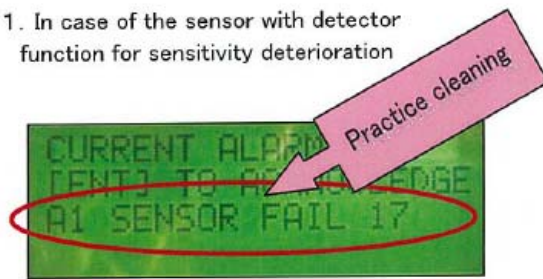
- ⑩⑪ After having dried, prepare a strip (w.10 ~12mm) of white paper, insert a strip of paper into the hole in lower part of sensor hood, and confirm digital value goes up to 1023.
(Confirmation by smoke spray or other fake oil mist is possible.)



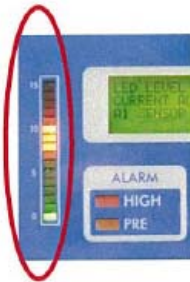
- ⑫ When digital value 1023 on the controller LCD is confirmed, it is possible for the sensor to operate on the engine. If digital value does not go up to 1023 even after cleaning with cleaning liquid designated by Daihatsu Diesel, replace the sensor with new one.

JUDGMENT STANDARD FOR CLEANING OF MD-SX SENSOR

1. In case of the sensor with detector function for sensitivity deterioration



"SENSOR FAIL 17" is shown on controller LCD.



Mist indicator level when "SENSOR FAIL 17" is shown.

2. In case of the sensor without detector function



- ① In case change of mist density level between engine running and stopping has become extremely small.
- ② In case the indicator indicates only 0 or 1 even when engine is running.



Normal mist indication during engine running

3. Confirmation for digital value change of each sensor between engine running and stopping.

《Digital value reading procedure》

- ① Press MODE key on the controller.



- ② At "1. STATUS", press ENTER key.



- ③ Choose "3. MIST/ALARM LEVEL" by ▼ key, press ENTER key.



- ④ At "1. MIST/ALARM LEVEL", press ENTER key.



- ⑤ At "1. ENGINE A", press ENTER key.



Sensor No.

Confirm digital value of each sensor using ▼ key.

Digital value

- 1) When the difference of digital value between engine running and engine stopping has become less than 10.
- 2) When the digital value has decreased more than 10 than the same load operation before.

Practice cleaning

16.4 Attention of using LOOP wiring for sensor cable routing

DAIHATSU recommend the cable routing method of MD-SX sensor unit is “daisy chain” topology.

Almost all MD-SX system is installed on engine with the daisy chain wiring. The troubleshooting in wiring defectiveness is easy, and cable cost and installation cost are reduced. Therefore DAIHATSU recommends the “daisy chain” topology.

In case of applying the “loop” topology, it is necessary to understand the difference between the *loop* and *daisy chain* topology. And please judge which is suitable.

The difference of MD-SX oil mist detecting system with the “loop” wiring.

- The addition of a cable for returns is necessary.
- All termination switch of MD-SX sensor unit must change [OFF] position.
- Using *loop* wiring, MD-SX system can improve reliability for the disconnection of cable. But in short circuit situation of the cable, the reliability is same as to use *daisy chain* wiring .
- MD-SX system can work as normal operation under one disconnection circuits point. However, MD-SX cannot detect a wiring defectiveness warning. (communicate through other connected line)
- In case of disconnection circuits point two or more , MD-SX can detect a wiring defectiveness and show warning as “Sensor Fail 20”. but to identify disconnection points might be slightly difficult.

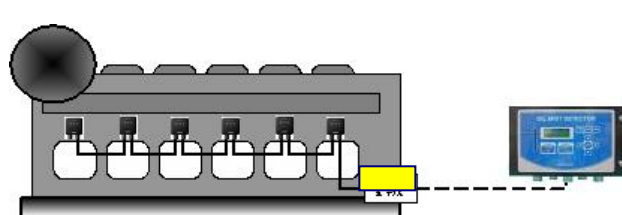


Fig.36 Daisy chain wiring

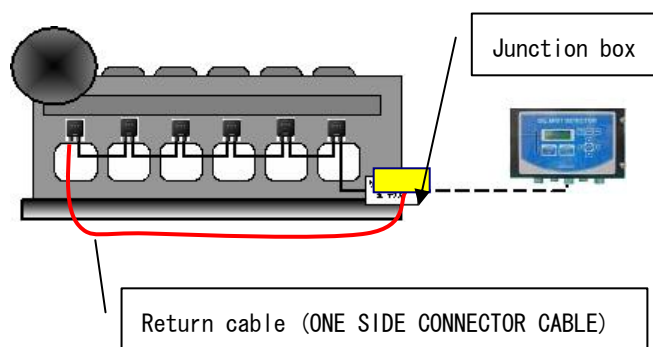


Fig.37 Loop wiring

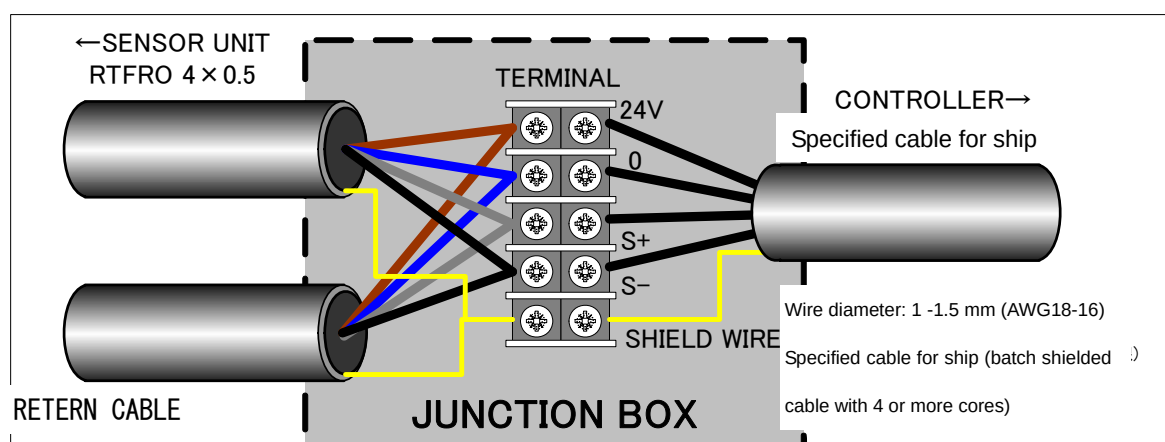


Fig. 38 Specification for connection in the junction box with loop wiring (Terminal box)

NOTE) The color specification of DAIHATSU supply cable is written the table of page 18.



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●Please refer to the separate brochure for "DAIHATSU AFTER-SERVICE NETWORK".

- All information contained in this Manual is corrected at the time of printing, but will be subject to change without notice.

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