



Energy Measuring Unit

MODEL

EMU4-FD1-MB

User's Manual (Details)

- Before operating the instrument, you should first read thoroughly this operation manual for safe operation and optimized performance of the product.
Deliver this user's manual to the end user.

Safety precautions

Thank you for purchasing the Energy Measuring Unit.

- This manual describes setup and usage for the Energy Measuring Unit. Before using the product, please read this manual carefully to ensure correct use. Especially, in the case of where this unit is to be installed, please read "1. Precautions for Use" to ensure correct use.
- Make sure that the end users read this manual and then keep the manual in a safe place for future reference.
- Make sure to deliver this manual to the end-user.
- If you are considering using this unit for special purpose such as nuclear power plants, aerospace, medical care or passenger vehicles please refer to our sales representative.(For details, please see at the end of this manual.)

- Notations in this manual

Use the following marks in this manual.

Mark	Meaning of the icons
 Danger	Indicates that incorrect handling may result in death or severe injury, ignoring this marking.
 Caution	Indicates that incorrect handling may result in injury or property damage, ignoring this marking.
 Supplement	Indicates that precautions to avoid a malfunction and to work the unit properly.
	Indicates that the pages described that related matters.

- This unit cannot be used for deal and proof of electric energy measurement stipulated in the measurement law. Please use the certified watt-hour meter to be used for deal and proof of electric energy measurement stipulated.
- When using this unit, make sure to use it in combination with 5A/1A current transformer.

Features

- This Energy Measuring unit can measure various types of electric quantity such as voltage, current, electric power and electric energy.
- The measured data can be sent to the high-end device, such as a monitoring device by MODBUS® RTU communication function.
- This Energy Measuring unit has one external input terminal, which can switch between pulse input and contact input. Production quantity and water, gas, air (other than electricity) can be measured in the pulse input setting. Monitoring of condition and alarm, measurement of operating time and electric energy during operation can be done in the contact input setting.

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1. Precautions for Use

Precautions for Operating Environment and Conditions

- This unit is premised on being used in pollution degree 2* environment. When used in higher pollution degree, protect this unit from pollution on another device side to be incorporated.
- Over voltage category of measuring circuit in this unit is CAT III*, and that of auxiliary power circuit (MA, MB) is CAT III*.
- Do not use this product in the places listed below. Failure to follow the instruction may cause malfunctions and a life decrease of product.
 - Places the Ambient temperature exceeds the range -5 - +55°C.
 - Places the average daily temperature exceeds +35°C.
 - Places the Relative humidity exceeds the range 30-85% or places with dewfall.
 - Vibration and impact exceed the specifications.
 - Dust, corrosive gas, saline and oil smoke exist.
 - Places exposed to direct sunlight.
 - Places exposed to rain or water drop.
 - Places in strong electromagnetic field or places large amounts of external noise exist.
 - Places metal fragments or conductive substance are flying.
 - Altitude exceeds 2000m.

< For prevention of electric shock>

- This unit is designed to be housed within another device for prevention of electric shock. House this unit within the device such as the grounded control panel before use.
- To prevent persons with little knowledge about electric equipment from electric shock, panel must be taken either following measure.
 - Lock the panel so that only those who get an education about electric equipment and have sufficient knowledge can unlock, or shut off power supply automatically by opening the panel.
 - Cover the dangerous part of this unit. (Required protection code is higher than IP2X.)

*: For the definition of the pollution degree and the over voltage category, refer to EN61010-1/2010.

Matters concerning the precaution before use

- Use the unit in the specified usage environment and conditions.
- The setting of this unit (phase system, primary voltage, primary current) is necessary before use it.

Installation and Wiring Precautions

Make sure to read this manual carefully before Installation and Wiring.

⚠ Caution

<Precautions for Electric work>

- Any person who is involved in the installation and the wiring of this unit should be fully competent to do this work.
- Work under the electric outage condition when installing and wiring. Failure to do so may cause electric shock, a failure of the unit, a fire etc.
- When tapping or wiring, take care not to entering any foreign objects such as chips and wire pieces into this unit.
- Check the connection diagram when wiring. Wrong wiring may cause failure of the unit, a fire or electric shock.
- For protection against noise, transmission lines and input/output lines shall not be placed close to or bound together with the power lines and high-voltage lines.
- The wires to be connected to this unit shall be placed in a duct or fixed together by cramping. If the electric wires are not placed in the duct or crimped together, loosen wires or their movement or careless stretch may cause a breakage of the unit or wire or a malfunction due to poor contact of electric wires.
- If transmission lines and input/output lines are placed close to or bound together with the power lines and high-voltage lines, keep distance as below between them.

Condition	Distance
Power line 600V or less	300mm or longer
Other power line	600mm or longer

<Connection of terminal block>

- Strip the wires with proper length. Overlong stripping length may cause short to next wire. Shorter stripping length may cause contact failure.
- Take care not to short to next terminal by a filament. (Do not plate the wires with solder.)
- Do not connect three or more wires to one terminal of a terminal block for preventing loose contact and wires dropout.
- Use appropriate size of electric wires. If inappropriate size of electric wire is used, it may cause a fire due to generated heat.
- Circuits connected to an auxiliary power circuit (MA, MB) need to be used the over current protection device (fuse, circuit breaker, etc.) to prevent shorting connecting wires. (Select an appropriate rating to prevent burnout of the wires.)
- Tighten the screw within the specified torque. Over tightening can damage the screw and/or terminal.
- After tightening the screws, be sure to check all the screws tightened. Loose screw may cause malfunction of the unit, a fire or electric shock.
- Be sure to attach the terminal cover to prevent electric shock.
- Do not directly touch any conductive part of the unit. Doing so can cause electric shock, failure or malfunction of the unit.
- If the wires connected to this unit are strongly pulled off, it may cause a malfunction or a breakage to the unit or the wire.

<Connection of frame GND terminal>

- Do not exceed the specified voltage when doing an insulation resistance test and a commercial frequency withstand voltage test. Do not connect to frame GND terminal during the insulation resistance test and pressure test.
- Use the crimp-type terminal appropriated for the size of electric wires. If inappropriate crimp-type terminal is used, a wire breakage or a contact failure may occur, which may cause a device malfunction, a failure, a burnout or a fire.
- Frame GND terminal must be grounded according to the D-type ground (ground resistance is not exceed 100Ω).

Precautions for Use

- **This unit cannot be used for deal and proof of electric energy measurement stipulated in the measurement law.**
- Before operating the product, check that active bare wire and so on does not exist around the product. If any bare wire exists, stop the operation immediately, and take an appropriate action such as isolation protection.
- In the event of a power outage during the setting, the unit is not set correctly. Please set again after power recovery.

 **Danger**

- Do not touch the live part. It may cause electric shock, electric burn injury or damage of the device.
- Work under the electric outage condition when installing and wiring.

 **Caution**

- Do not disassemble or modify this unit. It may cause failure, malfunction, injury or fire.
- Use this unit within the ratings specified in this manual. If it is used outside the ratings, it may cause not only malfunction or failure but also fire burnout.
- When using this product, make sure to use it in combination with 5A current transformer(max 30V AC).
- Do not open the secondary side of the CT circuit. If the CT is not connected properly or if the secondary side of the CT is open, it may result in high voltage on the secondary side of the CT, the insulation of the secondary winding wire may be damaged, and burnout may be caused.

Maintenance Precautions

- Use a soft dry cloth to clean off dirt of the unit surface. Do not let a chemical cloth remain on the surface for an extended period of time nor wipe the surface with thinner or benzene.
- Check for the following items to use this unit properly for long time.
 - (1) Daily maintenance
 - (a) No damage on this unit
 - (b) No abnormality with LCD indicators
 - (c) No abnormal noise, smell or heat
 - (2) Periodical maintenance (Once every 6 months to 1 year)
 - No looseness with installation and wire connection

 **Caution**

Do periodical maintenance under the electric outage condition. Failure to do so may cause electric shock, failure of the unit or a fire. Tighten the terminal regularly to prevent a fire.

Storage Precautions

- To store this unit, turn off the power and remove wires, and put it in a plastic bag.
- For long-time storage, avoid the following places. Failure to follow the instruction may cause a failure and reduced life of the unit.
 - Places the Ambient temperature exceeds the range -10 - +60°C.
 - Places the average daily temperature exceeds +35°C.
 - Places the Relative humidity exceeds the range 30-85% or places with dewfall.
 - Vibration and impact exceed the specifications.
 - Dust, corrosive gas, saline and oil smoke exist.
 - Places metal fragments or conductive substance are flying.
 - Places exposed to rain, water drop or direct sunlight.

Disposal Precautions

When disposing of this unit, treat it as industrial waste.

About packaging materials and this manual

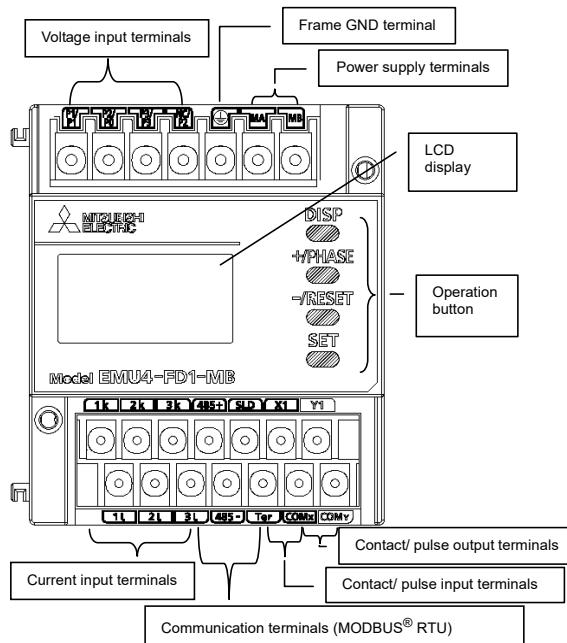
For reduction of environment load, packaging materials are produced with cardboard, and this manual is printed on recycled paper.

2. Disclaimer

- It is prohibited to reprint or copy all contents of this document in any form without our permission.
- The contents of this document will be updated to follow revisions to software and hardware, however under unavoidable circumstances it may not be synchronized.

3. Name and function of each part

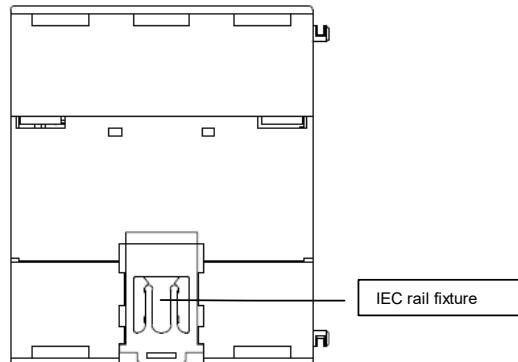
- Name of each part



Sign and function of the terminal block

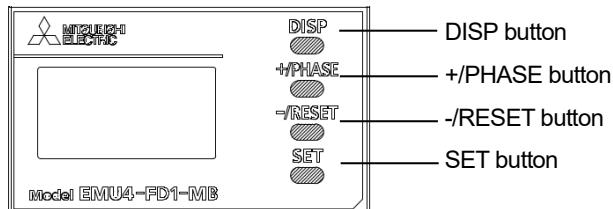
Terminal symbols	Function	Description
P1/P1, P2/P0, P3/P3, NC/P2	Input voltage	Connect the voltage input wire of the measuring circuit.
⊕	Frame GND (FG)	Connect to ground. (D-type ground)
MA, MB	Auxiliary power	Connect the auxiliary power supply.
1k, 1L, 2k, 2L, 3k, 3L	Input current	Connect the secondary output of the current transformer (CT) connected to the measurement circuit's current wire.
485+, 485-	MODBUS® communication	Connect the communication wire (MODBUS® RTU).
SLD		Connect to ground. (D-type ground)
Ter		Connect with "485-" terminals (the unit at end of the link) page 13
X1, COMx	Pulse input/contact input	Connect pulse input/contact input wires.
Y1, COMy	Pulse output/contact output	Connect pulse output/contact output wires.

- Back view



• Function of operation buttons

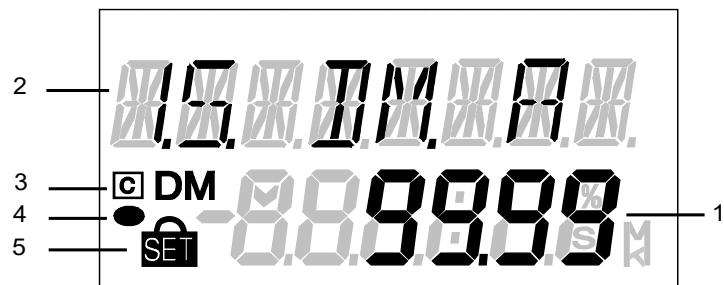
Control buttons have many functions as below. (How to change mode  page 15.)



Meaning of symbol: ○ (Press), □ (Press more than 1 sec), ○ (Press more than 2 sec), — (Press both at the same time)

Mode	Operation				Function
	SET	-/RESET	+/PHASE	DISP	
Operating Mode				○	Change measured items
			○		Change phase
		○			Change harmonic order (at harmonic display)
		○			Clear alarm (at alarm keeping)
	○				Transition to confirmation mode
	○	—	○		Transition to setting mode
	Contact display	○			Clear contact latch
	Integrated value display	—	○		Transition to preset display
		—	—	○	Transition to reset display of all data
Setting mode / Confirmation mode	Menu display	○			Enter setting menu
		○ (□)	○ (□)		Moving up or down of menu number (Move at fast speed when pressing more than 1sec)
	Setting mode / Setting display	○			Change of setting items (forward) Transition to setting menu number (at final setting item)
		○ (□)	○ (□)		Moving up or down of setting value (Move at fast speed when pressing more than 1sec)
				○	Change setting items (backward) Transition to setting menu number (at beginning setting item)
		□			Go back to setting menu
	Confirmation mode / Setting display	○			Change setting items (forward) Transition to setting menu number (at final setting item)
				○	Change setting items (backward) Transition to setting menu number (at beginning setting item)
		□			Transition to setting menu
	Confirmation display of setting reflection	○			At "END" display, memorize changed setting and transition to operating mode At "CANCEL" display, annul changed setting and transition to operating mode
		○	○		Moving up or down of setting value
		—	—	○	Reset setting values to factory default (only effective at CANCEL display)

• Functions of LCD



No.	Indicator	Description
1	Measured value	Display measured value digitally.
2	Measured item	Display measured item displayed on indicator 1.
3	Communication	Light when connecting communication unit.
4	Energy Measurement	Light when measuring electric energy
5	Setting	Indicator  lights on setting mode. Indicator  lights on confirmation mode.

4. Attaching and removing the unit

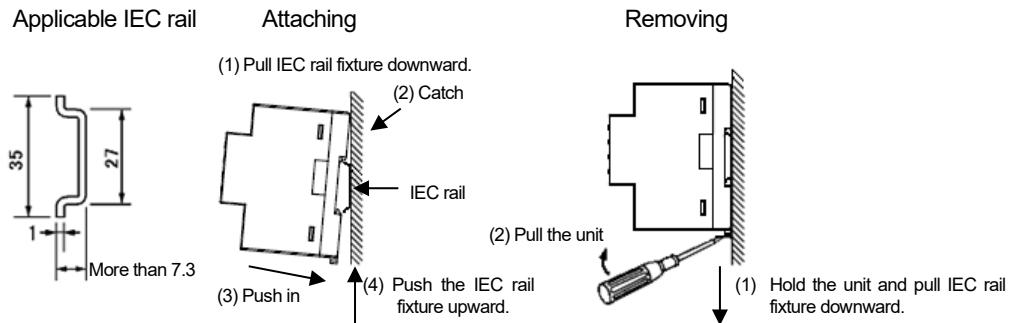
Caution

Any person who is involved in the installation and the wiring of this unit should be fully competent to do this work.

There are two installation methods, surface mounting and panel mounting

· Surface mounting

(1) How to attach to the IEC rail

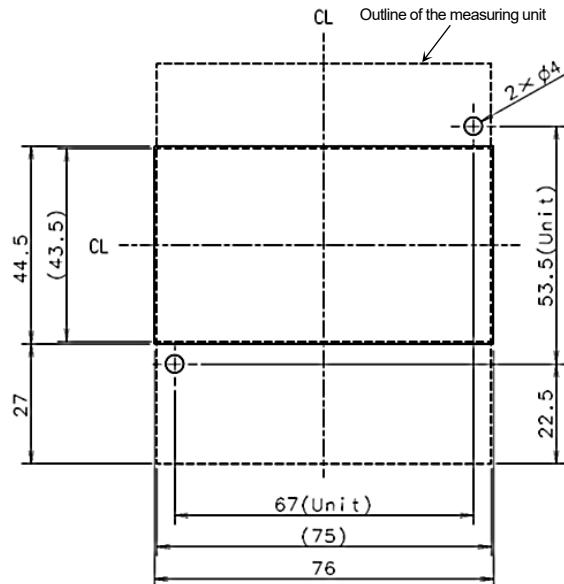


*1: When showing the display part by cutting the panel face in mounting the IEC rail, cut the panel at where it is more than 50mm away from the fulcrum of the open/close of the door.

· Plate mounting

(1) Screw mounting (Measuring unit)

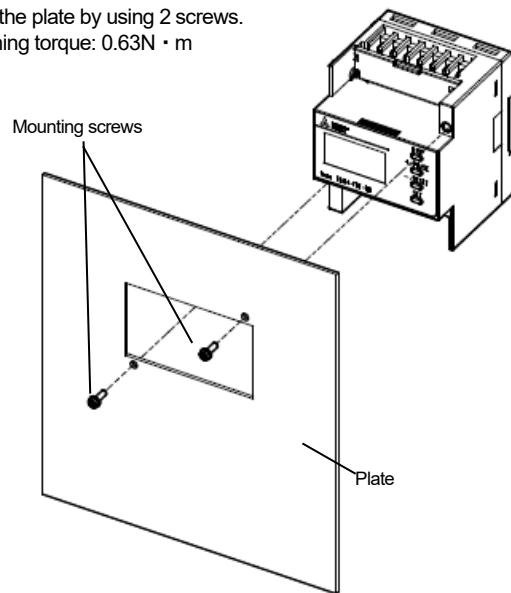
Dimensions of hole panel(76×44.5)



Attaching

Attach the plate by using 2 screws.

Tightening torque: 0.63N · m



Recommended screws

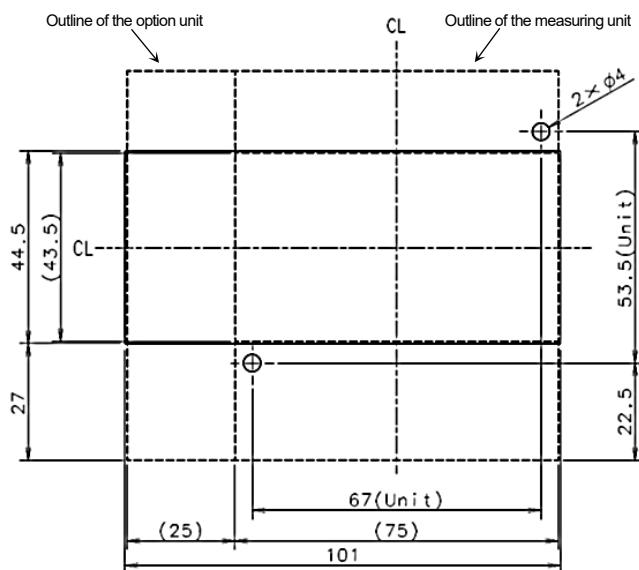
cross recessed head screw with captive washer and flat washer
M3×10 2pcs

*Panel cut dimensions are made larger than the product considering tolerance in panel cut.

