ULVAC

CRYO-METER MBD-D

Instruction Manual

Export Control Policy

We recommend that ALL customers be sure to follow all rules and regulations such as Foreign Exchange and Foreign Trade Law when exporting or reexporting our products.

D/N.MGMBD02E,2018.12 **ULVAC CRYOGENICS INCORPORATED**

Introduction

Thank you for choosing our products. This instruction manual gives information and precautions on handling, installation, operation, and maintenance of the product.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. To ensure proper use of this product, read this instruction manual carefully and keep this manual close at hand so that you can use for reference during operation.

If you purchased our other products and/or optional devices with this product, read relevant instruction manuals carefully.

1. About the personnel who are involved in handling our products

All personnel involved in handling our products should take a general safety education and training that is officially accepted in the country where our product is used. The personnel are also required to have specialized knowledge/skills and qualification on the electricity, the machinery, the cargo handling, and the vacuum. Especially, the personnel should be familiar with handling a cryopump in order to use it safely. Since we offer a training session (which is subject to fees) as needed for people who use cryopumps for the first time, please do not hesitate to contact our Service Engineering Division to join the training session.

2. Warranty

2.1 Gratis warranty period and Warranty coverage

【Gratis warranty period】

Note that an installation period of less than one year after installation in your company or your customer's premises or a period of less than 18 months (counted from the date of production) after shipment from our company, which is shorter, is selected.

【Coverage】

(1) Failure diagnosis

As a general rule, diagnosis of failure should be done on site by customer. However, ULVAC CRYOGENICS or our service network can perform this service for an agreed fee upon the customer's request. There will be no charge if the cause

of the breakdown is found to be a fault of ULVAC CRYOGENICS.

(2) Damage during transportation

When damage by delivery/transportation is admitted, the product will be repaired free of charge within the range of the guarantee expressed in the sales contract.

(3) Breakdown repairs

There will be a charge for breakdown repairs, replacements and on-site visits for the following seven conditions. In those cases the cost shall be your own expense even though the product is within the warranty period.

① Breakdowns due to improper storage or handling, careless accident, software or hardware design by the customer.
② Breakdowns due to modifications of the product without consent of the manufacturer.
③ Breakdowns due to maintenance of the product without authentic parts or breakdowns resulting from using the product outside the specified specifications of the product.
④ Breakdowns due to contamination or corrosion caused by user's use conditions.
⑤ Breakdowns due to natural disasters (such as fire, earthquake, flood, lightning, salt damage, and so on) , environmental pollution, irregular voltage, and /or usage of undesignated power source.
⑥ Breakdowns that are outside the terms of warranty.
⑦ Consumables and/or replacement service.

Since the above services are limited to within Japan, diagnosis of failures, etc are not performed abroad. If you desire the after service abroad, please contact ULVAC CRYOGENICS and consult us for details in advance.

2.2 Exclusion of opportunity loss from warranty liability

Regardless of the gratis warranty term, compensation to opportunity losses incurred to your company or your customers by failures of ULVAC CRYOGENICS products and compensation for damages to products other than ULVAC CRYOGENICS products and other services are not covered under warranty.

2.3 Repair period after production is discontinued

ULVAC CRYOGENICS shall accept product repairs for seven years after production of the product is discontinued.

3. Service Form

After the products are delivered, please fill out the following information in the blanks. If you have any questions or technical problems, please feel free to contact the nearest Customer Support Center or headquarters. Please refer to "Service Network".

Cryopump／Super trap Model	: _____
Cryopump／Super trap Serial No.	: _____
Refrigerator Model	: _____
Refrigerator Serial No.	: _____
Compressor Model	: _____
Compressor Serial No.	: _____
Temperature controller／Thermal display Model	: _____
Temperature controller／Thermal display Serial No.	: _____
Option Part Model	: _____
Optional Part Serial No.	: _____

4. Notes for repair and maintenance requests

We may decline your request for the repair or the maintenance of our products if you refuse to give us information about the presence of the hazardous substance and/or contaminant.

Also, please be aware that we do not accept liability for damages by the contaminant, which might be caused during transportation to our office or the nearest customer support center. To avoid such accident, please pay careful attention to packing of the product

5. In case of breakdown and accident

When breakdown or accident occurs, we may ask for keeping the product on site as it is or retrieving the product to investigate its cause. Also we may ask for reporting the detailed process and/or the operating condition. When unidentified malfunction was generated, please contact our Service Engineering Division or

the nearest customer support center with reference to the chapter of Service Network. We ask for cooperation about the above.

6. General Precautions

(1) It is strictly prohibited to duplicate, open, and transfer this instruction manual or any of its parts to a third person without written permission from ULVAC CRYOGENICS.

(2) Information in this document might be revised without a previous notice for the specification change and the improvement of the product.

(3) If you have any questions or comments on this document, please do not hesitate to contact us. The phone numbers of local customer support centers are listed at the end of this manual.

Safety Considerations

Our products have been designed to provide extremely safe and dependable operation when properly used. Following safety precautions must be observed during normal operation and when servicing them.