If you want to prevent dust and other intrusion the gap of panel cut, cut the panel according to the product to be mounted.

(2) Screw mounting (Measuring unit + optional unit)

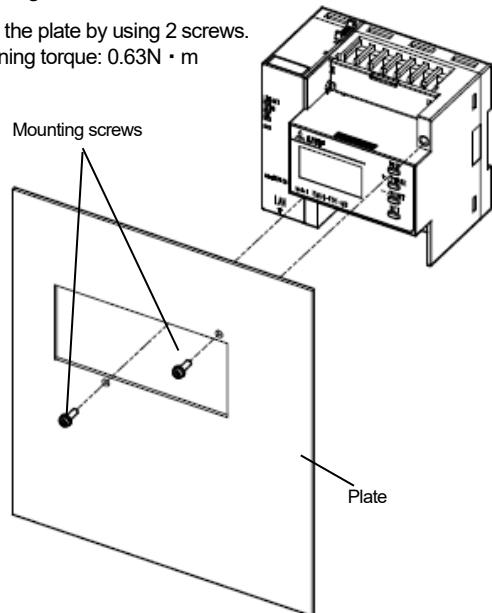
Dimensions of hole panel(101×44.5)



Attaching

Attach the plate by using 2 screws.

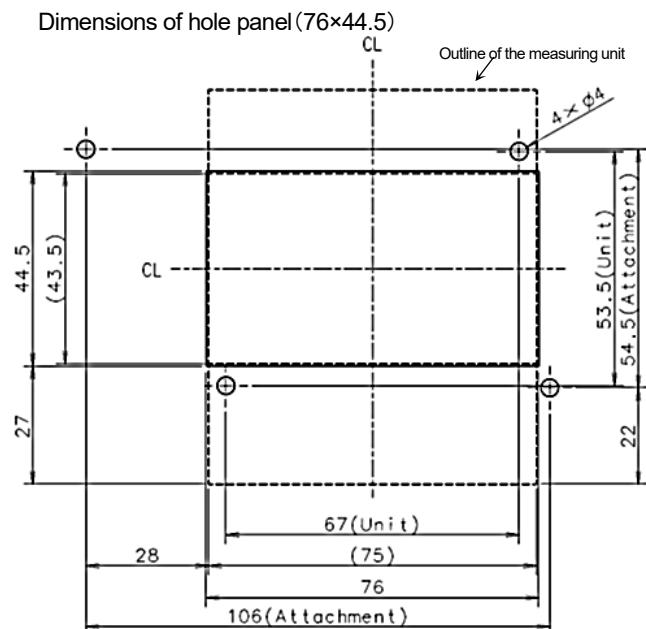
Tightening torque: 0.63N · m



*Panel cut dimensions are made larger than the product considering tolerance in panel cut.

If you want to prevent dust and other intrusion the gap of panel cut, cut the panel according to the product to be mounted.

(3) Screw mounting (When using the measuring unit and the attachment for panel mounting)



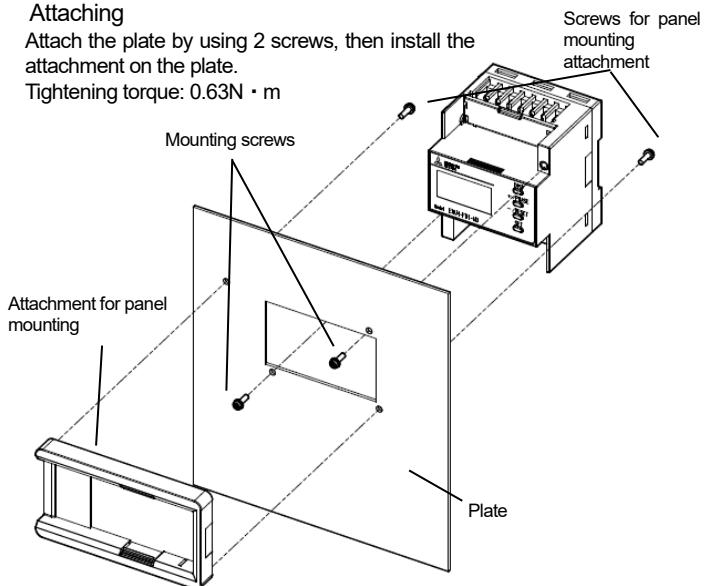
*Panel cut dimensions are made larger than the product considering tolerance in panel cut.

If you want to prevent dust and other intrusion the gap of panel cut, cut the panel according to the product to be mounted.

Attaching

Attach the plate by using 2 screws, then install the attachment on the plate.

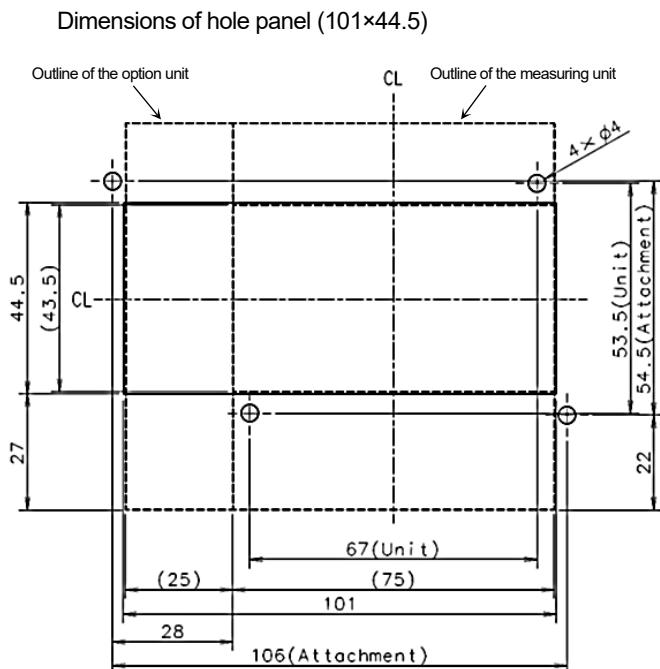
Tightening torque: 0.63N · m



*Please screw up the panel mounting attachment where there are high levels of vibration.

*The screws (mounting screws and screws for panel mounting attachment) are supplied with panel mounting attachment.

(4) Screw mounting (Measuring unit + optional unit, when using the attachment for panel mounting)



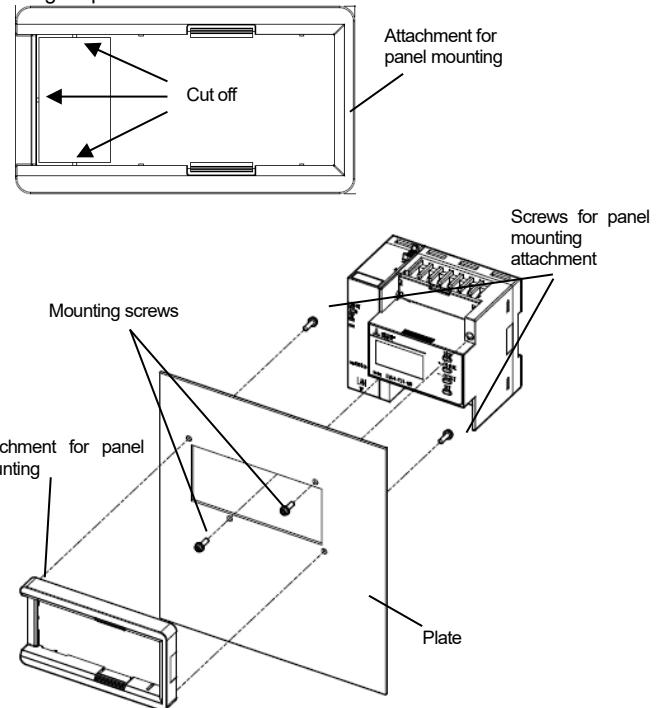
*Panel cut dimensions are made larger than the product considering tolerance in panel cut.

If you want to prevent dust and other intrusion the gap of panel cut, cut the panel according to the product to be mounted.

Attaching

Attach the plate by using 2 screws, then install the attachment on the plate (Use the attachment to cut the three points as below).

Tightening torque: 0.63N · m



*Please screw up the panel mounting attachment where there are high levels of vibration.

*The screws (mounting screws and screws for panel mounting attachment) are supplied with panel mounting attachment.

5. Procedure for wiring

Wiring for EMU4-FD1-MB

Rating voltage for every phase wire system

Phase wire type	Type	Rating voltage	Figure
3-phase 4-wire type	STAR	max AC277V(L-N)/480V(L-L)	Figure 1
3-phase 3-wire type	DELTA	max AC220V(L-L)	Figure 2
	STAR	max AC440V(L-L)	Figure 3
1-phase 3-wire type	—	max AC110V(L-N)/220V(L-L)	Figure 4
	DELTA	max AC220V(L-L)	Figure 5
1-phase 2-wire type (Note)		max AC440V(L-L)	Figure 6

Note. In case of a circuit which is wired from the delta connection of a 3-phase 3-wire type, a circuit of a transformer of a 1-phase 2-wire type or a 1-phase 3-wire type, the maximum rating is "AC220V".

In case of a circuit which is wired from a 3-phase 4-wire type or the star connection of a 3-phase 3-wire type, the maximum rating is "AC440V".

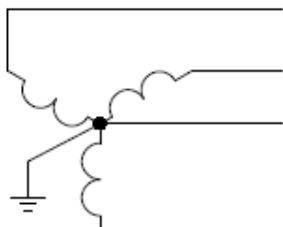


Figure1. 3-PHASE 4-WIRE(STAR)

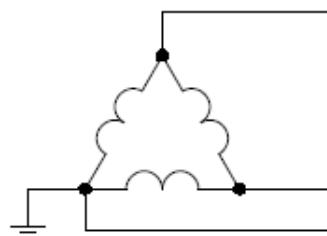


Figure2. 3-PHASE 3-WIRE(DELTA)

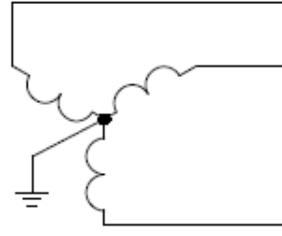


Figure3. 3-PHASE 3-WIRE(STAR)

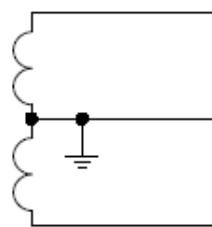


Figure4. 1-PHASE 3-WIRE

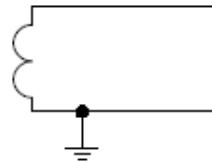
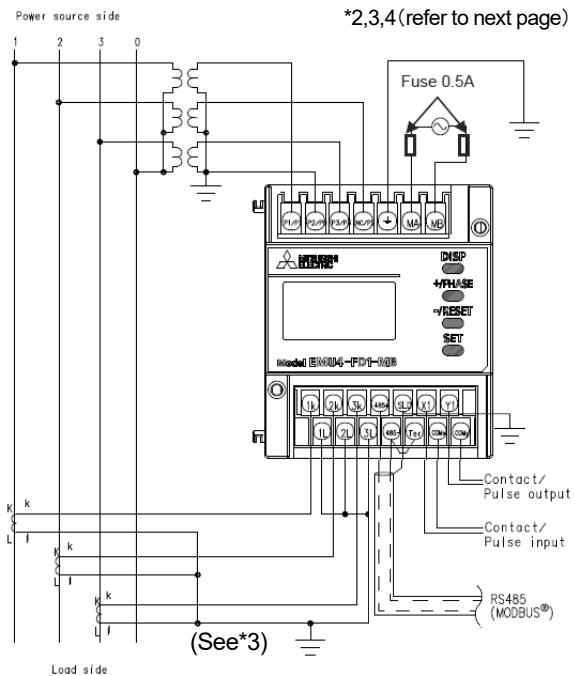


Figure5. 1-PHASE 2-WIRE(DELTA)

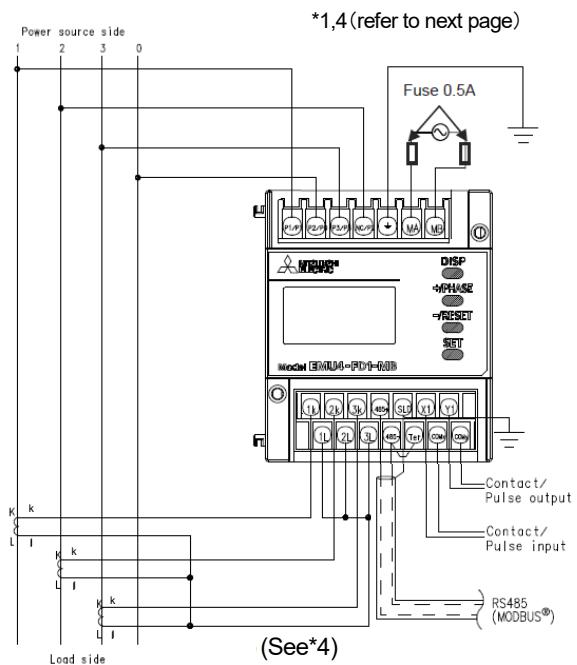


Figure6. 1-PHASE 2-WIRE(STAR)

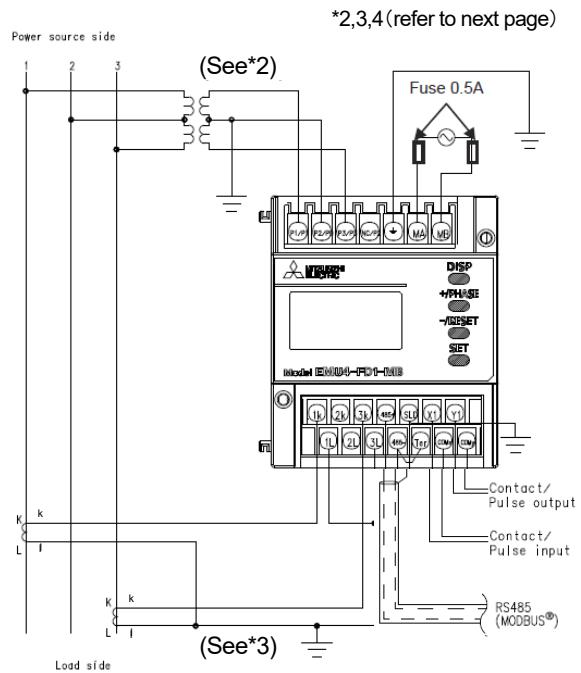
3-phase 4-wire(in combination with VT)



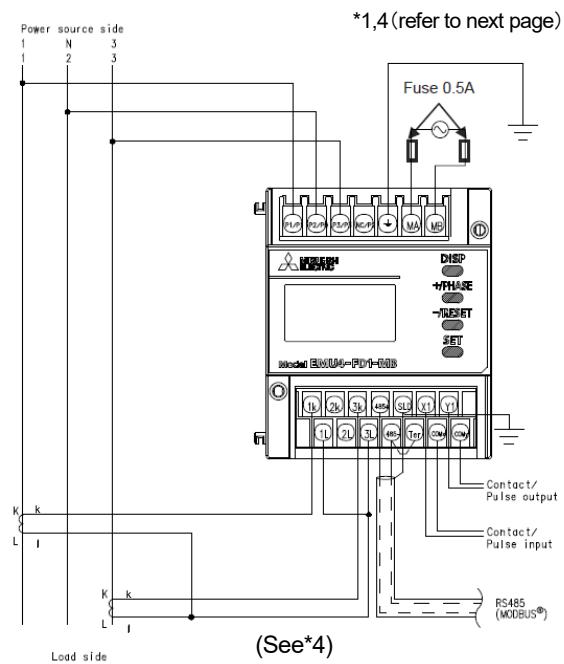
3-phase 4-wire(for lowvoltage circuit)



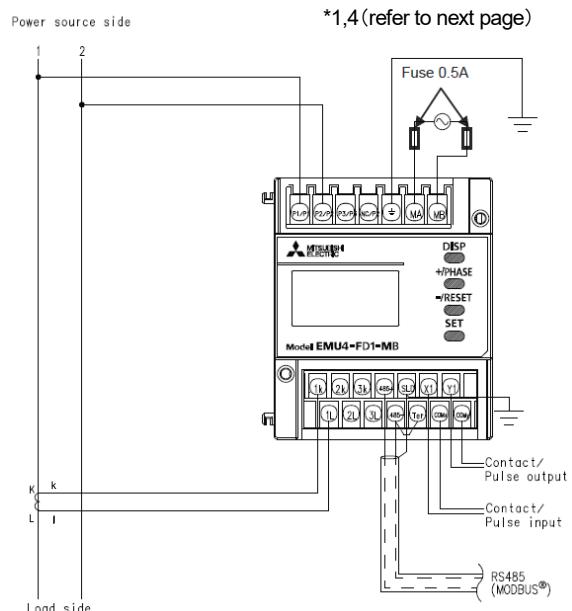
3-phase 3-wire(for high voltage circuit)



1-phase 3-wire / 3-phase 3-wire(for low voltage circuit)

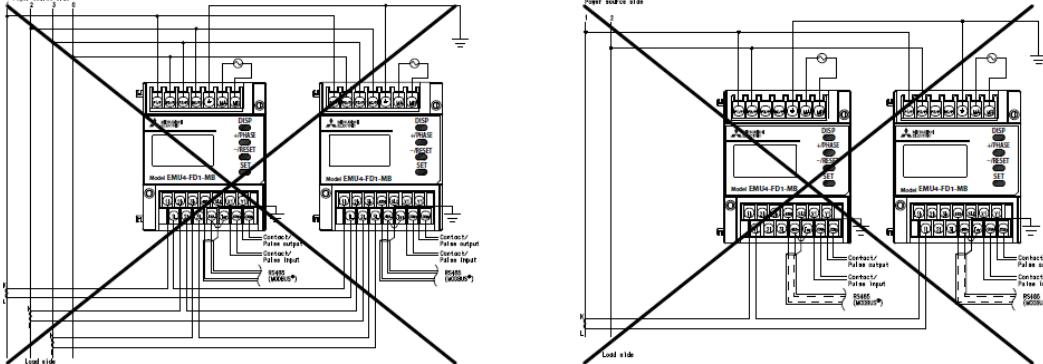
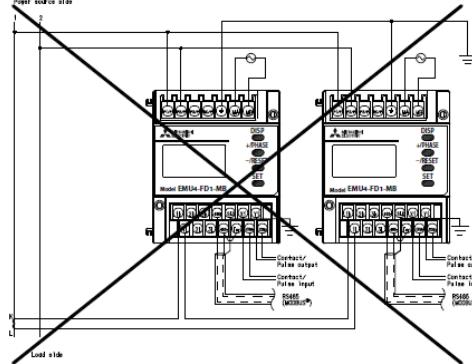


1-phase 2-wire(for lowvoltage circuit)



* Fuse is required to conform to UL.

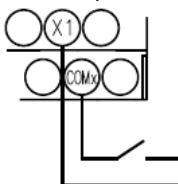
Note 1: For low voltage circuits, do not connect to grounding the secondary side of VT and CT.