WARNING **A warning describes safety hazards or unsafe practices which could result in severe injury or loss of life.**

CAUTION **A caution describes safety hazards or unsafe practices which could result in personal injury or equipment damage.**

Toxic gas or chemicals used.
There is a risk of severe injury upon contact.

Corrosive chemicals used.
There is a risk of severe injury upon contact.

Flammable gas used.
There is a danger of fire or burn injury.

Explosive gas used.
There is a risk of fire or explosion.

Hazardous voltage .
Electric shock may cause severe injury or loss of life.

Hot heating part present.
There is a risk of burn injury.

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Disposal Considerations

Disposal of our products must be done in accordance with applicable national and local laws and regulations.

WARNING

The cryopumps or cryocoolers may contain residue of hazardous substances resulting from actual use. Contact your safety supervisor and follow the instructions to remove such toxic substances before disposing.

We provide Safety Data Sheet (SDS) of our products upon your request.
Please contact us if necessary.

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SHIPPING LIST

Our product has been fully inspected before shipment. However, please make sure that there is no damage or shortage of delivered items by checking the shipping list below and the external view of the products.

ITEM	VOLUME
CRYO METER MBD-D (with power cable) (*1)	1
Clamp Kit (Holder & Set Screw x 2)	1
Connector Kit (R03-PB3M, R03-PB2F) (See table 3-1) (*2)	1
Instruction Manual (this book)	1

(*1) The length of the power cable is 3m.

(*2) Types of cables for connecting to MBS-C or MBS are listed on Table 1-2 in MBS-C instruction manual. Please refer to the table and place a separate order for an appropriate cable.

<Note> The connector kit on the above table will not be provided if the order for the above cable is placed.

1. Features

The CRYO METER MBD-D displays cryogenic temperature used in conjunction with MBS-C or MBS cryogenic thermocouple temperature meter attached to our cryopump.

The MBD-D receives the analog output signal from the cryogenic thermocouple and displays the 1st and 2nd stage temperatures digitally. The display shows the second-stage temperature from 10K to 350K, and the first-stage from 45K to 350K.

The power source should be in the range between 100VAC and 240VAC, and the power cable terminal be round shaped. The MBD-D communicates with C30S via RS485 (Modbus).

The figure 1-1 shows the exterior of MBD-D.

Figure 1-1 Exterior of MBD-D

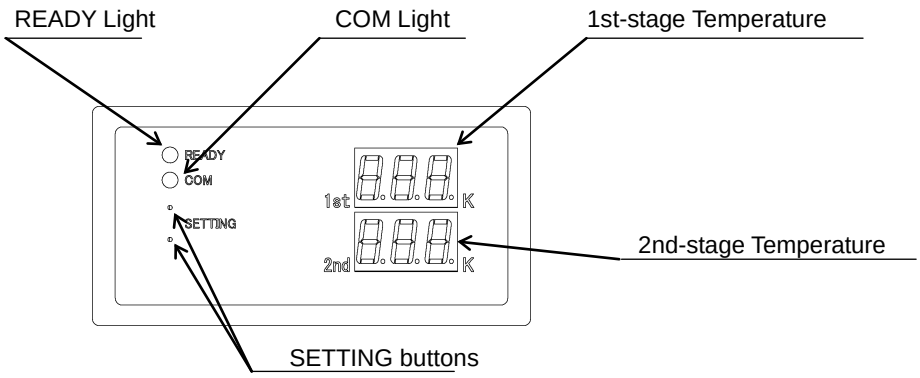


Figure 1-2 MBD-D Front Panel

2. Specifications

Table 2-1 General Specifications

Model		MBD-D
Dimensions		96(W) x 48(H) x 120(D) (mm) (Refer to the external drawing)
Temperature Display		1st / 2nd Stage (3 digits / 3 digits)
Display Range		1st: 45K – 350K 2nd: 10K – 350K
2nd-Stage Accuracy		±0.5% (full scale)
1st-Stage Accuracy (*1)		123K – 350K: 0.5% (full scale) 73K – 123K: 3% (full scale) 45K – 73K: Outside the scope of accuracy assurance
Analog Input		5V – 0V(10K – 350K)
K Thermocouple Input		Available
Power Supply	Voltage	100 - 240VAC ±10%
	Current	55mA typ.
Power Terminal		Round terminal ends 3m (Crimping Terminal with Sleeve ϕ4)
24V Output (POWER OUT)		Cryo-Meter MBS / MBS-C dedicated power source(*2) Voltage：24 VDC±2.5%, Current:400mA max
Ambient Conditions		Indoors, below amplitude of 1000m Refrain from direct sunshine or corrosive gasses Temperature while in operation: 0 - 40°C (typ. 25°C) (Display accuracy can be maintained at 25±5°C Humidity: 40 – 85%RH (no condensation)
Insulation Resistance		AC Input – FG: 100MΩ or above
Dielectric Strength		AC Input - FG: AC1500V / 1min 24V Output - FG: AC500V / 1min
Applicable Standards		Low Voltage Directive(LVD):2014/35/EU ・EN 61010-1:2010 Electro Magnetic Compatibility Directive(EMC):2014/30/EU ・EN 61326-1:2013 ・EN 55011/A1:2010 Group1[Class A] ・EN 61000-3-2:2014 ・EN 61000-3-3:2013
Weight		Approx 465g

<Notes>

(*1) This refers to the accuracy of K thermocouple, not including the accuracy of reference junction.