<p>Caution</p>	<ul style="list-style-type: none"> *1 For low voltage circuits, do not connect to grounding the secondary side of VT and CT. *2 When this unit is used at a high voltage circuit, the terminal P0 (P2) must be connected to ground. *3 When grounding a CT line, please make the L side of the CT a common line and connect 1L,2L,3L terminal for the unit side by the shortest course. *4 When connecting the L side of the CT by a common line, please connect 1L, 2L, 3L terminal for the unit side by the shortest course. ▪ For protection against noise, transmission lines and input/output lines shall not be placed close to or bound together with the power lines and high-voltage lines. Keep distance as below between them. (except for the terminal block) 															
	<table border="1"> <tr> <td>Condition</td><td>distance</td></tr> <tr> <td>Power line 600V or less</td><td>300mm or longer</td></tr> <tr> <td>Other power line</td><td>600mm or longer</td></tr> </table>	Condition	distance	Power line 600V or less	300mm or longer	Other power line	600mm or longer									
Condition	distance															
Power line 600V or less	300mm or longer															
Other power line	600mm or longer															
<ul style="list-style-type: none"> ▪ For the actual usage, connect the FG terminal to ground. (D-type ground: Type 3) Connect it directly to the ground terminal. 																
<p>This is being bonded to the conductive part of the product for safety reasons and being connected to the terminal which is connected the outside protection grounding system.</p>																
<ul style="list-style-type: none"> ▪ Do not connect to FG terminal during the insulation resistance test and pressure test. ▪ Do not connect together more than one EMU4-FD1-MB on the secondary side of a current transformer. ▪ Do not connect together other units and EMU4-FD1-MB on the secondary side of a current transformer. 																
																
																
<ul style="list-style-type: none"> ▪ Use appropriate crimp-type terminal. Appropriate crimp-type terminal is as below. 																
<ul style="list-style-type: none"> ▪ Use electric wires as below, and tighten the terminal screws by the torque as below. 																
<table border="1"> <thead> <tr> <th></th><th>Applicable wire</th><th>Tightening torque</th><th>Recommended crimp-type terminal</th></tr> </thead> <tbody> <tr> <td>Auxiliary power, voltage input terminals</td><td>stranded wire: AWG26-14(0.13~2.0mm²) single wire : AWG26-14(Φ 0.41~1.62mm)</td><td>0.8~1.0N·m</td><td>For M3.5 screw of external diameter below 5.6mm</td></tr> <tr> <td>Current input terminals</td><td>stranded wire: AWG18-14(0.82~2.0mm²) *5 single wire : AWG18-14(Φ 1.03~1.62mm)</td><td>0.5~0.6N·m</td><td>For M3 screw of external diameter below 5.6mm</td></tr> <tr> <td>Input and output terminals</td><td>stranded wire : AWG22-14(0.33~2.0mm²) single wire : AWG22-14(Φ 0.65~1.62mm)</td><td>0.5~0.6N·m</td><td>For M3 screw of external diameter below 5.6mm</td></tr> </tbody> </table>		Applicable wire	Tightening torque	Recommended crimp-type terminal	Auxiliary power, voltage input terminals	stranded wire: AWG26-14(0.13~2.0mm ²) single wire : AWG26-14(Φ 0.41~1.62mm)	0.8~1.0N·m	For M3.5 screw of external diameter below 5.6mm	Current input terminals	stranded wire: AWG18-14(0.82~2.0mm ²) *5 single wire : AWG18-14(Φ 1.03~1.62mm)	0.5~0.6N·m	For M3 screw of external diameter below 5.6mm	Input and output terminals	stranded wire : AWG22-14(0.33~2.0mm ²) single wire : AWG22-14(Φ 0.65~1.62mm)	0.5~0.6N·m	For M3 screw of external diameter below 5.6mm
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Auxiliary power, voltage input terminals	stranded wire: AWG26-14(0.13~2.0mm ²) single wire : AWG26-14(Φ 0.41~1.62mm)	0.8~1.0N·m	For M3.5 screw of external diameter below 5.6mm													
Current input terminals	stranded wire: AWG18-14(0.82~2.0mm ²) *5 single wire : AWG18-14(Φ 1.03~1.62mm)	0.5~0.6N·m	For M3 screw of external diameter below 5.6mm													
Input and output terminals	stranded wire : AWG22-14(0.33~2.0mm ²) single wire : AWG22-14(Φ 0.65~1.62mm)	0.5~0.6N·m	For M3 screw of external diameter below 5.6mm													

*5: If the diameter of the wire is small, the conductor resistance of the wire will be high and the consumption VA of the wire will increase. Decide wire diameter and wire length so that it does not exceed the rated burden of CT to be connected.

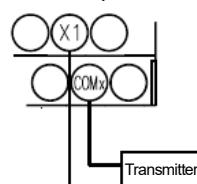
- Maximum voltage of the circuit connected to this unit directly is 277 / 480V. For the circuit over this voltage, use the transformer. Using the transformer, primary voltage is configurable up to 6600V. (Primary voltage of VT can be set up to 6600V, and secondary voltage of VT can be set up to 220V as optional setting.)
- For MODBUS®RTU communication wiring, recommended to have the extra length wires about 200mm (When extended to B / NET transmission from MODBUS® communication, use of MODBUS®RTU communication wiring is possible).
- When screwing the terminals at both ends of the terminal block, be careful not to touch the projection of the terminal block cover.
- In case using external input and/or external output, refer to the following.

External input: For the case of contact input



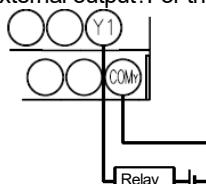
No-voltage a-contact
Use an appropriate type for
5V DC 7mA switching.

External input: For the case of pulse input



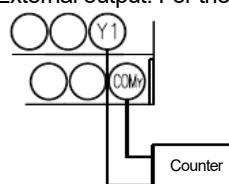
No-voltage a-contact
Use an appropriate type for
5V DC 7mA switching.

External output: For the case of contact output

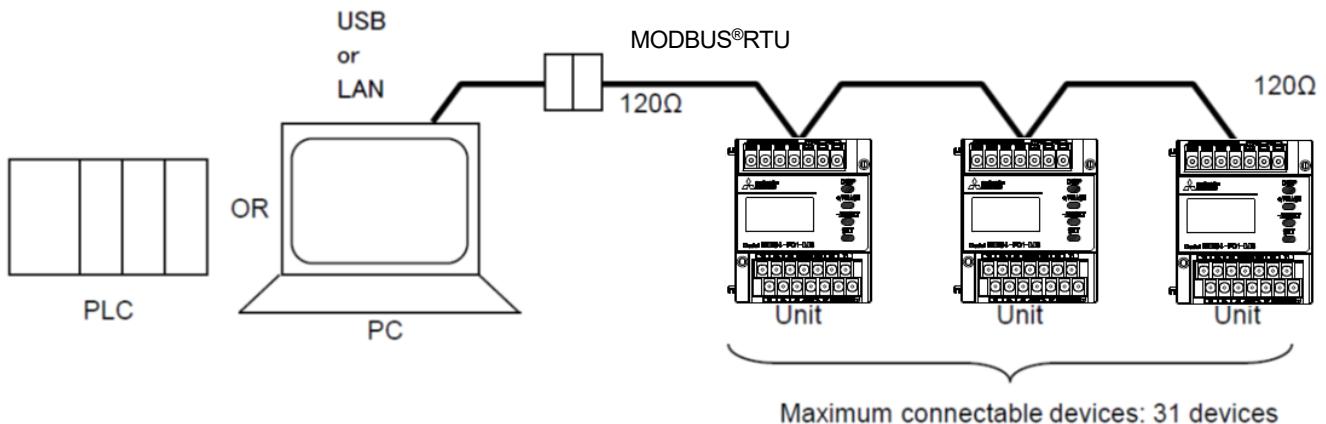


No-voltage a-contact
35V DC 75mA or,
24V AC 75mA (power factor : 1)

External output: For the case of pulse output



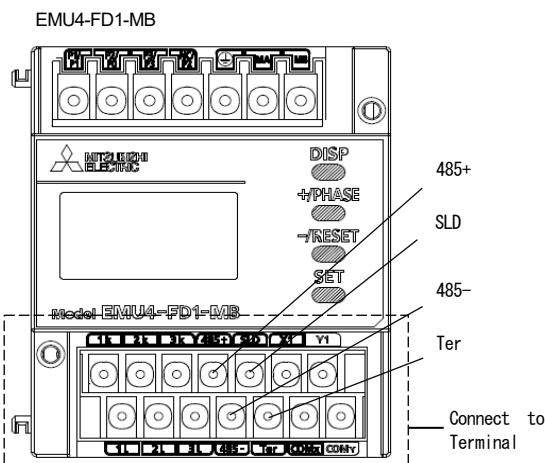
No-voltage a-contact
35V DC 75mA or,
24V AC 75mA (power factor : 1)



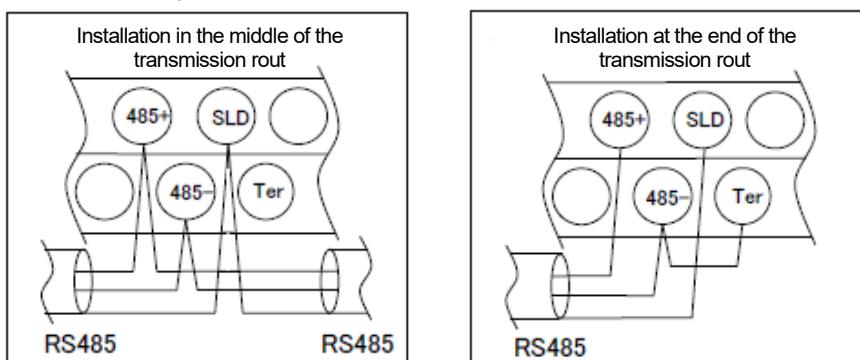
• Connection of MODBUS®RTU communication terminals:

1. Use the twisted shielded pair cable for transmission lines.(Recommended cable  page 66.)
2. About the terminal resistance of the MODBUS®RTU transmission line
 - Please get terminal resistance of 120Ω to the apparatus of transmission line both ends.
(Termination resistances of 120Ω can be used by short-circuiting "485+" and "Ter" terminals.)
 - When you are connected to the PLC on transmission line one, please get terminal resistance of 110Ω in the PLC side.
(Please refer to  Page14, "-Wiring for MODBUS®UNIT(QJ71MB91) and EMU4-FD1-MB " for the details.)
 - When you are connected to the GOT on transmission line one, please get terminal resistance of 110Ω in the GOT side.
(Please refer to  Page14, "-Wiring for GOT(GOT1000) and EMU4-FD1-MB " for the details.)
3. Connect to ground by using thick wires to decrease impedance.
4. MODBUS®RTU transmission lines shall not be placed close to or bound together with the high-voltage lines.
5. Ground the "SLD" terminal at one end.

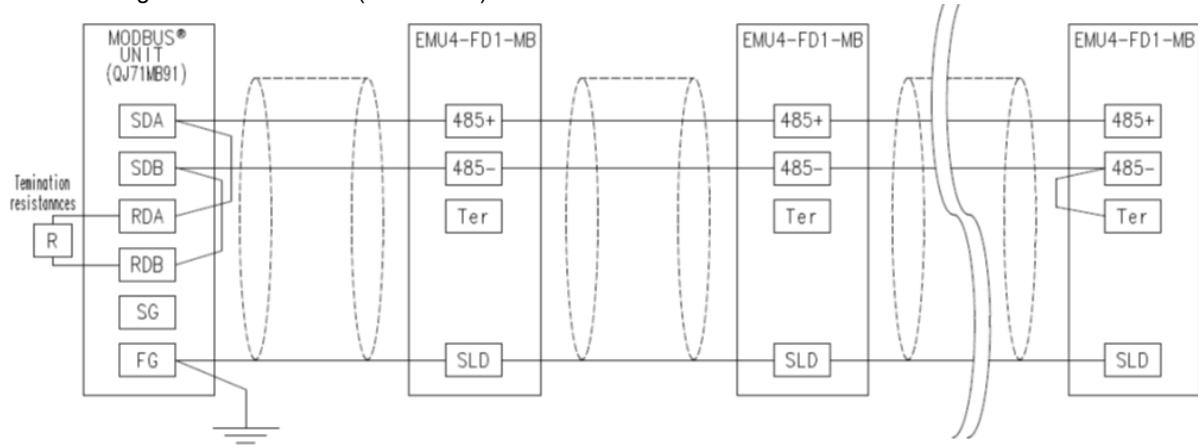
• wiring terminal



• Procedure for wiring



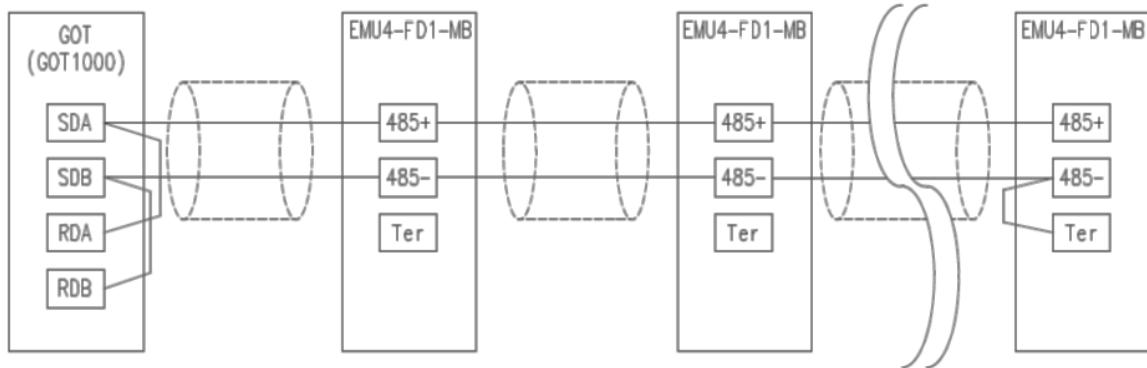
•Wiring for MODBUS®UNIT(QJ71MB91) and EMU4-FD1-MB



Note) The terminal resistance of the MODBUS® unit (QJ71MB91) side, please connect "110Ω 1/2W".

For details, please refer to "Mitsubishi frequent use sequencer MELSEC-Q Series (QJ71MB91) MODBUS®interface unit (details)."

•Wiring for GOT(GOT1000) and EMU4-FD1-MB



Note) Please set the terminal resistance of the GOT(GOT1000) "110 Ω".

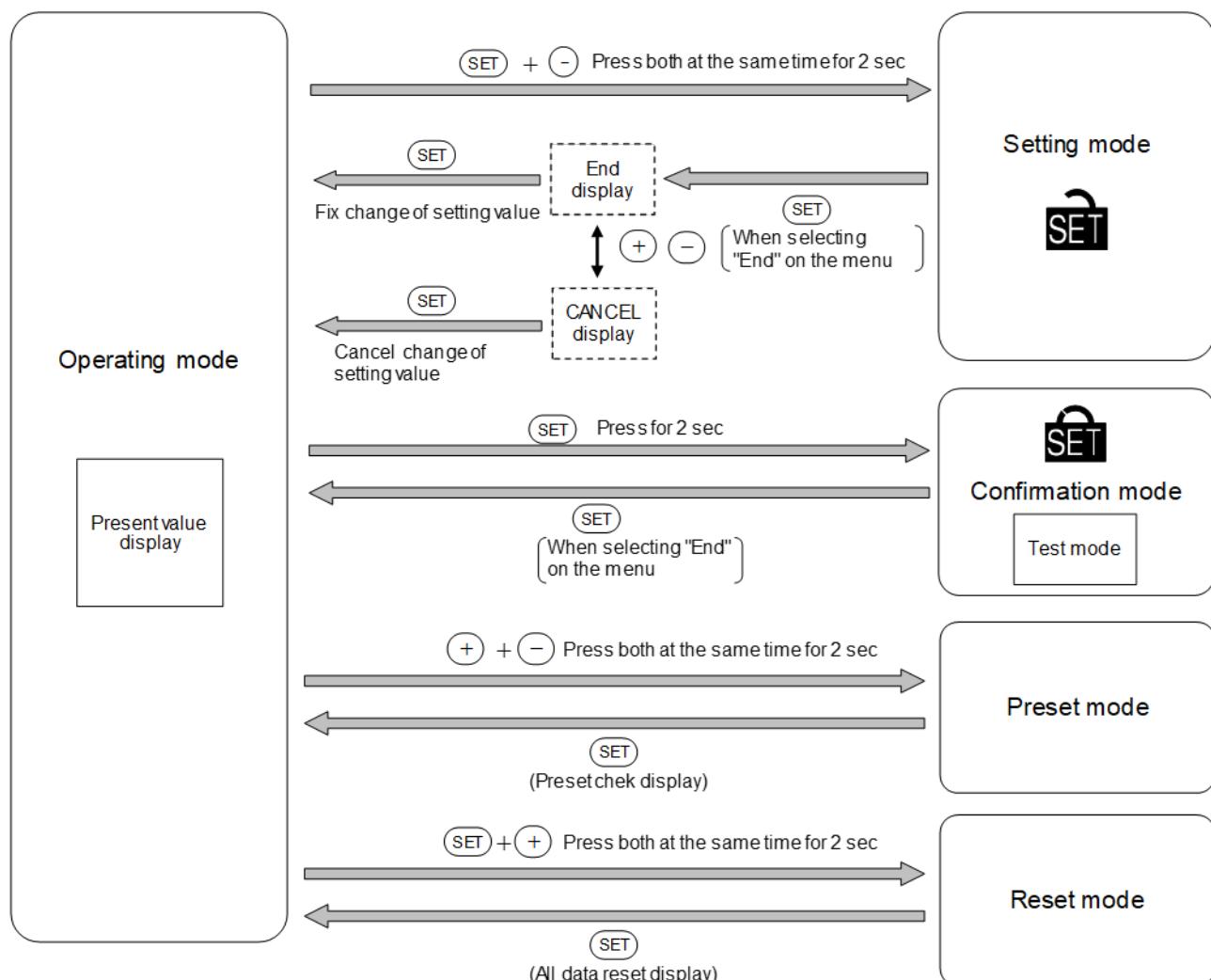
Please refer to " GOT1000 Series Connection Manual (Microcomputer, MODBUS Products, Peripherals) for GT Works3".

6. Operating mode

This unit has the operating modes. Switch these modes according to the purposes. The operating mode is displayed immediately after the auxiliary power loading.

Mode	Function	Reference
Operating mode	Display measured value digitally. It can display the condition of contact input and present time (*1) other than the present value of the measured values.	☞ page 49
Setting mode	Set basic setting for phase wire method, primary voltage, primary current and alarm monitoring for alarm output elements.	☞ page 16
Confirmation mode (Test mode)	Mode to confirm the setting value for each setting item. (The Setting cannot be changed in this mode, so it can be prevented setting change by human error.) In addition, this unit has the test function that can be used for such as set up of an equipment. - Discrimination support display for incorrect wiring: Display useful to discriminate for incorrect wiring such as phase angle display of voltage, current. - Pulse, Alarm test: Switch pulse output contact and alarm contact without measurement (voltage and current) input. - Communication test: Send back fixed numerical data without measurement (voltage and current) input.	☞ page 30 ☞ page 34
Reset mode / Preset mode	Reset: Integrated values (electric energy, operating time, etc.) can be zeroed. Preset: Preset of electric energy and reactive energy.	☞ page 56

*1: Only when connecting logging unit.



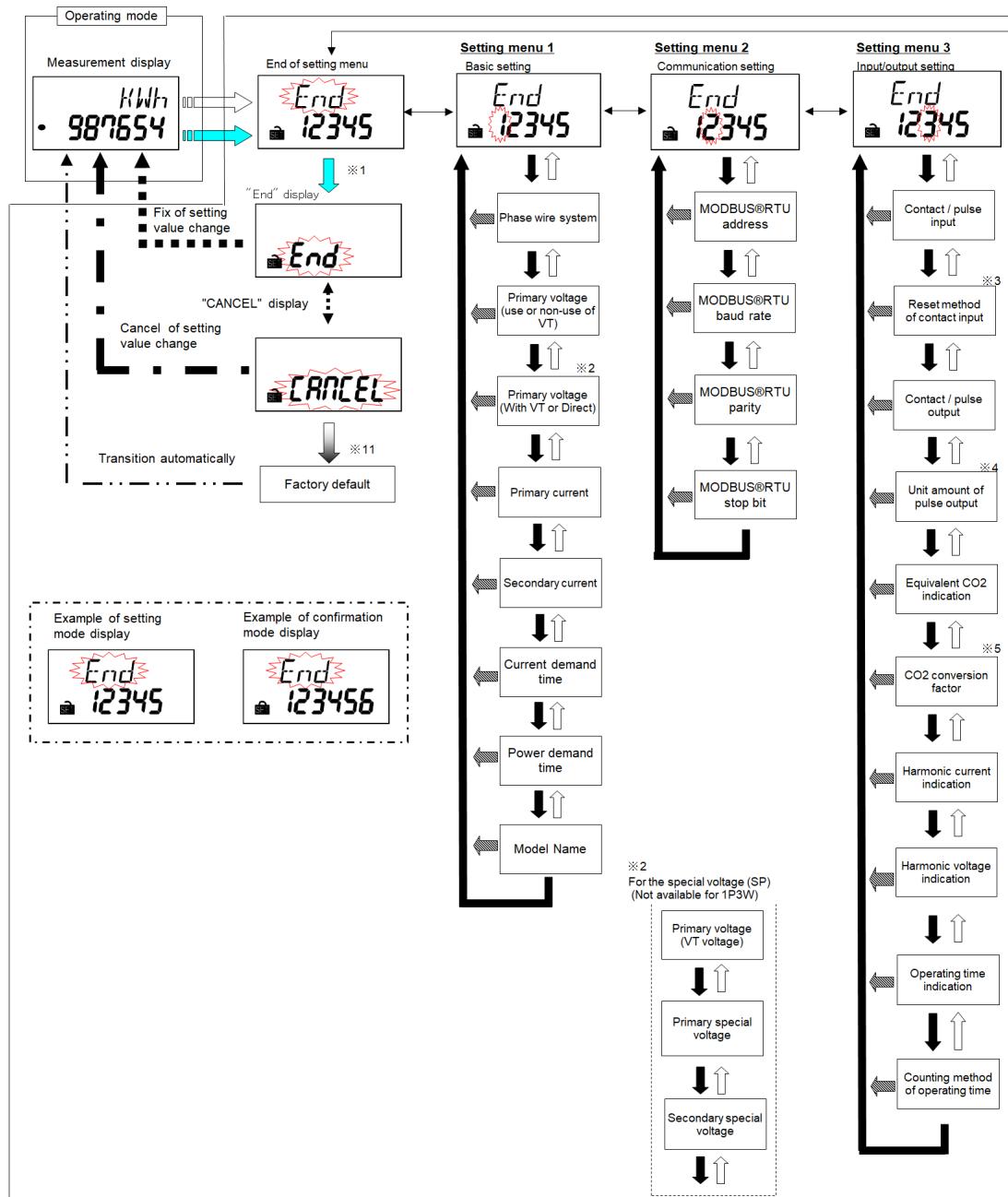
7. Setting method

Procedures for setting

Set items such as phase wire system, primary voltage, and primary current in the setting mode to measure and monitor. Under normal use, it shall be sufficient to set the setting menu 1 (Basic setting) only. For details, refer to after the following page.

<How to set>

- (1) Go into the setting mode by pressing both **SET** and **- / RESET** at the same time for 2 sec.
- (2) Select the setting menu number by pressing **+ / PHASE** **- / RESET**
- (3) Determine the setting menu number by pressing **SET**.
- (4) Set each setting item.
- (5) After all setting are done, select "End" on the setting menu and press **SET**.
- (6) When prompted for End display, select "End" and press **SET**.



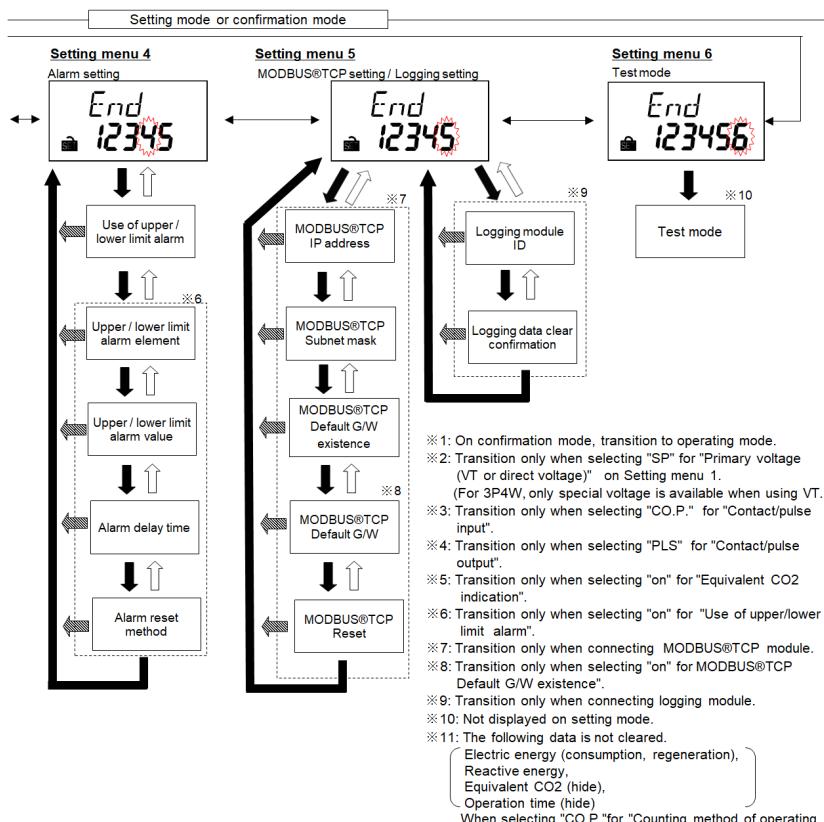
⚠Caution

- Setting menu 5 related to the logging Unit is shifted to Setting mode from Operating mode, and Please go in a procedure to set only Setting menu 5. ↗ page 28
- If you change setting, related setting items and measured data are initialized. Please check them beforehand. ↗ page 31

Procedures for setting

Basic operations in setting

Function	Operation	Supplement
Choose setting value	Press [+ / PHASE] or [- / RESET] .	Press for more than one second to fast-forward
confirm setting value	Press SET .	After setting value is confirmed, transition to next item.
Go back the previous setting item	Press DISP .	
Go back to setting menu during setting	Press SET for one second.	Setting value of the last item before return is effective.

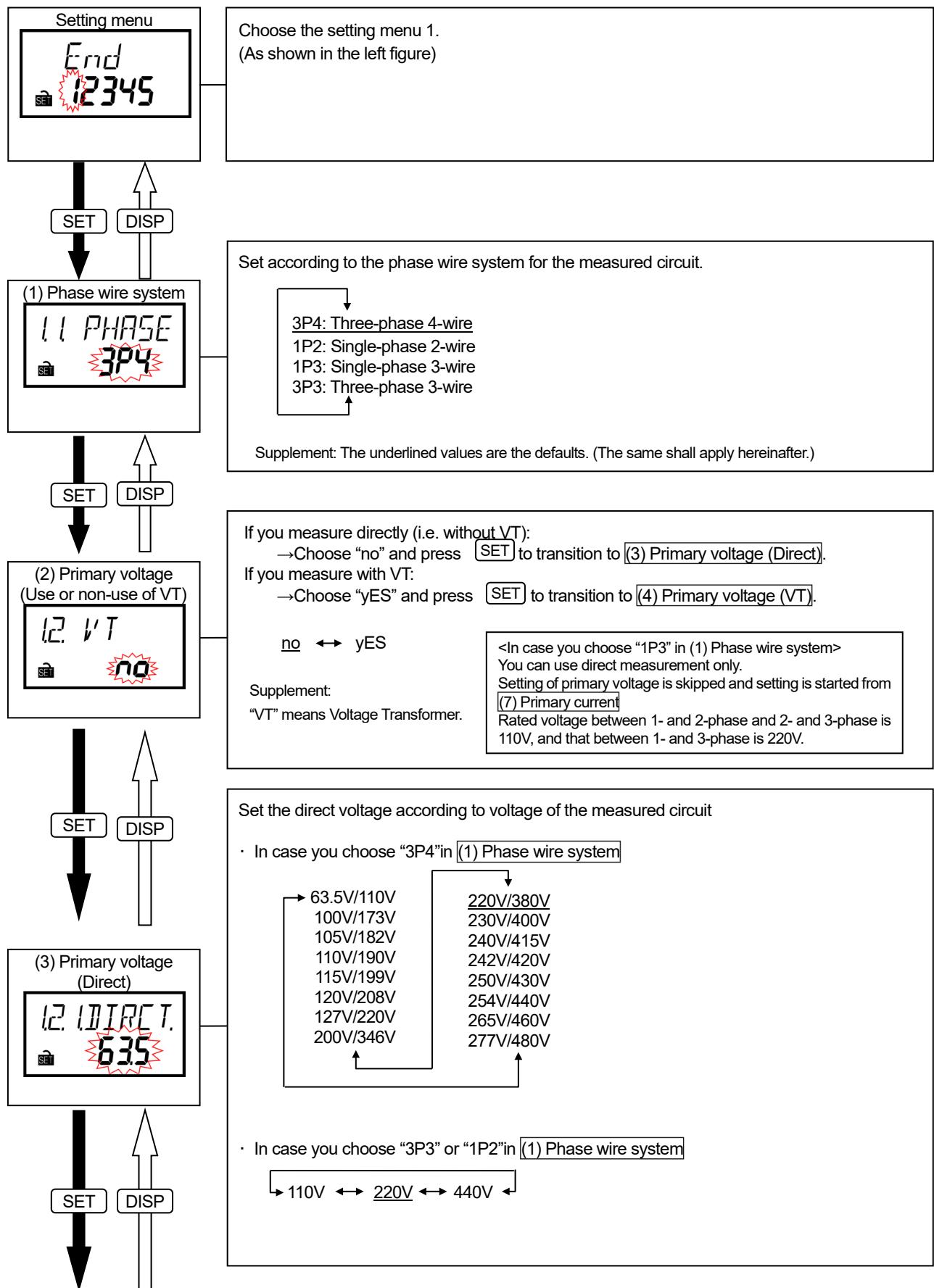


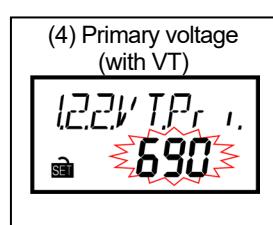
Symbol	Behavior	Operation of control button	
	Transition from operating mode to setting mode.	"SET" + "-"	Press both at the same time for 2 sec
	Transition from operating mode to confirmation mode	"SET"	Press for 2 sec
	Select menu number or "End".	"+" or "-"	Press several times
	Enter each setting display or transition to next item.	"SET"	Press once
	Go back to previous setting display.	"DISP"	Press once
No display	Select setting value.	"+" or "-"	Press several times
	Transition to "End" display.	"SET"	Press once
	Memorize changed setting and transition to operating mode.	"SET"	Press once
	Select "CANCEL".	"+" or "-"	Press once
	Cancel change of setting value.	"SET"	Press once
	Skip other items during setting.	"SET"	Press for 1 sec
	Reset setting values to factory default.	"DISP" + "-"	Press once

Setting menu 1: Phase wire system, primary voltage, primary current, demand time, etc.

In this menu, set phase wire system, primary voltage, primary current, demand time, etc.

In operating mode, press both **SET** and **- / RESET** at the same time for more than two seconds to transition to setting mode and enable the following operations.





Set the primary voltage of combined VT

690V ↔ 1100V ↔ 2200V ↔ 3300V ↔ 6600V ↔ SP ↔

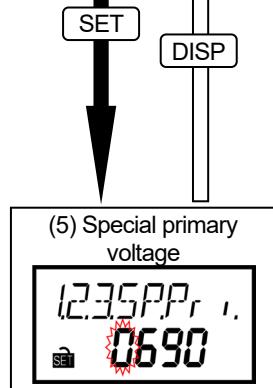
Caution:

If there is no values above you want to set to, choose "SP" to enable the special primary voltage and the special secondary voltage.

In case you choose "3P4" (three-phase 4-wire system) in (1) Phase wire system, the special voltage is only available.

If you choose "SP", transition to "(5) Special primary voltage".

If you choose the value except for "SP", transition to "(7) Primary current".
(In this case, secondary voltage is fixed to 110V.)



Set the special primary voltage of combined VT.

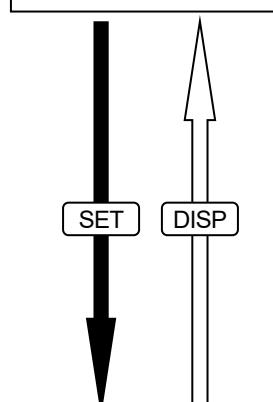
Setting range: 1V to 6600V

Default value is 690V

Setting of special primary voltage

- Press **[+ / PHASE]** or **[- / RESET]** to choose the value at flashing digit.
- Press **SET** for the setting digit (flashing digit) to shift to lower.
- Press **DISP** for the setting digit (flashing digit) to shift to upper.
- You can set the upper three digit of the value to the range of 1V to 6600V.
Caution: In case you set the value except for between 1V and 6600V, indicate the error (E005). When indicating the error, press **SET** to check the setting values and set the new value again.
- Press **SET** at the lowest digit to transition to "(6) Special secondary voltage".

The values set the upper fourth digit and lowers are rounded down. After setting value flashes three times, transition to "(6) Special secondary voltage".



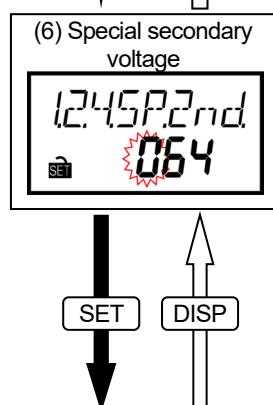
Set the special secondary voltage of combined VT.

Setting range: 1V to 220V

Default value is 110V (for three phase 3-wire system and single-phase 2-wire system), or 64V (for three-phase 4-wire system).

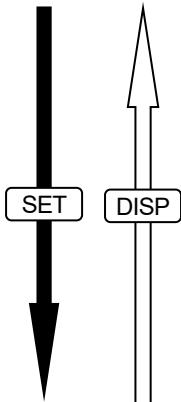
Setting of special secondary voltage

- Press **[+ / PHASE]** or **[- / RESET]** to choose the value at flashing digit.
- Press **SET** for the setting digit (flashing digit) to shift to lower.
- Press **DISP** for the setting digit (flashing digit) to shift to upper.
- You can set the value to the range of 1V to 220V.
Caution: In case you set the value except for between 1V and 220V, indicate the error (E005). When indicating the error, press **SET** to check the setting values and set the new value again.
- Press **SET** at the lowest digit to transition to "(7) Primary current".



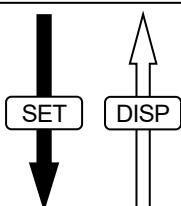
(7) Primary current

13 CTPr 1.
SET 100



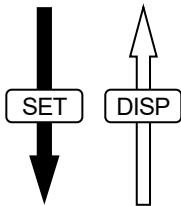
(8) Special primary current

13 15PPr 1.
SET 01000



(9) Secondary current

13 2CT2nd
SET 5



Set the primary current of combined CT.

1A	30A	250A	1500A
5A	40A	300A	1600A
6A	50A	400A	2000A
7.5A	60A	500A	2500A
8A	75A	600A	3000A
10A	80A	750A	4000A
12A	100A	800A	5000A
15A	120A	1000A	6000A
20A	150A	1200A	SP
25A	200A	1250A	

Supplement:

"CT" means Current Transformer.

Supplement: If there is no values above you want to set to, choose "SP" to enable the special primary current.

If you choose "SP", transition to "(8) Special primary current".

If you choose the value except for "SP", transition to "(9) Secondary current".

Set the special primary current of combined CT.

Setting range: 1A to 6000A (Default: 100.0A)

Setting of special primary current

- Press **[+ / PHASE]** or **[- / RESET]** to choose the value at flashing digit.
- Press **SET** for the setting digit (flashing digit) to shift to lower.
- Press **DISP** for the setting digit (flashing digit) to shift to upper.
- You can set the value in the range from 1A to 6000A.

If the value is less than 10A, you can set upper two digits of it.

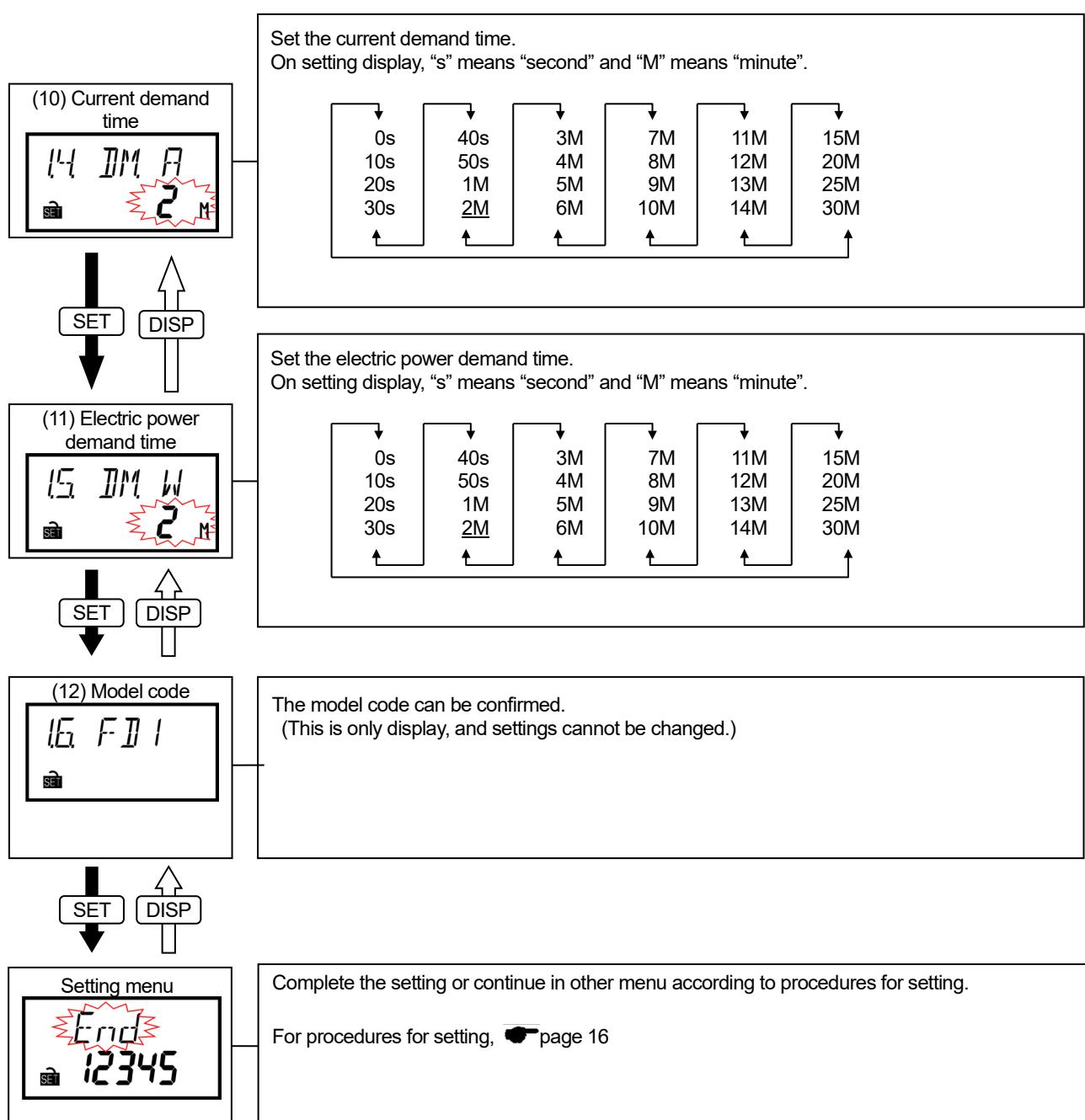
If the value is 10A or more, you can set upper three digits of it.