(*2) The power source must be dedicated to single cryo-meter and must not be used for multiple units or for other devices.

3. Connector Specifications

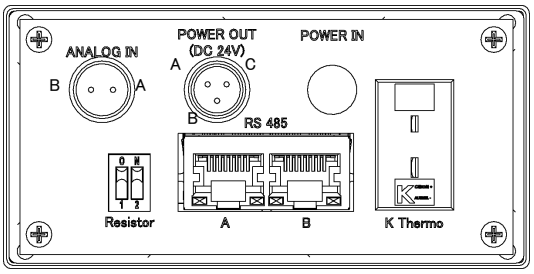
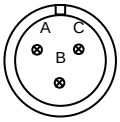
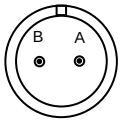
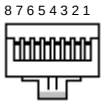
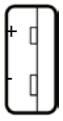


Figure 3-1 MBD-D Rear Panel

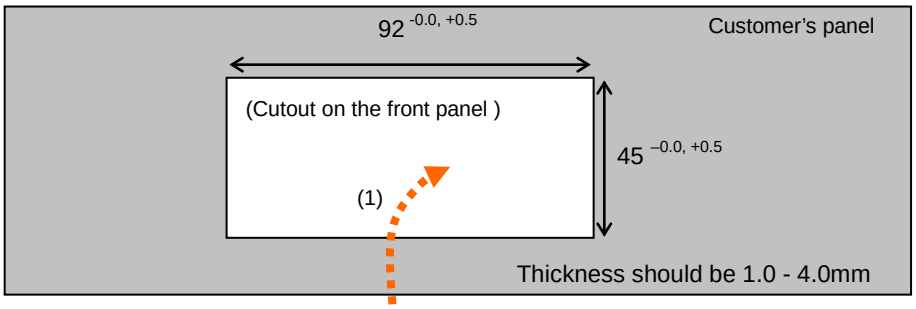
Table 3-1 Connectors Input / Output Pins

Item	Receptacle Pin	Compatible Plug	Assignment		Function
POWER OUT 24V ⎓		R03-PB3M or R03-P3M (Cables are optional)	A	+24V	MBS/MBS-C 24V Power Output
			B	No Connection	
			C	0V	
ANALOG IN		R03-PB2F or R03-P2F (Cables are optional)	A	+ INPUT	Analog signal input from MBS/MBS-C +5 – 0V /10 – 350K
			B	- ACOM	
RS 485 (A/B)		RJ-45	1	No Connection	For communication via RS485(Modbus)
			2	No Connection	
			3	No Connection	
			4	D+	
			5	D-	
			6	No Connection	
			7	No Connection	
			8	No Connection	
K Thermo		SMPW-K-M	+	Chromel	For K Thermocouple
			-	Alumel	

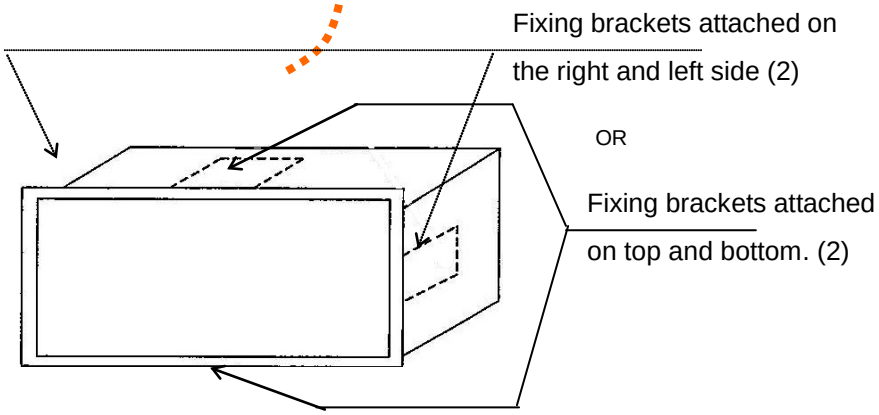
4. Installation

Follow the steps below to attach the MBD-D to the customer's display panel using the clamp kit delivered with the MBD-D.

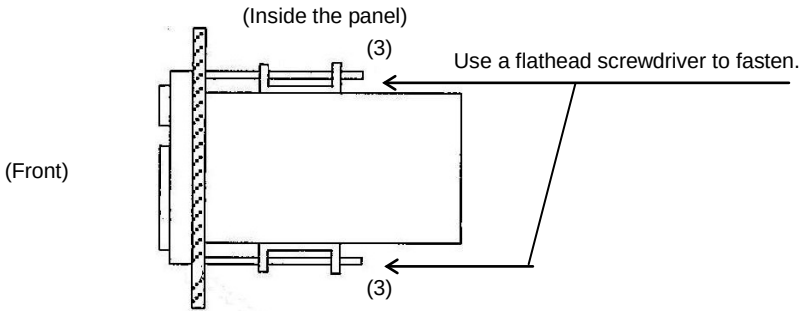
(1) As shown in the figure below, insert the MBD-D from the front through the rectangle cutout on the front panel all the way seated in.