Caution: In case you set the value except for the range from 1A and 6000A, indicate the error (E005). When indicating the error, press **SET** check the setting values and set the new value again.

- Press **SET** at the lowest digit to transition to "(9) Secondary Current".

Set the secondary current of combined CT.

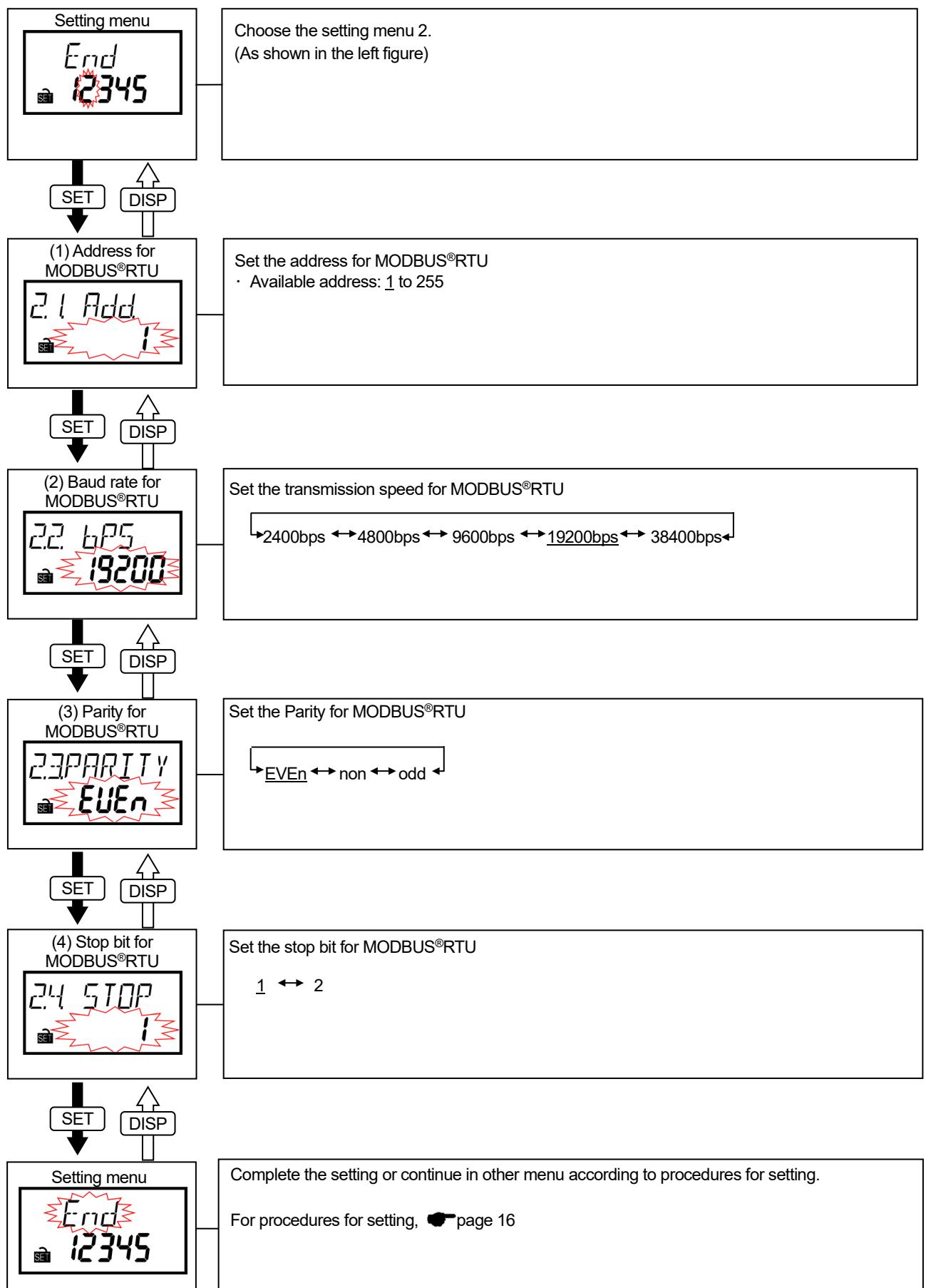
5A ↔ 1A



Setting menu 2: MODBUS® RTU communication

In this menu, set address, baud rate, parity and stop bit for MODBUS®RTU communication.

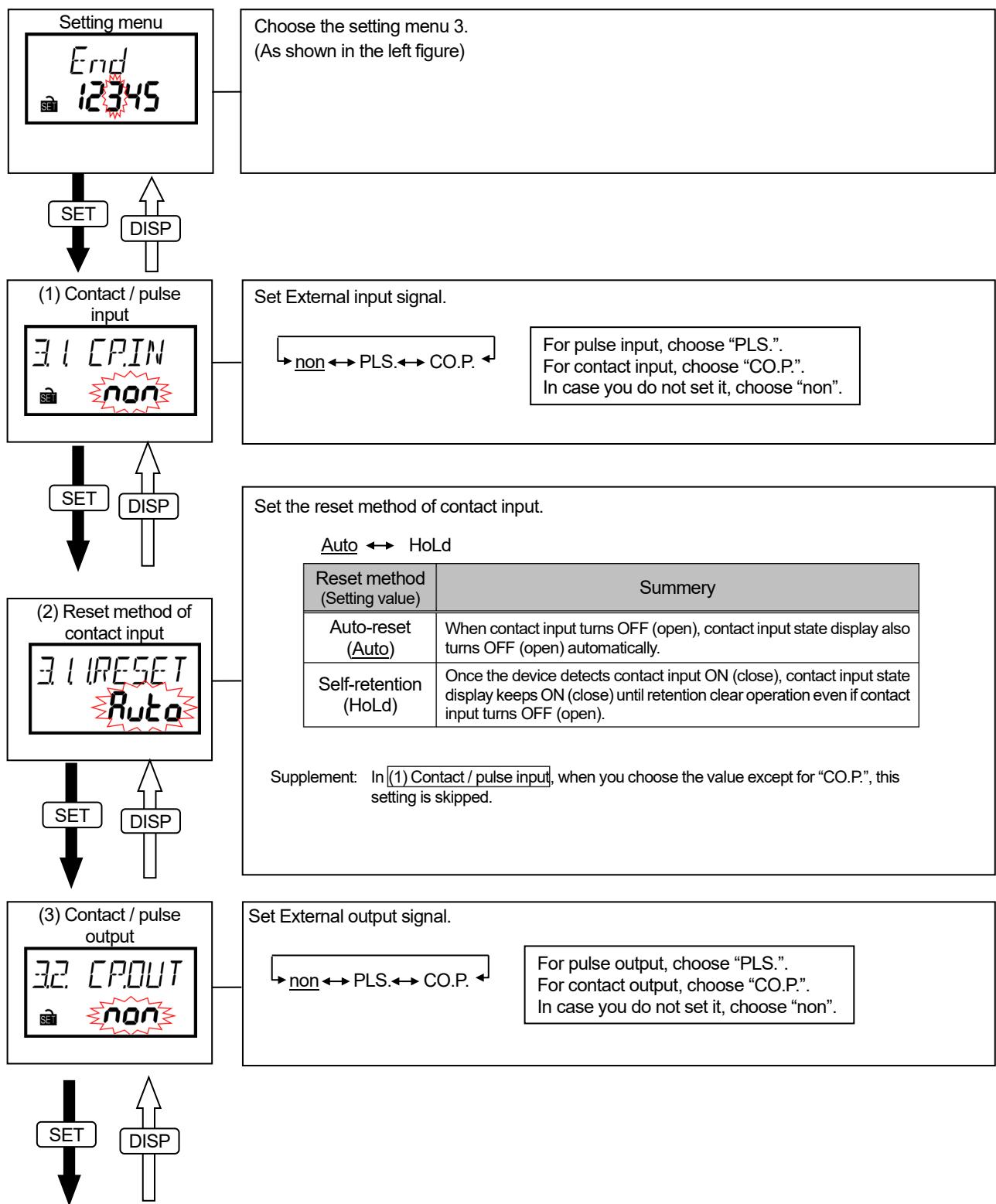
In operating mode, press both **SET** and **- / RESET** at the same time for more than two seconds to transition to setting mode and enable the following operations.

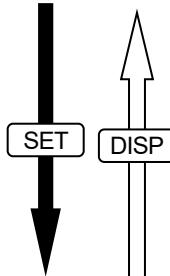
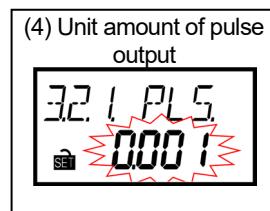


Setting menu 3: Contact / pulse input/output, equivalent CO₂, harmonic, operating time, etc.

In this menu, set contact / pulse input/output, equivalent CO₂, harmonic, operating time, etc.

In operating mode, press both **SET** and **- / RESET** at the same time for more than two seconds to transition to setting mode and enable the following operations.





Set the unit amount per pulse of pulse output.
Selectable unit amount is as follows depending on the full load power:

Full load power [kW] =	$\frac{\alpha \times (\text{VT primary voltage}) \times (\text{CT primary current})}{1000}$	$\alpha: 1$	Single-phase, 2-wire
		2	Single-phase, 3-wire
		$\sqrt{3}$	Three-phase, 3-wire
		3	Three-phase, 4-wire

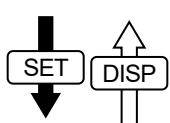
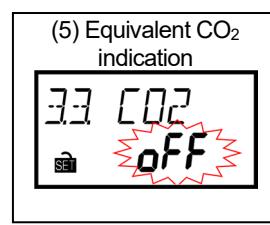
*1: VT primary voltage in single-phase 3-wire system is regarded as 110V.

*2: Using direct connection, replace VT primary voltage with direct voltage in calculation above.

*3: In three-phase 4-wire system, replace VT primary voltage or direct voltage with phase voltage in calculation above.

Full load power [kW]	Selectable unit amount per pulse [kWh/pulse]				Default value
less than 12	1	0.1	0.01	0.001	<u>0.001</u>
12 or more and less than 120	10	1	0.1	0.01	<u>0.01</u>
120 or more and less than 1200	100	10	1	0.1	<u>0.1</u>
1200 or more and less than 12000	1000	100	10	1	<u>1</u>
12000 or more	10000	1000	100	10	<u>10</u>

Supplement: In (3) Contact / pulse output, when you choose the value except for "PLS.", this setting is skipped.

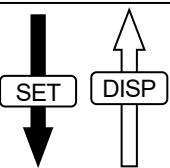
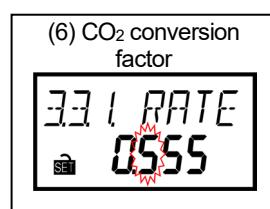


Set whether the equivalent CO₂ is indicated or not.

oFF ↔ on
(Do not indicate) (Indicate)

CO₂ equivalent is the integration of the value obtained by multiplying electric energy and CO₂ conversion factor.

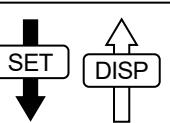
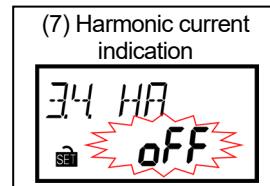
- If you need this indication, choose "on" and press **SET** to transition to the setting below.
- If you do not need this indication, choose "oFF" and press **SET** to transition to (7) Harmonic current indication.



Set the CO₂ conversion factor
(Default value: 0.555kg - CO₂ / kWh)

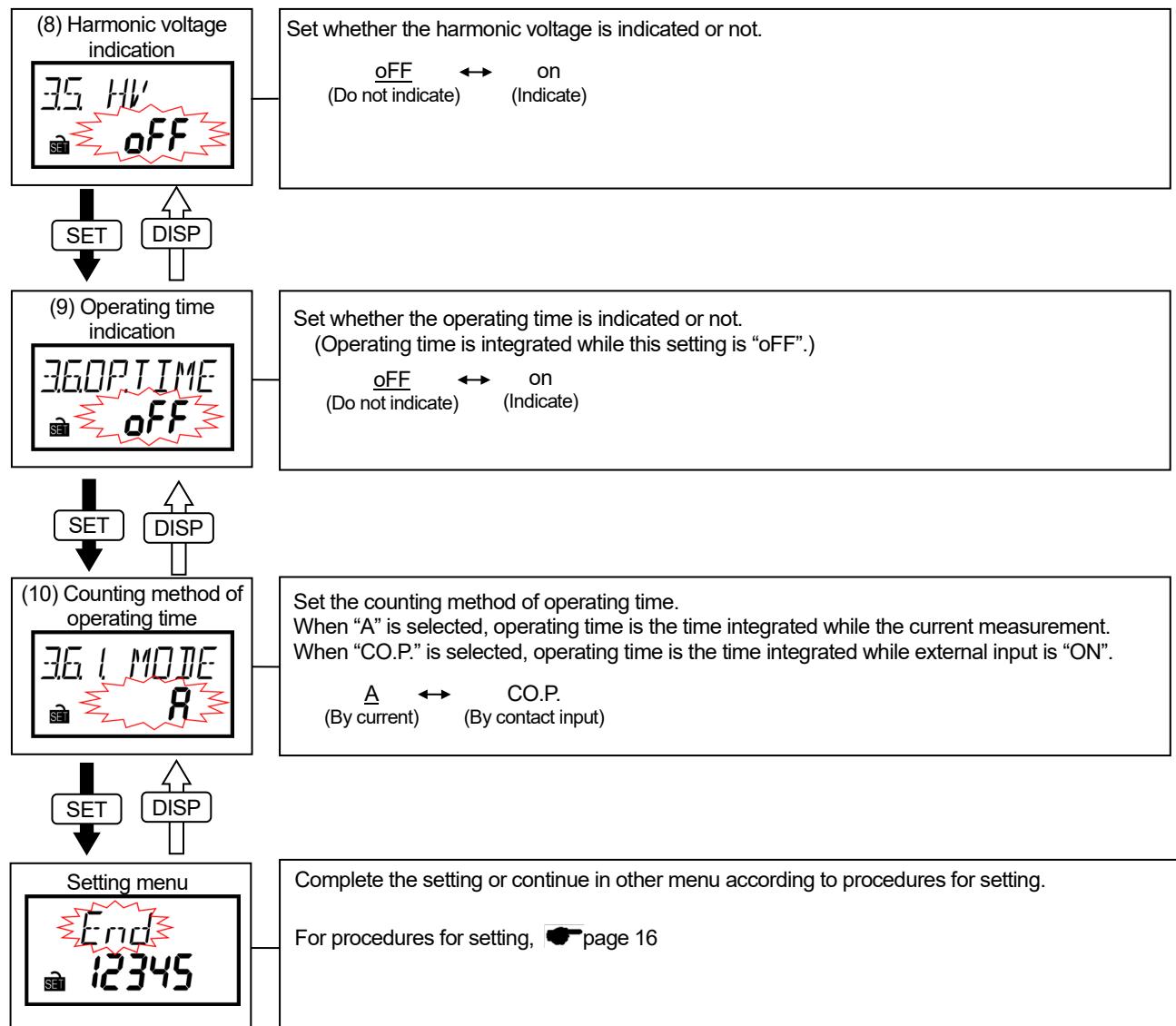
Setting of CO₂ conversion factor

- Press **+ / PHASE** or **- / RESET** to choose the value at flashing digit.
- Press **SET** for the setting digit (flashing digit) to shift to lower.
- Press **DISP** for the setting digit (flashing digit) to shift to upper.
- You can set the value to the range of 0.000 to 0.999 (kg - CO₂ / kWh).
- Press **SET** at the lowest digit to transition to (7) Harmonic current indication.



Set whether the harmonic current is indicated or not.

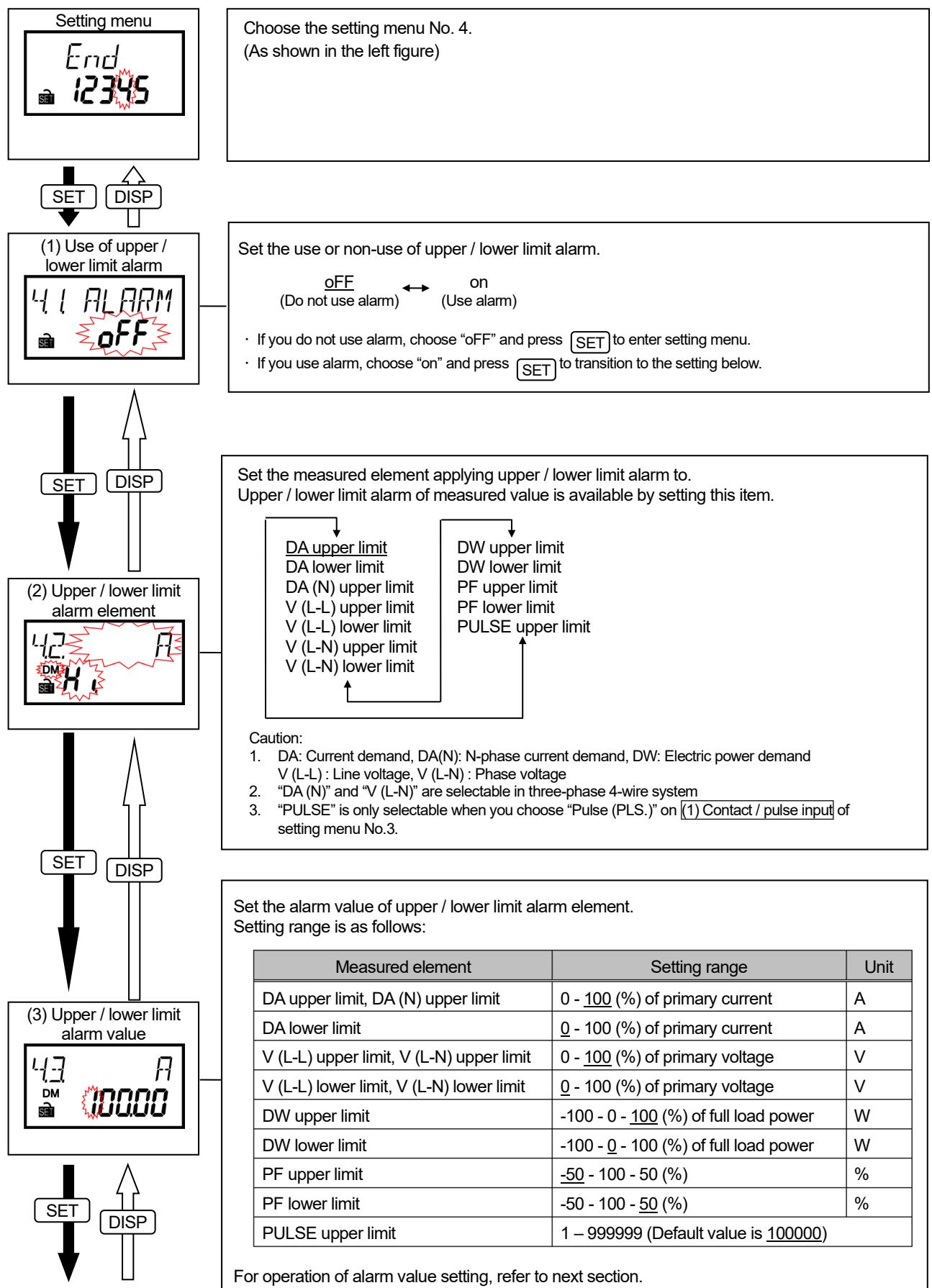
oFF ↔ on
(Do not indicate) (Indicate)



Setting menu 4: Upper / lower limit alarm setting, alarm delay time, alarm reset, etc.

In this menu, set the upper / lower alarm, alarm delay time, reset method of alarm clear, etc.

In operating mode, press both **SET** and **- / RESET** at the same time for more than two seconds to transition to setting mode and enable the following operations.



Operations in alarm value setting display are as follows:

Setting of "Upper / lower limit alarm value"

- Press **+/PHASE** or **-/RESET** to choose the value at flashing digit.
- Press **SET** for the setting digit (flashing digit) to shift to lower.
- Press **DISP** for the setting digit (flashing digit) to shift to upper.
- Setting range is different for each alarm element. (refer to previous section)
Caution: In case the value is set to outside-set-value, indicate the error (E005)
When indicating the error, press **SET** check the setting values and set the new value again.
- Press **SET** at the lowest digit to transition to **(4) Alarm delay time**.

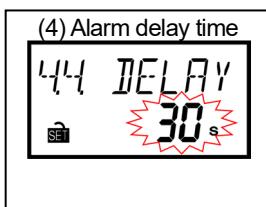
Set the delay time from fulfilling alarm occurring condition.

Set the alarm delay time if you want to avoid the alarm caused by such as instant overload and noise.

Once setting, the alarm does not occur unless the time of exceeding the upper / lower limit alarm value is over the specified delay time.

In setting display, "s" means "second" and "M" means "minute".

↓	0s	↓	30s	↓	2M
	5s		40s		3M
	10s		50s		4M
	20s		1M		5M
↑		↑		↑	



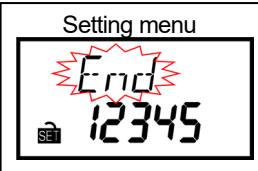
SET

DISP



SET

DISP



Set the alarm reset method in alarm occurrence.

Alarm reset method (Setting value)	Summary (For details, page 54)
Auto-reset (Auto)	Reset the alarm automatically when alarm occurring condition is gone.
Self-retention (HoLd)	The alarm is held even after alarm occurring condition is gone. Button operation is necessary to clear the alarm.

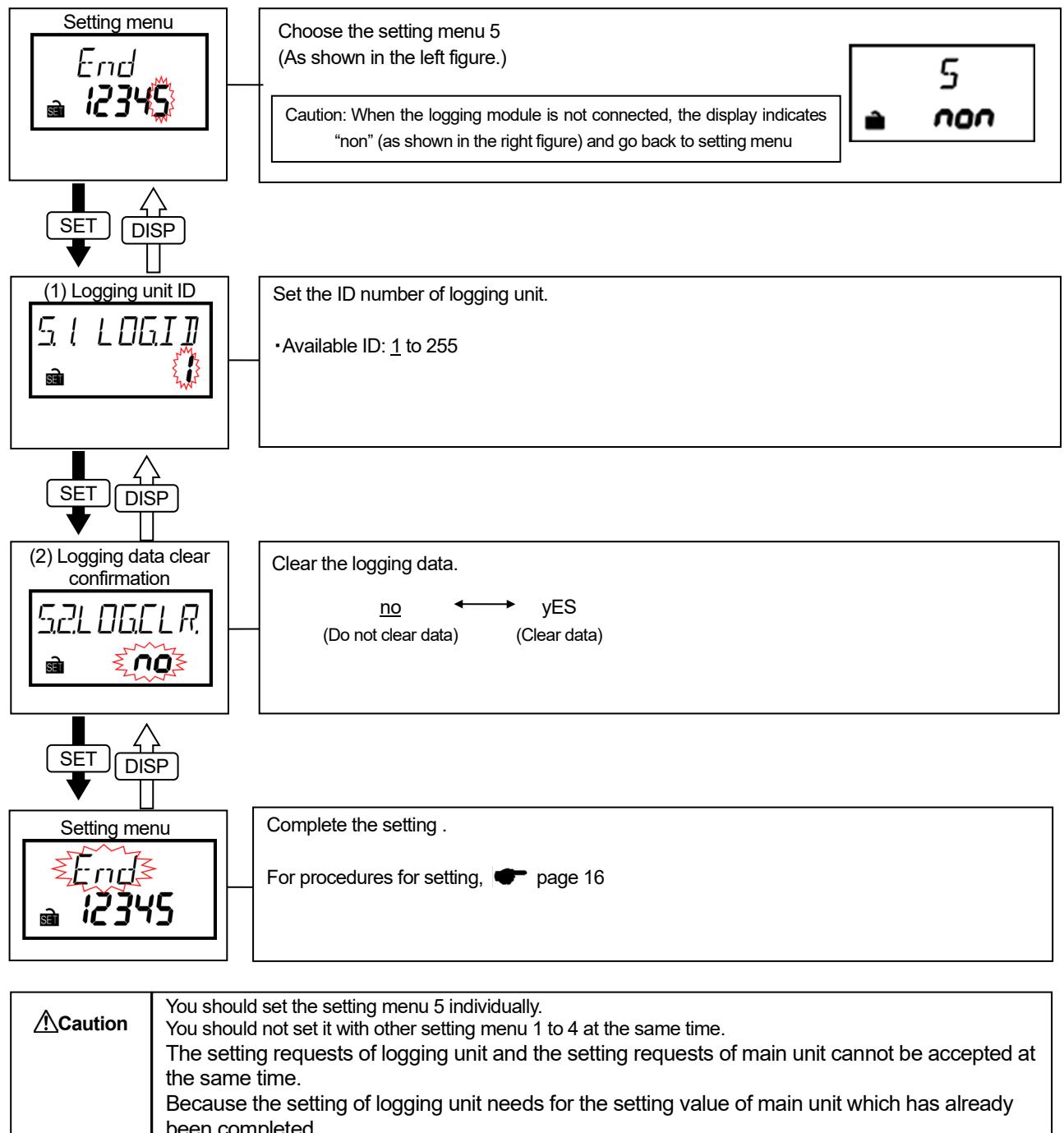
Complete the setting or continue in other menu according to procedures for setting.

For procedures for setting, page 16

Setting menu 5: Setting related to logging unit

In this menu, set the logging unit ID or logging data clear.

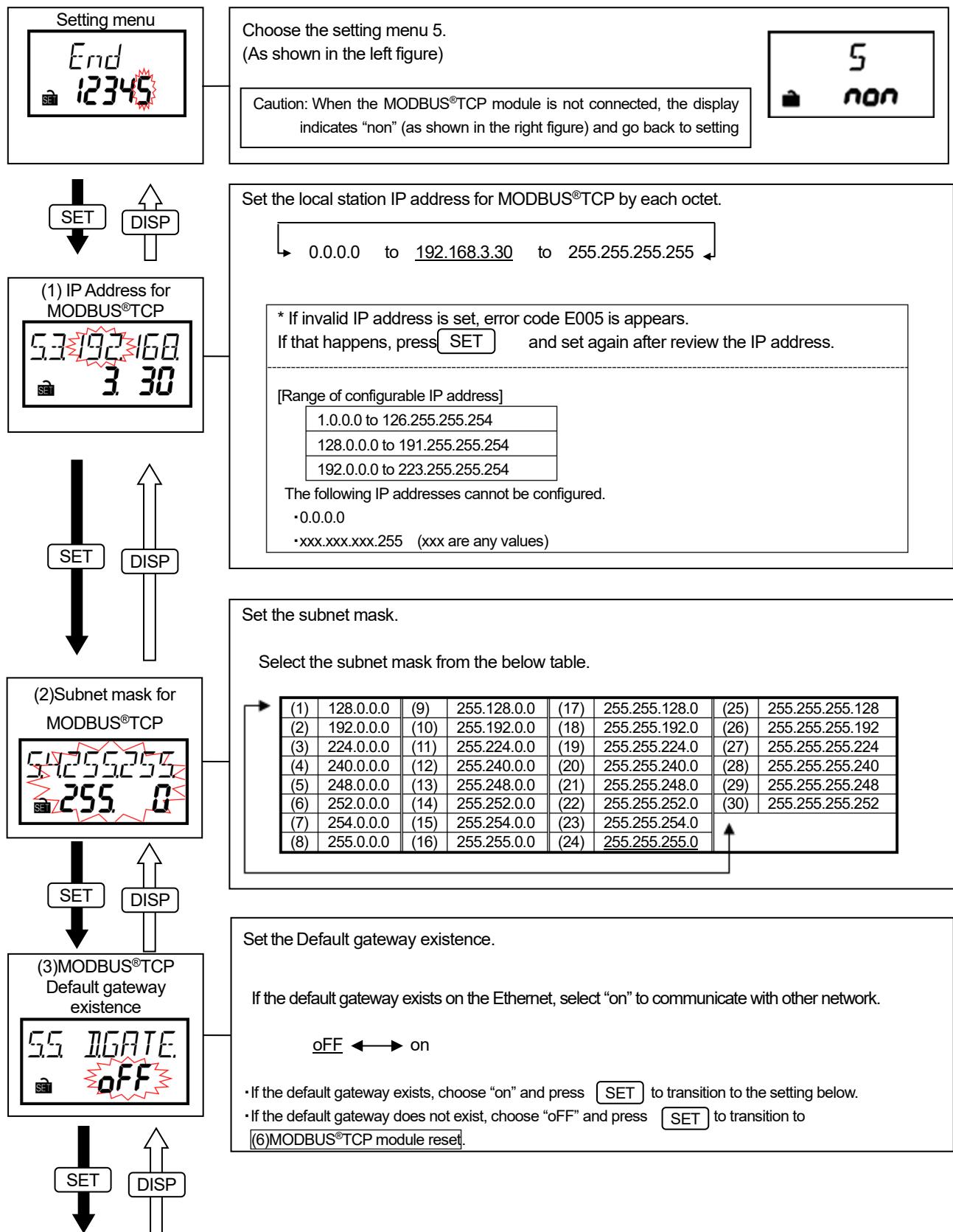
In operating mode, press both **SET** and **- / RESET** at the same time for more than two seconds to transition to setting mode and enable the following operations.

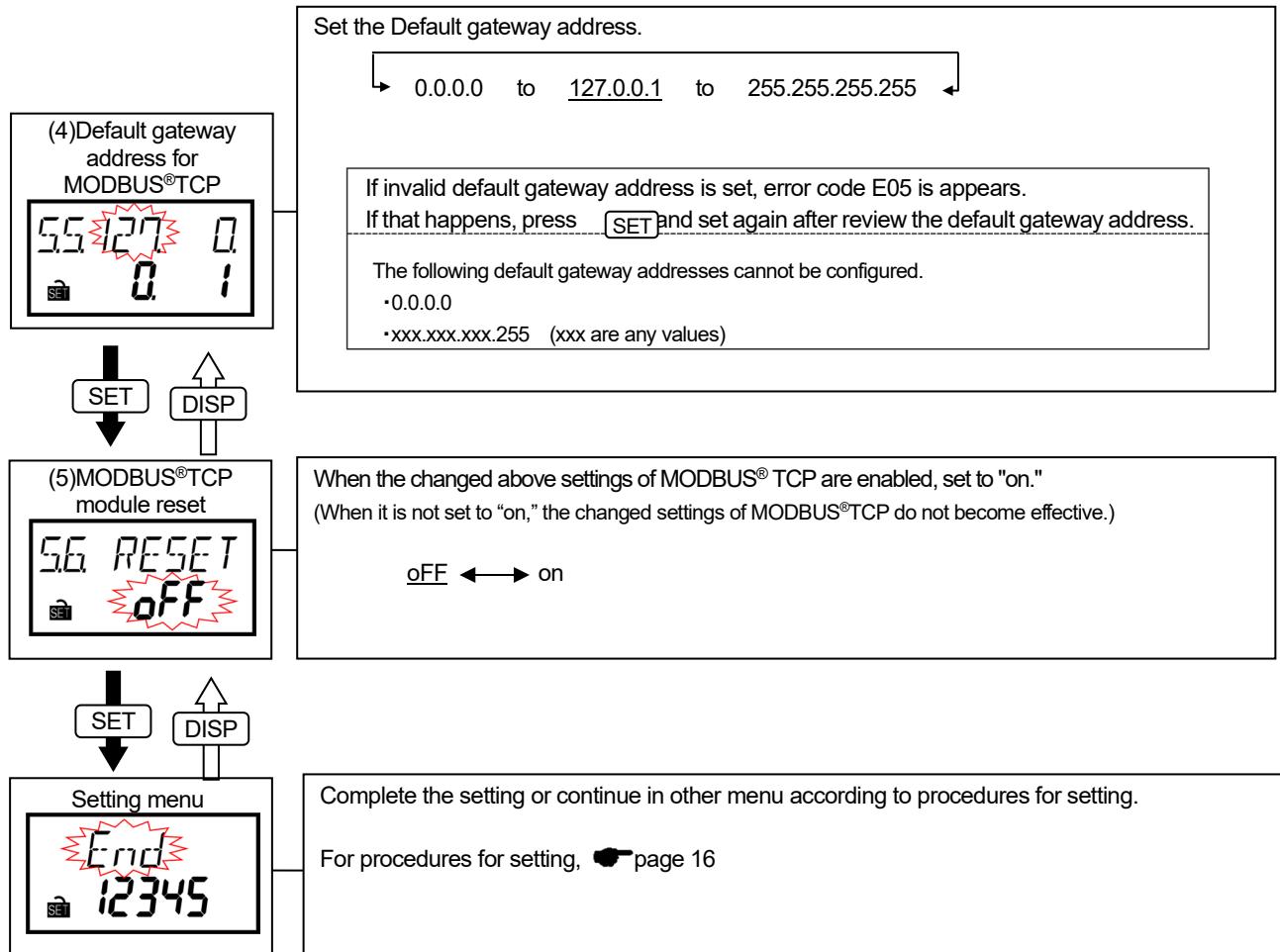


Setting menu 5: MODBUS® TCP communication

In this menu, IP address, subnet mask, and default gateway for MODBUS®TCP communication.

In operating mode, press both **SET** and **- / RESET** at the same time for more than two seconds to transition to setting mode and enable the following operations.





Confirmation menu 1 - 5: Confirmation of setting values in setting menu 1 - 5

In operating mode, press **SET** for more than two seconds to transition to confirmation mode and enable operation.
Transition of display and operation is as same as those of setting menu 1 - 5.
For setting menu 1 - 5, **→** p.18 – 30
(Caution: Change of setting is not available in confirmation mode.)

Initialization of related items by change of setting

Setting item		Changed setting value									
		Menu 1		Menu 2		Menu 3		Menu 4		Menu 5	
Initialized item	Phase wire system	Phase wire system	Use of VT	Direct voltage	Primary voltage (Special primary voltage)	Secondary voltage	Primary current (Special primary current)	Secondary current	Electric power demand time	MODBUS@RTU address	MODBUS@RTU baud rate
	Use of VT	●									
	Direct voltage		●								
	Primary voltage (Special primary voltage)	●									
	Secondary voltage	●									
	Primary current (Special primary current)	○									
	Secondary current	○									
	Electric power demand time										
	Current demand time										
	MODBUS@RTU address										
Menu 2	MODBUS@RTU baud rate										
	MODBUS@RTU parity										
	MODBUS@RTU stop bit										
	Contact/pulse input										
Menu 3	Contact reset status										
	Contact/pulse output										
	Pulse output unit										
	With or without CO2 indication										
	Equivalent CO2 setting										
	Harmonic current indication setting										
	Harmonic voltage indication setting										
	Operating time indication setting										
	Operating time measured item setting										
	Use of upper/lower limit alarm	○	○	○	○	○	○		□		
Menu 4	Upper/lower limit alarm element	○	○	○	○	○	○		□		
	Upper/lower limit alarm value	○	○	○	○	○	○		□		
	Alarm delay time								□		
	Alarm reset method									○	
	Logging unit ID										
Menu 5	Logging date clear confirmation										
	MODBUS@TCP IP address										
	MODBUS@TCP Subnet mask										
	MODBUS@TCP Default gateway existence										
	MODBUS@TCP Default gateway address										

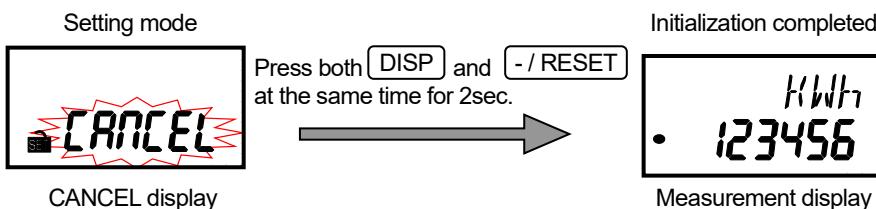
Symbol	Meaning
○	Initialized
●	Change to default value corresponding to phase wire system
□	Initialized when the upper limit of pulse count is set and input method is changed from pulse to contact.
None	Not initialized

All settings are reset to factory default by the following operation.

Settings are only initialized. Integrated values (such as electric energy, reactive energy and operating time) are not changed.

Enter CANCEL display in setting mode and operate as follows to initialize all settings.

For entering CANCEL display, refer to procedures for setting. (page 16)

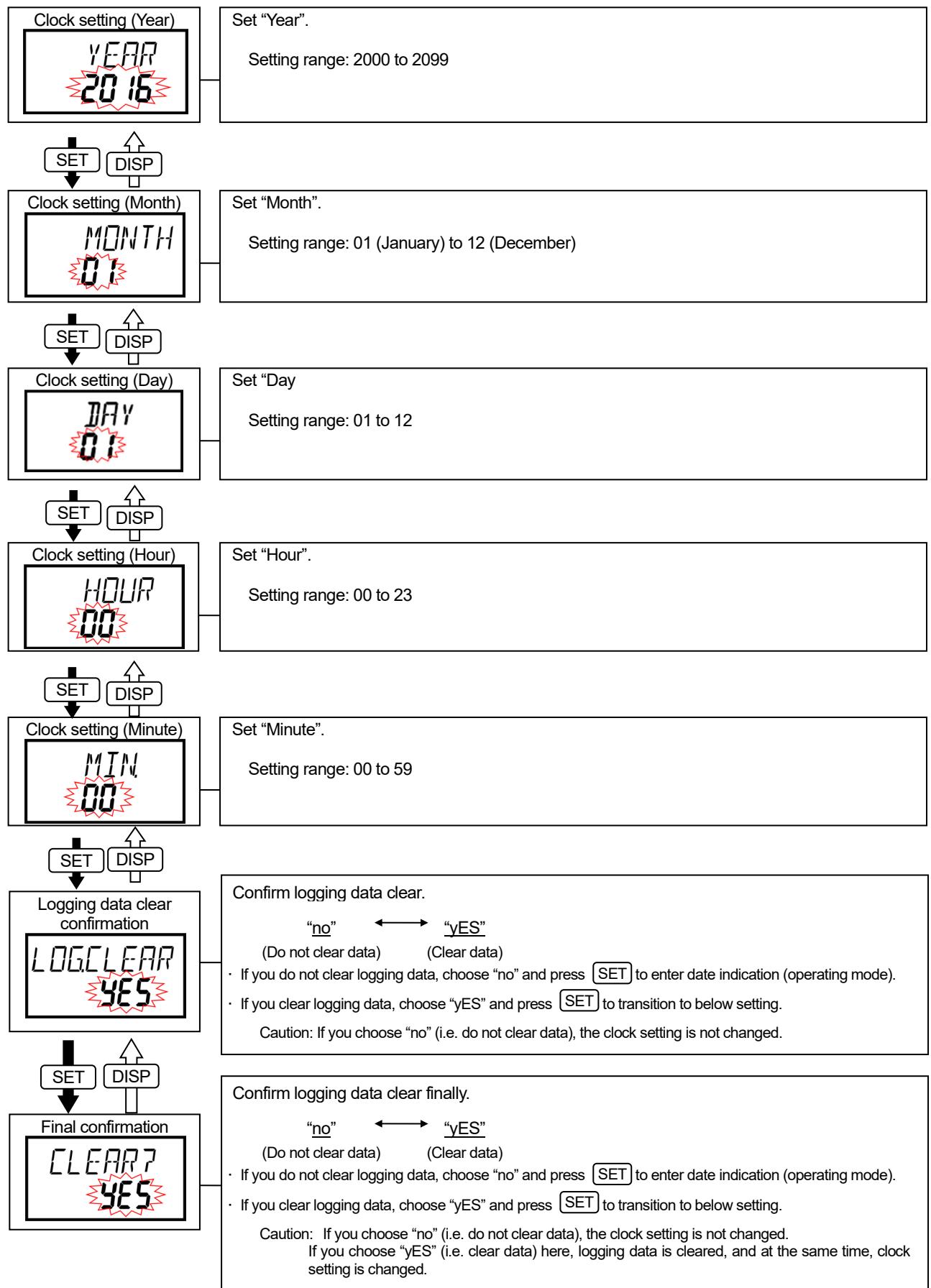


Clock setting and logging data clear

When connecting logging unit, you can set the clock of it.