(2) Attach the fixing bracket on top and bottom, or left and right sides of the MBD-D



(3) Fasten the screws to fix the MBD-D.

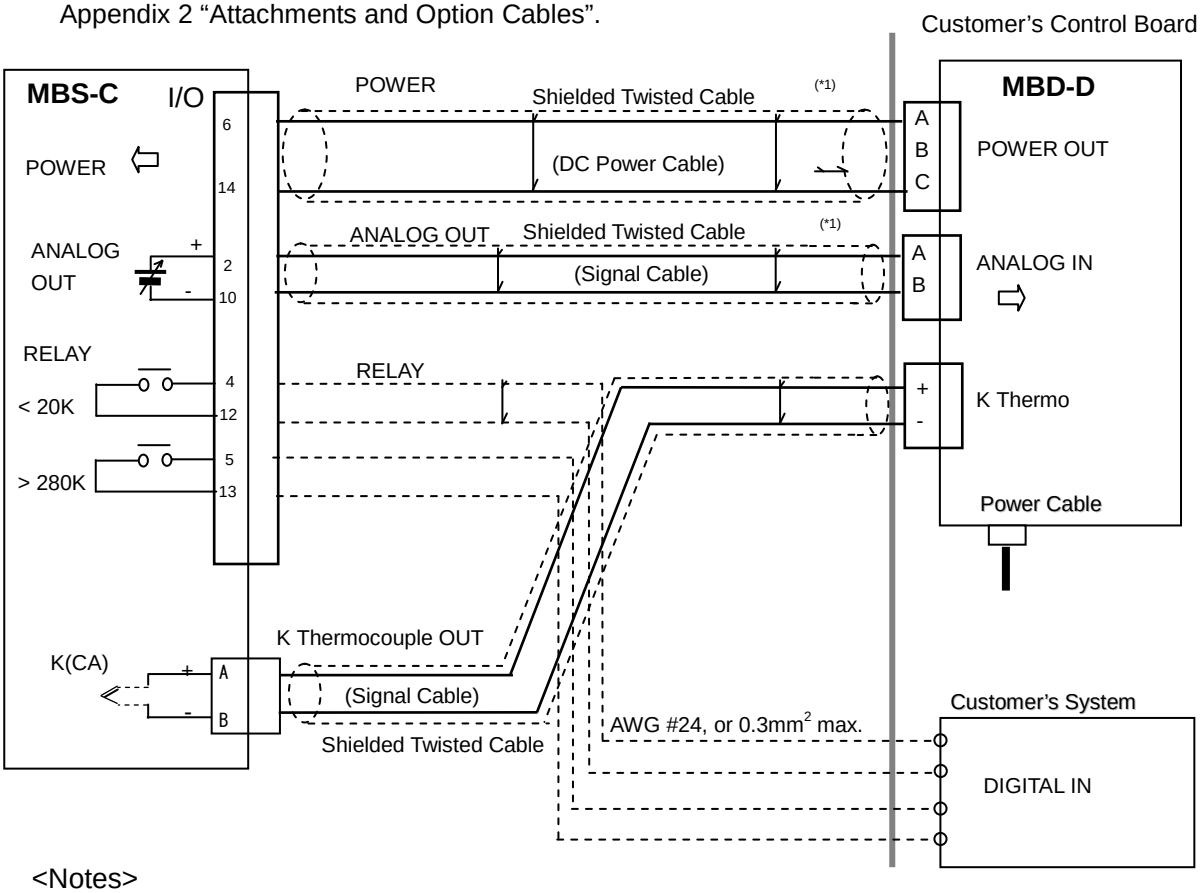


(4) Connect the cables included in the package to the MBD-D.

✧ Wiring

After attaching the MBD-D to the panel, wire the device to the MBS-C. Use the MBD and MBS-C connection cable (MBD-HS30) to connect POWER and ANALOG OUT in the I/O of the MBS-C. In this case, wiring of the RELAY shown in the dotted lines is to be done by the customer. The MBD-D receives the K(CA) signal from the MBS-C and display the first-stage temperature. Connect the K thermocouple cable between K(CA) connector of MBS-C and K thermo connector of MBD-D.

If you use other types of connection cables, refer to the MBS-C Instruction Manual Table 1-2 or Appendix 2 “Attachments and Option Cables”.



<Notes>

1. Maximum length of our optional MBD and MBS-C connection cable (MBD-HS30) is 20 meters.
2. The dotted lines are to be wired by customers.

Figure 4-1 Wiring MBD-D and MBS-C

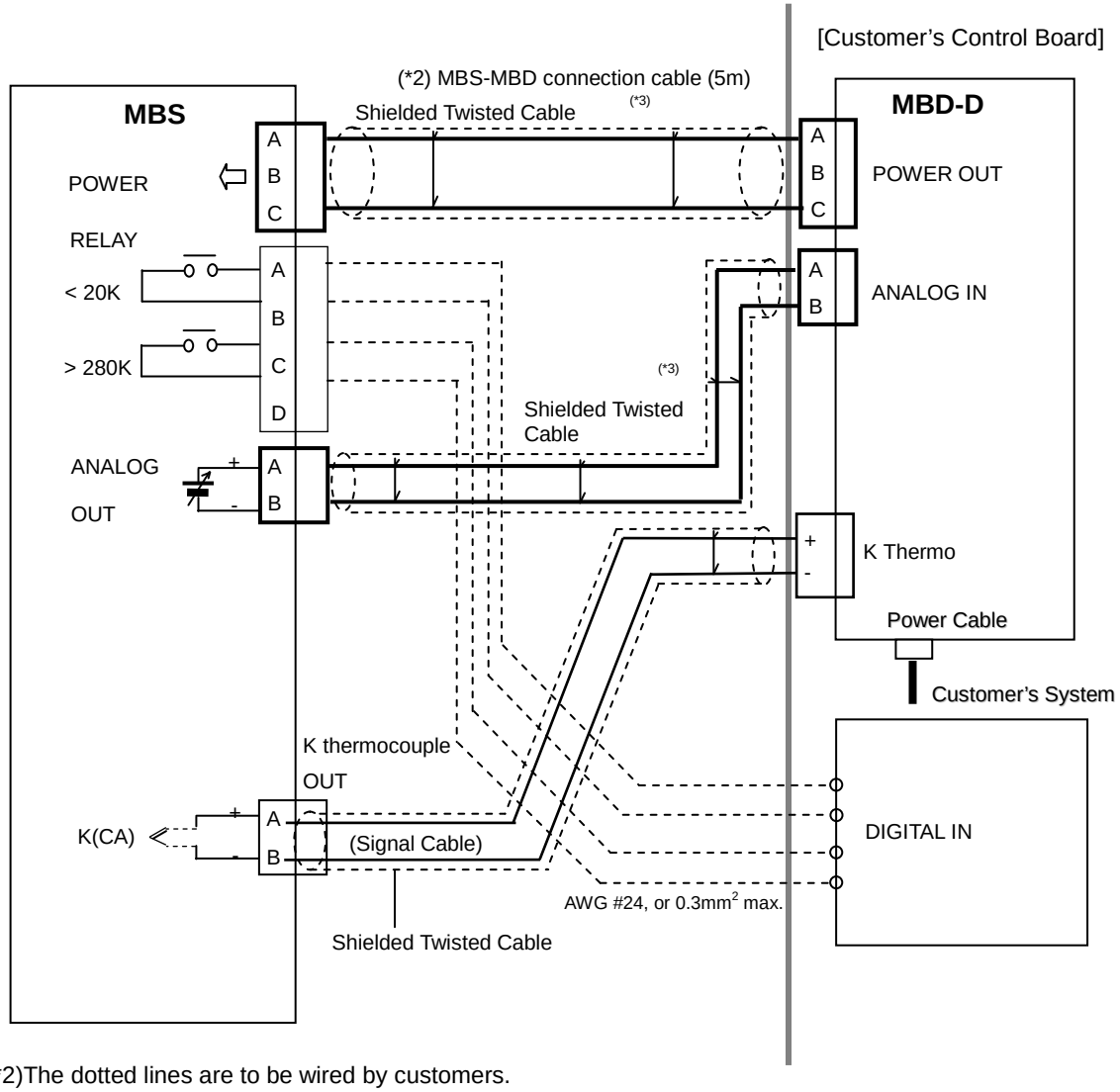
CAUTION

When routing cables;

In order to prevent mutual interference during operation, signal lines, control lines, and AC power lines should be placed in separate conduits. Especially, do not route MBS analog lines in a way such as to place together with AC power lines or control lines of other equipments in a same conduit, or to bundle them together. It may cause interference to MBS-C operation.

If separated conduits are not possible, keep enough distance between the lines (300mm or more) to avoid the interference.

The Connection with MBD-D includes connection with K-thermocouple cable. Connect the cable between the connector on the K thermocouple and the K Thermo connector on the MBD-D. The procedure is shown in Figure 4-2.



(*2)The dotted lines are to be wired by customers.

(*3) The length of our optional MBD - MBS connection cable is maximum 20meters.

Figure 4-2 MBD-D and MBS Wiring

CAUTION

When routing cables;

In order to prevent mutual interference during operation, signal lines, control lines, and AC power lines should be placed in separate conduits. Especially, do not route MBS analog lines in ways as to place together with AC power lines or control lines of other equipments in a same conduit, or to bundle them together. It may cause interference to MBS-C operation.

In case that separated conduits are not possible, keep enough distance between the lines (300mm or more) to avoid the interference.

✧ Power Connection and Protection

The MBD-D does not have a fuse internally. Make sure to attach fuses or protectors to the cables that connect to power supply terminal.

Recommended: 250VAC 3A / Medium time-delay or time-delay type

When it is necessary to comply with regulations of a country or international standard, use components that meet such requirements. (Refer to IEC60127, IEC60947 or others)

When the power source of 200V is used like as MBD-D, it is recommended to install a varistor near the terminal board as high surge current is likely to be developed.