On the date indication in operating mode, press both **+ / PHASE** and **- / RESET** at the same time for more than two seconds to transition to clock setting and enable the following operations.

*Caution: The date is not indicated in operating mode when the logging unit is not connected.

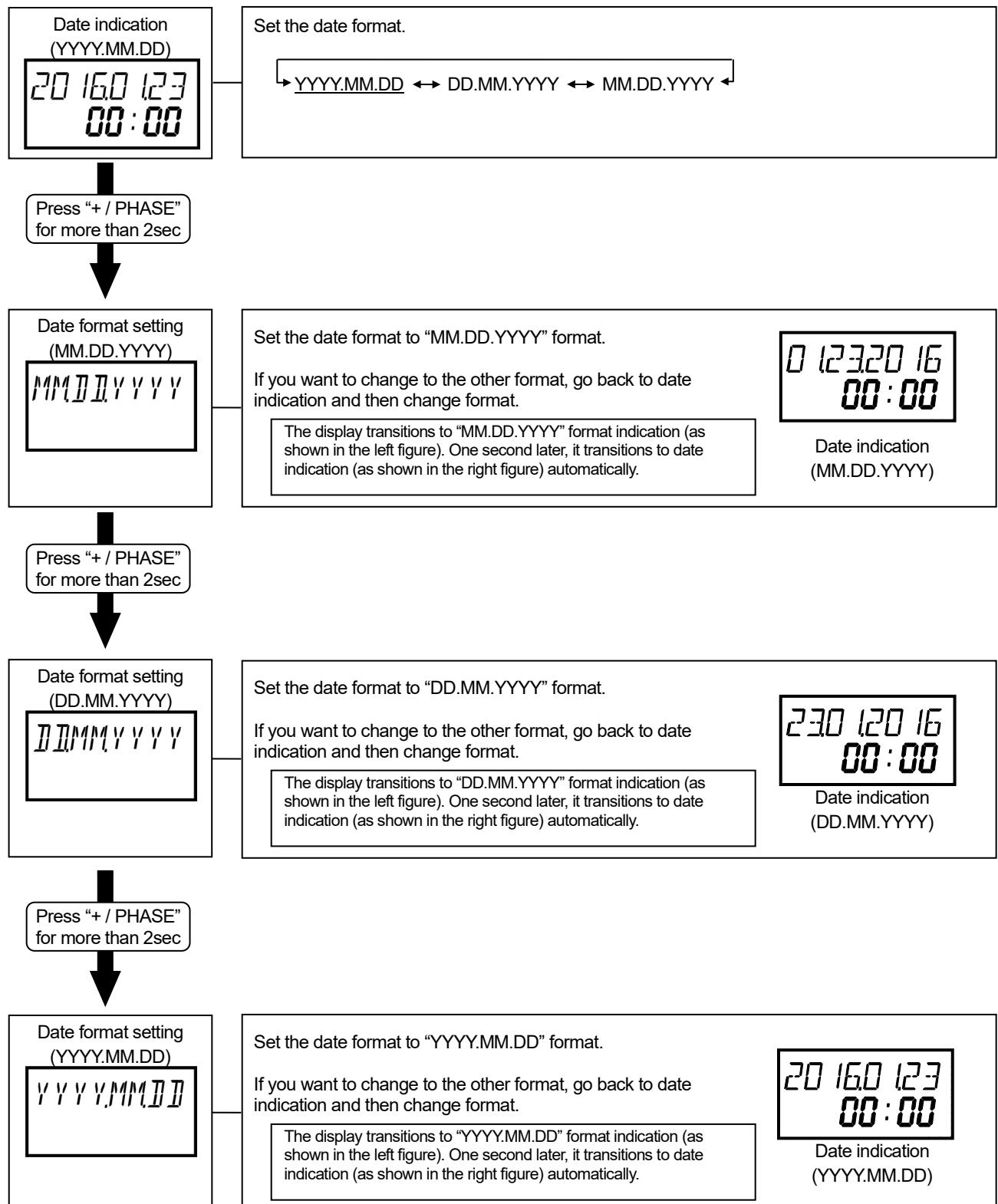


Change of date format

In date format setting, you can choose from "YYYY.MM.DD", "MM.DD.YYYY" or "DD.MM.YYYY" format.

On the date indication in operating mode, press **+ / PHASE** for more than two seconds to transition to date format setting and enable the following operations.

*Caution: The date is not indicated in operating mode when the logging unit is not connected.



How to use test mode

Test mode has the functions which you can utilize in such as the launch of equipment.

The functions in test mode are as follows:

Test menu	Details
1. Discrimination support function for improper connection	<p>Indicate phase angle of current and voltage, electric power, voltage and current of each phase.</p> <p>You can discriminate easily whether the input connection for measurement (voltage and current) is proper or not by checking each indicated values.</p>
2. Communication test	<p>For the device with communication function, it can send back the fixed numerical data without the input of measurement (voltage and current).</p> <p>Use for such as the opposing test to host system.</p>
3. Pulse output test	<p>You can check the pulse output without the input of measurement (voltage and current).</p> <p>Use for such as the check of the connection to the receiving device.</p>
4. Alarm output test	<p>You can check the alarm output without the input of measurement (voltage and current).</p> <p>Use for such as the check of the connection to the receiving device.</p>

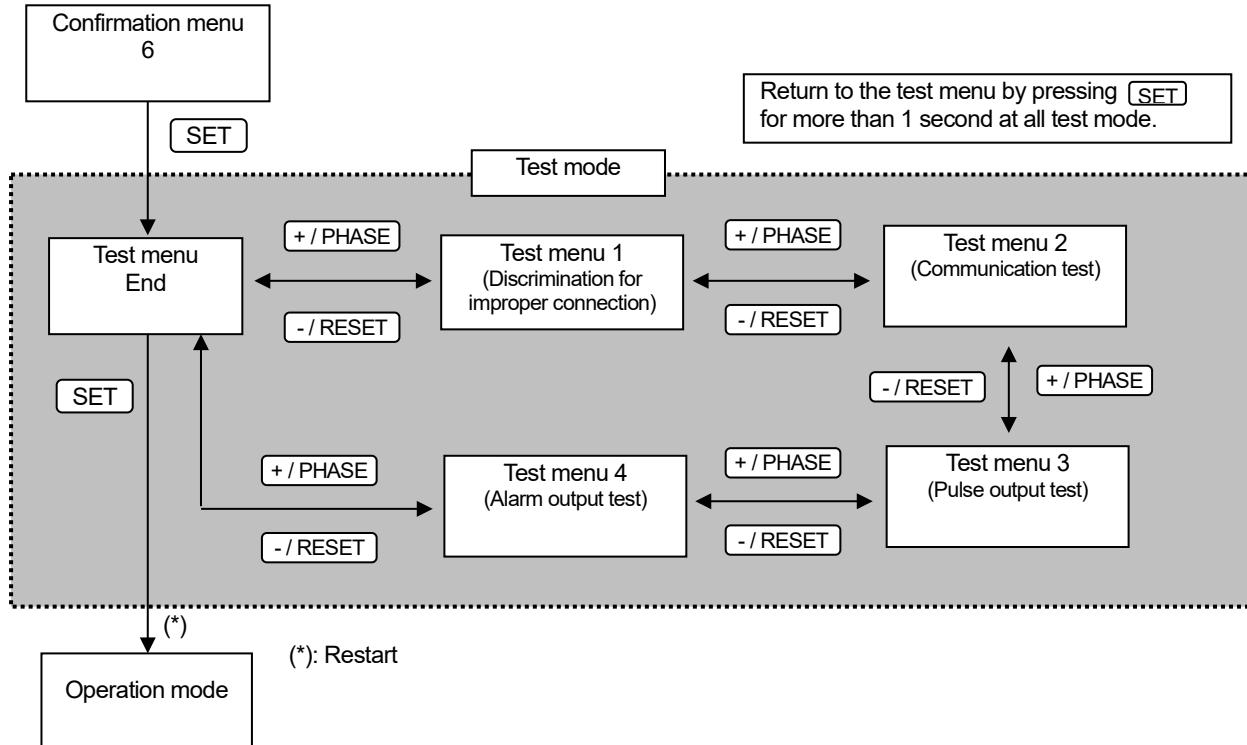
- How to test

- (1) Press **SET** for two seconds to enter confirmation mode.
- (2) Press **+ / PHASE** or **- / RESET** to choose confirmation menu 6.
(As shown in the right figure)
- (3) Press **SET** to enter test mode
- (4) Test for the each menu.



(Confirmation menu 6)

- Diagram for test mode

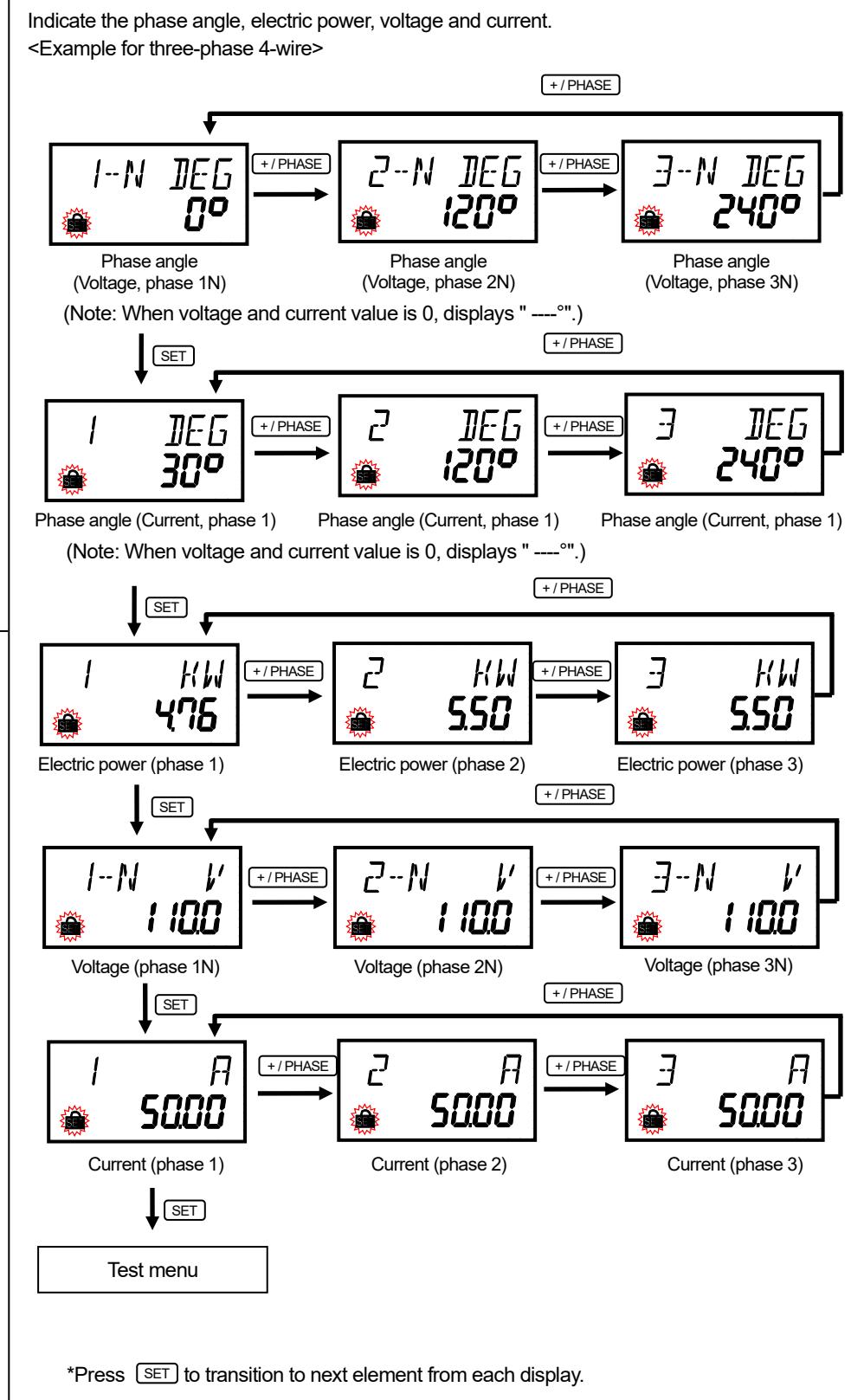


Test menu 1: Discrimination support function for improper connection

In configuration mode, choose menu "6" to enter test mode. (You cannot enter from setting mode.)
In test mode, the following operations can be possible.



Choose the test menu 1.
(As shown in the left figure)



Indicate the phase angle, electric power, voltage and current.

<Example for three-phase 3-wire>

(1) Discrimination support function for improper connection

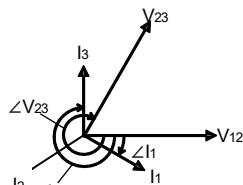
Press "SET" for more than 1sec

Test menu

*Press [SET] to transition to next element from each display.

· About phase angle

The phase angle is indicated in a clockwise direction from V_{12} , as baseline (0 degree).



$\angle V_{23}$: Phase angle between V_{23} and V_{12}

$\angle I_1$: Phase angle between I_1 and V_{12}

$\angle I_3$: Phase angle between I_3 and V_{12}

· Display example of discrimination support function for improper connection

For display examples for each connection pattern, p. 37 - 46

(Note: When the electric power value is minus indication, Please confirm the connection of a CT.)

Test menu

<If you continue other test menu>

→ Choose other test menu number and press [SET].

<If you finish the test mode>

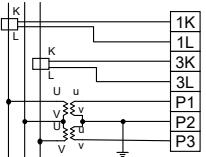
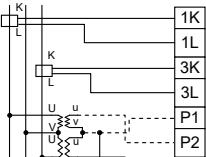
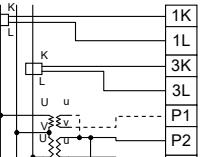
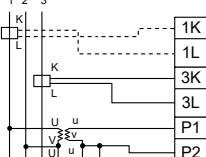
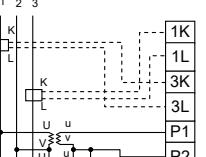
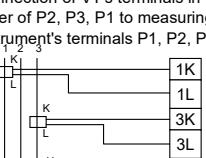
→ Choose "End" and press [SET] to return to operating mode.

Test menu 1: Discrimination support function for improper connection

■ Display example of discrimination support function for improper connection

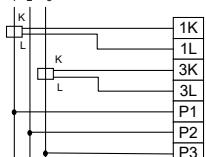
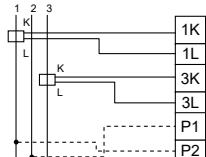
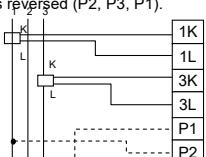
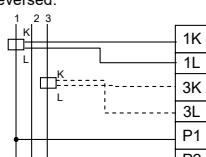
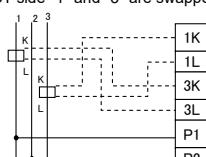
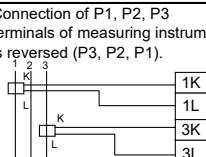
Display example (Connection example for three-phase 3-wire)

----- Indicates improper connection

No.	Power factor (Input)	At the average current ($V_{12}=V_{23}$, $I_1=I_3$)											Wiring								
		Phase angle display				Electric power display		Voltage display			Current display										
		$\angle V_{12}$	$\angle V_{23}$	$\angle I_1$	$\angle I_3$	W1	W3	V_{12}	V_{23}	V_{31}	I_1	I_2	I_3								
Normal status	Forward 0.707	0	300	345	225	W1>W3			V ₁₂ =V ₂₃ =V ₃₁			I ₁ =I ₂ =I ₃									
	Forward 0.866			0	240																
	1			30	270	W1=W3															
	Delayed 0.866			60	300	W1<W3															
	Delayed 0.707			75	315																
1	Forward 0.707	0	60	165	45	W1=Negative value W3=Positive value	V ₁₂ =V ₂₃ =V ₃₁			I ₁ =I ₂ =I ₃			Connection between P1 and P2 are reserved. 								
	Forward 0.866			180	60																
	1			210	90																
	Delayed 0.866			240	120																
	Delayed 0.707			255	135																
2	Forward 0.707	0	120	165	45	W1=Negative value W3=Positive value	V ₁₂ =V ₂₃ <V ₃₁			I ₁ =I ₂ =I ₃			Connection of VT side "1" is reversed. 								
	Forward 0.866			180	60																
	1			210	90																
	Delayed 0.866			240	120																
	Delayed 0.707			255	135																
3	Forward 0.707	0	300	165	225	W1=Negative value W3=Positive value	V ₁₂ =V ₂₃ =V ₃₁			I ₁ =I ₃ <I ₂			Connection of CT on side "1" is reversed. 								
	Forward 0.866			180	240																
	1			210	270																
	Delayed 0.866			240	300																
	Delayed 0.707			255	315																
4	Forward 0.707	0	300	225	345	W1=Negative value W3=Positive value	V ₁₂ =V ₂₃ =V ₃₁			I ₁ =I ₂ =I ₃			CT side "1" and "3" are swapped. 								
	Forward 0.866			240	0																
	1			270	30																
	Delayed 0.866			300	60	W1=Positive value W3=Negative value															
	Delayed 0.707			315	75																
5	Forward 0.707	0	300	225	105	W1=Negative value W3=Negative value	V ₁₂ =V ₂₃ =V ₃₁			I ₁ =I ₂ =I ₃			Connection of VT's terminals in order of P2, P3, P1 to measuring instrument's terminals P1, P2, P3. 								
	Forward 0.866			240	120																
	1			270	150	W1=0 W3=Negative															
	Delayed 0.866			300	180	W1=Positive value W3=Negative value															
	Delayed 0.707			315	195																

Display example (Connection example for single-phase 3-wire)