(*2)Recommended varistor model: Panasonic ERZV20D471

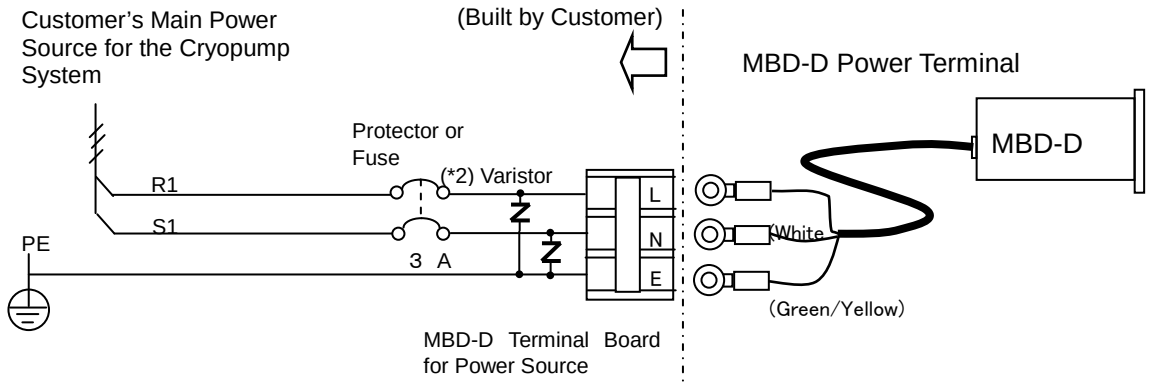


Figure 4-3 MBD-D Power Circuit

5. Operation

5.1 Turn ON MBD-D

Turn ON the power supply of MBD-D. If there is any sign of abnormal behavior and/or hazard on the device, shutdown the branch power supply for MBD-D. Refer to “6. Troubleshooting” and check cable routing. After turning ON the power, check that READY light is illuminated.
If the READY light blinks, the cable of the first-stage (K Thermo) or the second-stage (ANALOG IN) may be disconnected.

5.2 Monitor the Temperature with MBD-D

The MBD-D allows you to monitor the cryopump temperature in an easy and prompt manner by digitally displaying the first and second-stage temperatures of a cryopump.

Figure 5-1 MBD-D Display

5.3 MBD-D Communication Function

The MBD-D can communicate with the C30S compressor unit.
Connect the MBD-D and C30S at RS485 port with C30S cable (optional) to display cryopump temperature on the C30S. The measured temperature data can be recorded with the Data Logging function of the C30S. The COM light blinks in red or green while data transmission is taking place (green while sending, red while receiving the data).
Following settings are needed to use the communication function.

(1) Adjust the Transmission Speed

It is necessary to make the transmission rate consistent with the MBD-D to communicate. The rate can be set with the switch <2> of <Register> on the back of the MBD-D. Turn ON the switch <2> to set the transmission rate at 19200bps. When the switch is OFF, the transmission rate is 9600bps.

(2) Set Terminating Resistor

The last unit of connected MBD-D requires the terminating resistor settings. Turn ON the switch <1> of <Resistor> to activate, and turn it OFF to inactivate the terminating resistor.

(3) Set Address

Press and hold the <SETTING> circle button for longer than 3 seconds to start settings menu. You can change the address of the MBD-D by pressing the triangle button. Digits can be changed by pressing the circle button shortly. After settings are completed, press and hold the circle button for longer than 3 seconds to close the settings menu. Set the same figures to the address as C30S. The allowable figures are from 1 to 250. Note that communication may fail if an address is duplicated among multiple units of MBD-Ds.

5.4 Direct Communication with MBD-D

The procedure to transmit data directly without C30S is as follows.

Direct Communication Settings

From the rear of the MBD-D, connect the pin No.4 of RS485 and D+ (or RX(+) and TX(+)) of RS485 of the desired device, and connect the pin No.5 and D- (or RX(-) and TX(-)). After the connection has been made, check the transmission speed, terminating resistor, and address as described above. Refer to Table 3-1 for connector pin allocation.

After checking them, set the transmission speed consistent at the target device..

Other settings are as follows;

Data Bit : 8 Bit

Stop Bit : 1 Bit

Parity : None

5.5 Modbus Protocol

The MBD-D uses Modbus protocol for communication.

For detailed information on Modbus, visit the web site of Modbus.org.

The Modbus protocol message is composed as follows;

Device Address	Function Code	Data	Error Check (CRC)

- **Device Address**: The address of each MBD-D as a slave. Set different addresses to all the MBD-D units to be connected. If there is another MBD-D with the same address, it may invite communication trouble.

- **Function Code**: This code tells what kind of action to perform. Functions to read and write can be specified.

Function Code	Function	Data Type	Notes
0x03	Continuous reading	16Bit Word	Temperature and conditions
0x10	Continuous	16Bit Word	Parameter

- **Data**: Data differs by function code.
  If continuous reading is selected, the data comprises Register Address of the device where reading starts and the number of Registers to read. If continuous writing is selected, the data comprises Register Address of the device where writing starts, and the number of Registers to write continuously.

- **Error Check (CRC):** Checks the validity of the contents to communicate. IF the device is in communication and is experiencing entanglement or disconnection, such communication is regarded as invalid. The MBD-D performs Error Check following the CRC-16 method. The CRC-16 calculation is as follows;
  The data to send is divided by generator polynominal to work out the remainder.
  generator polynominal : $X^{16}+X^{15}+X^{2}+1$
  For detailed information on CRC calculation, refer to Modbus web site at Modbus.org.

- **Examples of Modbus Communication Protocol**

<Continuous reading (0x indicates hexadecimal) example>

Request message from the master

Address	Function Code	Register Address	Number of Registers	Error Check
0x68	0x03	0x0002	0x0002	0x6CF2
1	1	2	2	2

Byte (8)

Response message from the Slave(MBD-D)

Address	Function Code	Response Byte number	Data	Error Check
0x68	0x03	0x04	0x0B930B81	0x6CF2
1	1	1	4	2

Byte (9)

The above example is of the message of continuous reading of two registers from MBD-D register address of 104(0x68).

<Continuous writing (0x indicates hexadecimal) example>

Request message from the master

Address	Function Code	Register Address	Number of Registers	Data Bytes	Data
0x68	0x10	0x0065	0x0004	0x08	0x0640
1	1	2	2	1	2

Data	Data	Data	Error Check
0x06A4	0x0708	0x076C	0xA122
2	2	2	2

Number of bytes (17)

Reply message from the slave (MBD-D)

Address	Function Code	Register Address	Number of Registers	Error Check
0x68	0x10	0x0065	0x0004	0xD8EC
1	1	2	2	2

Number of bytes (8)

This is the example of continuous writing of four MBD-D register addresses of 104(0x68) starting from 0x0065.

- **Register Information**

Register Address	Description	Read/Write	Note
0x4001	Status Information	Read Only	Refer to the table “Status Information” on the next page.
0x4002	2nd-Stage Temperature (x10)	Read Only	AFC Thermocouple (10K-350K=>100-3500)
0x4003	1st-Stage Temperature (x10)	Read Only	K Thermocouple (45K-350K=>450-3500)
0x4064	2nd Comparative Temperature (x10)	Read/Write	Default : 200 (20K)
0x4065	1st Comparative Temperature (x10)	Read/Write	Default : 900 (90K)
0x4066	1st Comparative Temperature 2(x10)	Read/Write	Default : 1000 (100K)
0x4067	1st Comparative Temperature 3(x10)	Read/Write	Default : 1300 (130K)
0x4068	1st Comparative Temperature 4(x10)	Read/Write	Default : 2930 (293K)

- **Status Information**

Bit	Description	Active
15	(Reserved)	
14	(Reserved)	
13	(Reserved)	
12	(Reserved)	
11	(Reserved)	
10	Abnormal Temperature	1
9	1st-Stage(K Thermocouple) disconnection	1
8	2nd-Stage (AuFe-C) disconnection	1
7	(Reserved)	
6	(Reserved)	
5	1st comparative temperature 4 ≤ 1st measured temperature	1
4	1st comparative temperature 3 < 1st measured temperature < 1st comparative temperature 4	1
3	1st measured temperature ≤ 1st comparative temperature 3	1
2	280K ≤ 2nd measured temperature	1
1	2nd comparative temperature < 2nd measured temperature <280K	1
0	2nd measured temperature ≤ 2nd comparative temperature	1

6. Troubleshooting

Preventive Maintenance and Inspection

Check the following when performing scheduled maintenance.

- The housing or connected cables have no damage.
- No stress or force is added to the cables.
- Cable plugs are fastened tightly.

If any problems have been detected, take appropriate measures or contact us.

Troubleshooting Procedure

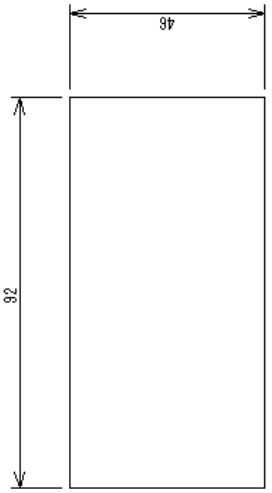
Table 6-1 List of Troubleshooting (1/2)

Problem	Part	Possible Cause	Corrective Action
READY light does not illuminate although the power is turned ON.	Main power Terminal ends Fuse (Inside)	1.Power supply to MBD-D is low or 0V 2. Wiring problem 3. MBD-D failure	Check the voltage of AC power supply for MBD-D. If no problem is observed, check MBD-D power terminal, connection status, (cables supplied by UCI is used), or proper voltage is supplied through the cable. If none of the above problems is detected, MBD-D might have failure. Contact us.
READY light is on, but none of MBS-C light is ON.	DC Power Cable MBD-D POWER OUT	1. Wiring problem 2. MBD-D failure 3. MBS-C failure	Check the connection status or failure of DC power cable (cables supplied by UCI should be used). Also, check the DC voltage from MBD-D POWER OUT is appropriate. If no problem is observed about the items above, MBD-D may have failure. Contact us for replacement of MBD-D or refer to MBS-C instruction manual for further inspection.
READY light is ON, but the temperature display shows nothing.	Signal Cable Inside of MBD-D	1. Wiring trouble 2. MBD-D failure	Check if the signal cable has any damage, or wiring is appropriate. If no problem is observed, MBD-D may have problems. Contact us.

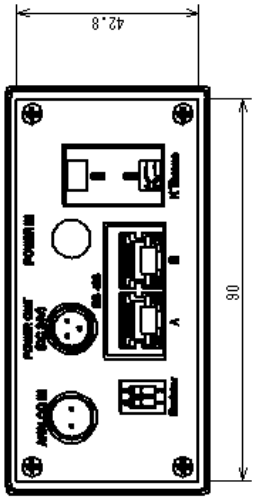
Table 6-2 List of troubleshooting(2/2)

Problem	Part	Possible Cause	Corrective Action
Temperature displayed by MBD-D is not consistent with MBS-C.	Signal cable	1. Wiring problems 2. MBD-D failure 3. MBS-C failure	Check the connection status or problem of the signal cable between MBD-D and MBS-C (supplied by UCI). If no problem is observed, check the voltage at the cable plug, and identify the corresponding temperature in the MBS-C instruction manual. If temperature displayed by the MBD does not match the above temperature, MBD-D may have trouble. Refer to MBS-C instruction manual for further inspection, or contact us.
Temperature display does not change although the cryopump is in operation.	Signal cable	1.Cryopump operation problems 2.Wiring problems 3.MBD-D failure 4.MBS-C failure	Check if the cryopump is operating appropriately. Also, check that the MBS-C display and MBD-D temperature display are consistent. If they are consistent, the problem lies in operation, not in MBD-D. If there is no problem in operation, follow the instruction in the above column.
Temperature display is unstable.	Signal cable DC power cable Power terminal	Cables and cable routing problems (Noise, surge, etc.)	Check the connection status or troubles in the signal cable between MBD-D and MBS-C, and DC power cable (supplied by UCI). If no problem is observed, check the routing of these cables. The cables should not be located near the power supply or drive output lines. Earth conductor of the power line should be kept apart from the MBD-D cables. Keep the MBD-D power terminal from the main power line of the device that switching electricity supply. Refer to the “When wiring” caution, and contact us to solve the problem.
Characters other than numeric figures are shown	Signal cable DC power cable Power terminal	Cables and cable routing problems (Noise, surge, etc.) MBD-D failure	Press and hold the SETTING round button for longer than 3 seconds to check if this transfers to Settings Menu. If the menu does not change, check if the cable routing is appropriate. If no problem is observed, MBD-D may have failure. Please contact us.

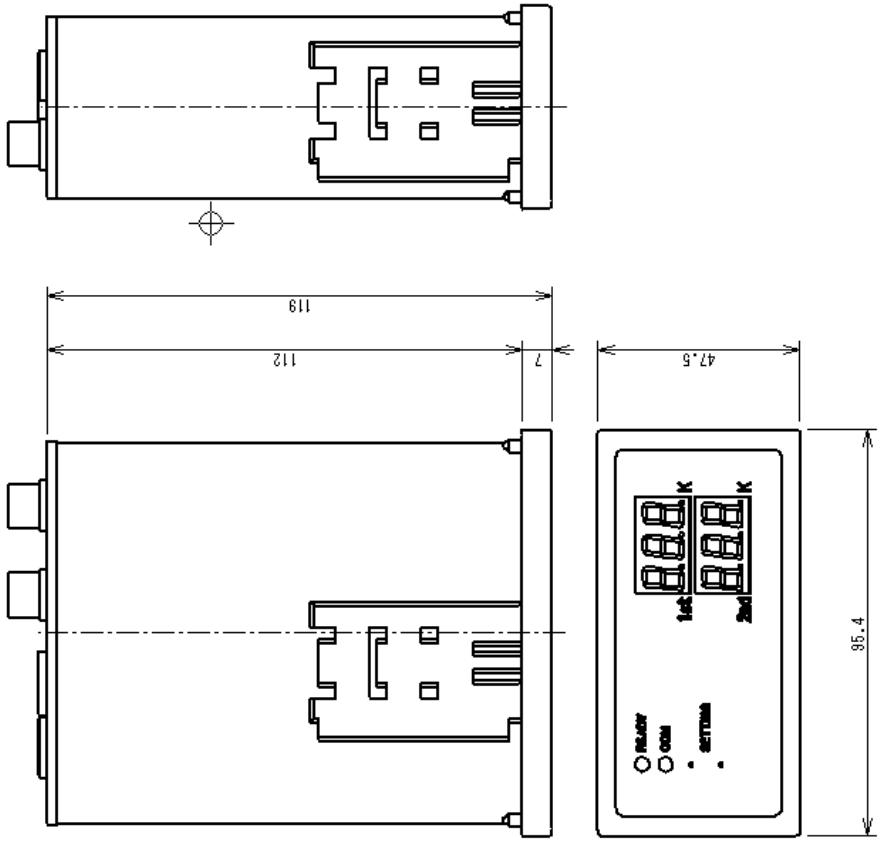
Appendix A Cryo-Meter MBD-D External Dimensions



Panel cutout dimensions



Connector locations



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Revision History

Date	Revision No.	Contents
2018-12-11	2018.12	First edition

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