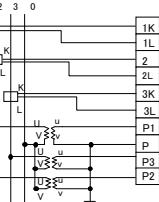
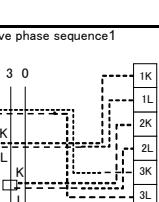
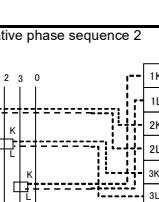
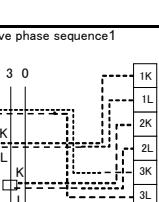
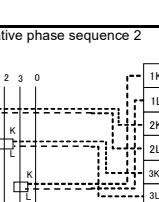
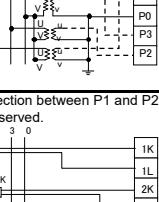
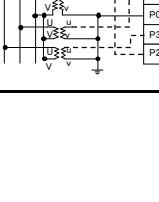
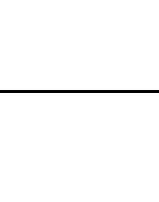
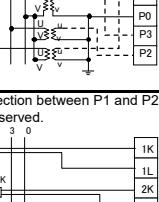
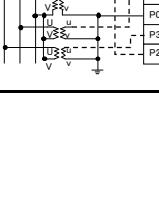
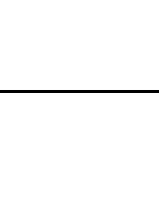
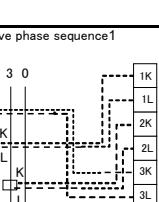
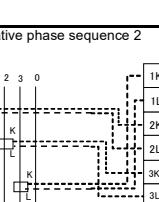
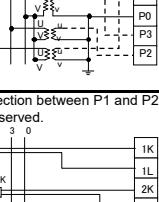
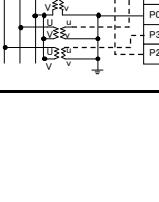
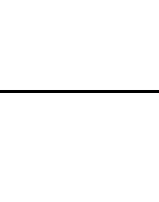
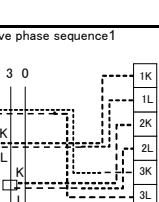
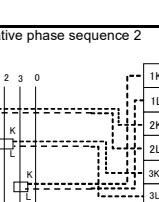
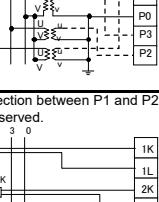
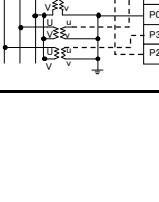
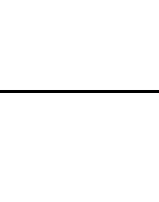
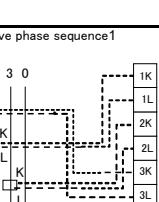
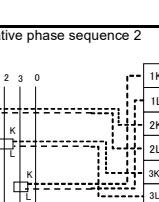
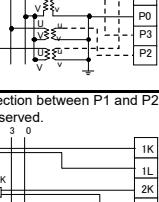
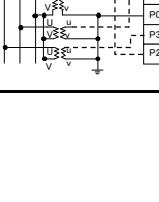
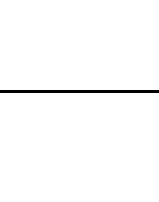
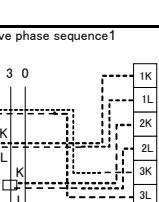
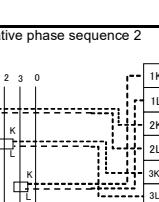
----- Indicates improper connection

No.	Power factor (Input)	At the average current ($V_{12}=V_{23}, I_1=I_3$)												Connection					
		Phase angle display				Electric power display		Voltage display			Current display			Voltage		Current		Connecting diagram	
		$\angle V_{12}$	$\angle V_{23}$	$\angle I_1$	$\angle I_3$	W1	W3	V_{12}	V_{23}	V_{31}	I_1	I_2	I_3	1	2	3	CT(side "1")	CT(side "3")	
Normal status	Forward 0.707	0	180	315	135	W1=W3	V12=V23<V31	I1=I3 I2=0	P1 P2 P3	1K 1L 3K 3L Forward	3K 3L Forward	1K 1L 3K 3L Forward	1K 1L 3K 3L Forward	P1 P2 P3	1K 1L 3K 3L Forward	1K 1L 3K 3L Forward	1K 1L 3K 3L Forward		
	Forward 0.866			330	150														
	1			0	180														
	Delayed 0.866			30	210														
	Delayed 0.707			45	225														
1	Forward 0.707	0	0	135	315	W1= Negative value W3= Positive value	V12=V23<V31	I1=I3 I2=0	P2 P1 P3	1K 1L 3K 3L Forward	3K 3L Forward	1K 1L 3K 3L Forward	1K 1L 3K 3L Forward	P2 P1 P3	1K 1L 3K 3L Forward	1K 1L 3K 3L Forward	1K 1L 3K 3L Forward		
	Forward 0.866			150	330														
	1			180	0														
	Delayed 0.866			210	30														
	Delayed 0.707			225	45														
2	Forward 0.707	0	0	135	315	W1= Negative value W3= Positive value	V12>V23=V31	I1=I3 I2=0	P2 P3 P1	1K 1L 3K 3L Forward	3K 3L Forward	1K 1L 3K 3L Forward	1K 1L 3K 3L Forward	P2 P3 P1	1K 1L 3K 3L Forward	1K 1L 3K 3L Forward	1K 1L 3K 3L Forward		
	Forward 0.866			150	330														
	1			180	0														
	Delayed 0.866			210	30														
	Delayed 0.707			225	45														
3	Forward 0.707	0	180	315	315	W1= Positive value W3= Negative value	V12=V23<V31	I1=I3<I2	P1 P2 P3	1K 1L 3K 3L Forward	3K 3L Forward	1K 1L 3K 3L Forward	1K 1L 3K 3L Forward	P1 P2 P3	1K 1L 3K 3L Forward	1K 1L 3K 3L Forward			
	Forward 0.866			330	330														
	1			0	0														
	Delayed 0.866			30	30														
	Delayed 0.707			45	45														
4	Forward 0.707	0	180	135	315	W1= Negative value W3= Negative value	V12=V23<V31	I1=I3 I2=0	P1 P2 P3	3K 3L Forward	1K 1L 3K 3L Forward	1K 1L 3K 3L Forward	1K 1L 3K 3L Forward	P1 P2 P3	1K 1L 3K 3L Forward	1K 1L 3K 3L Forward			
	Forward 0.866			150	330														
	1			180	0														
	Delayed 0.866			210	30														
	Delayed 0.707			225	45														
5	Forward 0.707	0	180	135	315	W1= Negative value W3= Negative value	V12=V23<V31	I1=I3	P3 P2 P1	1K 1L 3K 3L Forward	3K 3L Forward	1K 1L 3K 3L Forward	1K 1L 3K 3L Forward	P3 P2 P1	1K 1L 3K 3L Forward	1K 1L 3K 3L Forward			
	Forward 0.866			150	330														
	1			180	0														
	Delayed 0.866			210	30														
	Delayed 0.707			225	45														

■ Display example of discrimination support function for improper connection.

Display example (connection example for three-phase 4-wire)

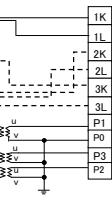
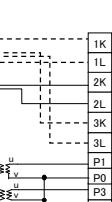
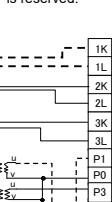
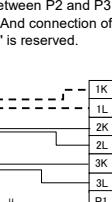
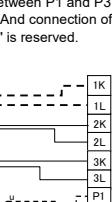
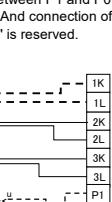
----- Indicates improper connection

No.	Power factor (input)	Phase angle display						At the average current ($V_{1N}=V_{2N}=V_{3N}$, $I_1=I_2=I_3$)						Wiring		
		$\angle V_{1N}$	$\angle V_{2N}$	$\angle V_{3N}$	$\angle I_1$	$\angle I_2$	$\angle I_3$	W ₁	W ₂	W ₃	V _{1N}	V _{2N}	V _{3N}	I ₁	I ₂	I ₃
Normal status	Forward 0.707	0	120	240	315	75	195	W ₁ =W ₂ =W ₃	V _{1N} =V _{2N} =V _{3N}	I ₁ =I ₂ =I ₃						
	Forward 0.866				330	90	210									
	1				0	120	240									
	Delayed 0.866				30	150	270									
	Delayed 0.707				45	165	285									
1	Forward 0.707	0	120	240	315	75	195	W ₁ =W ₂ =W ₃	V _{1N} =V _{2N} =V _{3N}	I ₁ =I ₂ =I ₃						
	Forward 0.866				330	90	210									
	1				0	120	240									
	Delayed 0.866				30	150	270									
	Delayed 0.707				45	165	285									
2	Forward 0.707	0	240	120	190	315	75	W ₁ =Negative value W ₂ =Positive value W ₃ =Positive value	V _{1N} =V _{2N} =V _{3N}	I ₁ =I ₂ =I ₃						
	Forward 0.866				210	330	90									
	1				240	0	120									
	Delayed 0.866				270	30	150									
	Delayed 0.707				285	45	165									
3	Forward 0.707	0	240	120	315	75	195	W ₁ =Positive value W ₂ =Negative value W ₃ =Positive value	V _{1N} =V _{2N} =V _{3N}	I ₁ =I ₂ =I ₃						
	Forward 0.866				330	90	210									
	1				0	120	240									
	Delayed 0.866				30	150	270									
	Delayed 0.707				45	165	285									
4	Forward 0.707	0	240	120	75	195	315	W ₁ =Positive value W ₂ =Positive value W ₃ =Negative value	V _{1N} =V _{2N} =V _{3N}	I ₁ =I ₂ =I ₃						
	Forward 0.866				90	210	330									
	1				120	240	0									
	Delayed 0.866				150	270	30									
	Delayed 0.707				165	285	45									
5	Forward 0.707	0	330	30	135	255	15	W ₁ =Negative value W ₂ =Positive value W ₃ =Positive value	V _{1N} <V _{2N} =V _{3N}	I ₁ =I ₂ =I ₃						
	Forward 0.866				150	270	30									
	1				180	300	60									
	Delayed 0.866				210	330	90									
	Delayed 0.707				225	345	105									

No.	Power factor (input)	Phase angle display						At the average current ($V1N=V2N=V3N$, $I1=I2=I3$)			Wiring			
		Electric power display			Voltage display		Current display							
		$\angle V_{1N}$	$\angle V_{2N}$	$\angle V_{3N}$	$\angle I_1$	$\angle I_2$	$\angle I_3$	W_1	W_2	W_3		V_{1N}	V_{2N}	V_{3N}
6	Forward 0.707	0	330	300	345	105	225	W1=Positive value W2=Negative value W3=Positive value	$V_{1N}=V_{3N}>V_{2N}$	$I_1=I_2=I_3$	<p>Connection between P2 and P0 are reserved.</p>			
	Forward 0.866				0	120	240							
	1				30	150	270							
	Delayed 0.866				60	180	300							
	Delayed 0.707				75	195	315							
7	Forward 0.707	0	60	30	285	45	165	W1=Positive value W2=Positive value W3=Negative value	$V_{1N}=V_{2N}>V_{3N}$	$I_1=I_2=I_3$	<p>Connection between P3 and P0 are reserved.</p>			
	Forward 0.866				300	60	180							
	1				330	90	210							
	Delayed 0.866				0	120	240							
	Delayed 0.707				15	135	255							
8	Forward 0.707	0	120	240	135	75	195	W1=Negative value W2=Positive value W3=Positive value	$V_{1N}=V_{2N}=V_{3N}$	$I_1=I_2=I_3$	<p>Connection of CT on side "1" is reserved.</p>			
	Forward 0.866				150	90	210							
	1				180	120	240							
	Delayed 0.866				210	150	270							
	Delayed 0.707				225	165	285							
9	Forward 0.707	0	120	240	315	255	195	W1=Positive value W2=Negative value W3=Positive value	$V_{1N}=V_{2N}=V_{3N}$	$I_1=I_2=I_3$	<p>Connection of CT on side "2" is reserved.</p>			
	Forward 0.866				330	270	210							
	1				0	300	240							
	Delayed 0.866				30	330	270							
	Delayed 0.707				45	345	285							
10	Forward 0.707	0	120	240	315	75	15	W1=Positive value W2=Positive value W3=Negative value	$V_{1N}=V_{2N}=V_{3N}$	$I_1=I_2=I_3$	<p>Connection of CT on side "3" is reserved.</p>			
	Forward 0.866				330	90	30							
	1				0	120	60							
	Delayed 0.866				30	150	90							
	Delayed 0.707				45	165	105							
11	Forward 0.707	0	120	240	75	315	195	W1=Positive value W2=Negative value W3=Positive value	$V_{1N}=V_{2N}=V_{3N}$	$I_1=I_2=I_3$	<p>CT side "1" and "2" are swapped.</p>			
	Forward 0.866				90	330	210							
	1				120	0	240							
	Delayed 0.866				150	30	270							
	Delayed 0.707				165	45	285							

Display example (connection example for three-phase 4-wire)

----- Indicates improper connection

No.	Power factor (input)	Phase angle display			At the average current (V1N=V2N=V3N, I1=I2=I3)			Wiring						
		$\angle V_{1N}$	$\angle V_{2N}$	$\angle V_{3N}$	$\angle I_1$	$\angle I_2$	$\angle I_3$	W1	W2	W3	V1N	V2N	V3N	I1
12	Forward 0.707	0	120	240	315	195	75	W1=Positive value W2=Positive value W3=Negative value	V1N=V2N=V3N	I1=I2=I3	CT side "2" and "3" are swapped.			
	Forward 0.866				330	210	90	W1=Positive value W2=0 W3=Negative value						
	1				0	240	120	W1=Positive value W2=Negative value W3=Negative value						
	Delayed 0.866				30	270	150	W1=Positive value W2=Negative value W3=0						
	Delayed 0.707				45	285	165	W1=Positive value W2=Negative value W3=Positive value						
13	Forward 0.707	0	120	240	195	75	315	W1=Negative value W2=Positive value W3=Positive value	V1N=V2N=V3N	I1=I2=I3	CT side "1" and "3" are swapped.			
	Forward 0.866				210	90	330	W1=Negative value W2=Positive value W3=0						
	1				240	120	0	W1=Negative value W2=Positive value W3=Negative value						
	Delayed 0.866				270	150	30	W1=0 W2=Positive value W3=Negative value						
	Delayed 0.707				285	165	45	W1=Positive value W2=Positive value W3=Negative value						
14	Forward 0.707	0	240	120	15	315	75	W1=Positive value W2=Positive value W3=Positive value	V1N=V2N=V3N	I1=I2=I3	Connection between P1 and P2 are reserved. And connection of CT on side "1" is reserved.			
	Forward 0.866				30	330	90	W1=Positive value W2=0 W3=Positive value						
	1				60	0	120	W1=Positive value W2=Negative value W3=Positive value						
	Delayed 0.866				90	30	150	W1=0 W2=Negative value W3=Positive value						
	Delayed 0.707				105	45	165	W1=Negative value W2=Positive value W3=Positive value						
15	Forward 0.707	0	240	120	135	75	195	W1=Negative value W2=Negative value W3=Positive value	V1N=V2N=V3N	I1=I2=I3	Connection between P2 and P3 are reserved. And connection of CT on side "1" is reserved.			
	Forward 0.866				150	90	210	W1=Negative value W2=Negative value W3=0						
	1				180	120	240	W1=Negative value W2=Negative value W3=Negative value						
	Delayed 0.866				210	150	270	W1=Negative value W2=0 W3=Negative value						
	Delayed 0.707				225	165	285	W1=Negative value W2=Positive value W3=Negative value						
16	Forward 0.707	0	240	120	255	195	315	W1=Negative value W2=Positive value W3=Negative value	V1N=V2N=V3N	I1=I2=I3	Connection between P1 and P3 are reserved. And connection of CT on side "1" is reserved.			
	Forward 0.866				270	210	330	W1=0 W2=Positive value W3=Negative value						
	1				300	240	0	W1=Positive value W2=Positive value W3=Negative value						
	Delayed 0.866				330	270	30	W1=Positive value W2=Positive value W3=0						
	Delayed 0.707				345	285	45	W1=Positive value W2=Positive value W3=Positive value						
17	Forward 0.707	0	330	30	315	255	15	W1=Positive value W2=Positive value W3=Positive value	V1N<V2N=V3N	I1=I2=I3	Connection between P1 and P0 are reserved. And connection of CT on side "1" is reserved.			
	Forward 0.866				330	270	30							
	1				0	300	60							
	Delayed 0.866				30	330	90							
	Delayed 0.707				45	345	105							

Display example (connection example for three-phase 4-wire)

----- Indicates improper connection

No.	Power factor (input)	Phase angle display						At the average current ($V1N=V2N=V3N$, $I1=I2=I3$)				Wiring					
		$\angle V1N$	$\angle V2N$	$\angle V3N$	$\angle I1$	$\angle I2$	$\angle I3$	W1	W2	W3	$V1N$	$V2N$	$V3N$	$I1$	$I2$	$I3$	
18	Forward 0.707	0	330	300	165	105	225	Wi = Negative value W2 = Negative value W3 = Positive value	$V1N=V3N > V2N$	$I1=I2=I3$	Connection between P2 and P0 are reserved. And connection of CT on side "1" is reserved.						
	Forward 0.866				180	120	240										
	1				210	150	270										
	Delayed 0.866				240	180	300										
	Delayed 0.707				255	195	315										
19	Forward 0.707	0	60	30	105	45	165	Wi = Negative value W2 = Positive value W3 = Negative value	$V1N=V2N > V3N$	$I1=I2=I3$	Connection between P3 and P0 are reserved. And connection of CT on side "1" is reserved.						
	Forward 0.866				120	60	180										
	1				150	90	210										
	Delayed 0.866				180	120	240										
	Delayed 0.707				195	135	255										
20	Forward 0.707	0	240	120	195	135	75	Wi = Negative value W2 = Negative value W3 = Positive value	$V1N=V2N=V3N$	$I1=I2=I3$	Connection between P1 and P2 are reserved. And connection of CT on side "2" is reserved.						
	Forward 0.866				210	150	90										
	1				240	180	120										
	Delayed 0.866				270	210	150										
	Delayed 0.707				285	225	165										
21	Forward 0.707	0	240	120	315	255	195	Wi = Positive value W2 = Positive value W3 = Positive value	$V1N=V2N=V3N$	$I1=I2=I3$	Connection between P2 and P3 are reserved. And connection of CT on side "2" is reserved.						
	Forward 0.866				330	270	210										
	1				0	300	240										
	Delayed 0.866				30	330	270										
	Delayed 0.707				45	345	285										
22	Forward 0.707	0	240	120	75	15	315	Wi = Positive value W2 = Negative value W3 = Negative value	$V1N=V2N=V3N$	$I1=I2=I3$	Connection between P1 and P3 are reserved. And connection of CT on side "2" is reserved.						
	Forward 0.866				90	30	330										
	1				120	60	0										
	Delayed 0.866				150	90	30										
	Delayed 0.707				165	105	45										
23	Forward 0.707	0	330	30	135	75	15	Wi = Negative value W2 = Negative value W3 = Positive value	$V1N < V2N=V3N$	$I1=I2=I3$	Connection between P1 and P0 are reserved. And connection of CT on side "2" is reserved.						
	Forward 0.866				150	90	30										
	1				180	120	60										
	Delayed 0.866				210	150	90										
	Delayed 0.707				225	165	105										

No.	Power factor (input)	Phase angle display						At the average current ($V_{1N}=V_{2N}=V_{3N}$, $I_1=I_2=I_3$)						Wiring	
		Electric power display			Voltage display			Current display							
		$\angle V_{1N}$	$\angle V_{2N}$	$\angle V_{3N}$	$\angle I_1$	$\angle I_2$	$\angle I_3$	W_1	W_2	W_3	V_{1N}	V_{2N}	V_{3N}	I_1	I_2
24	Forward 0.707	0	330	300	345	285	225	W ₁ =Positive value W ₂ =Positive value W ₃ =Positive value	$V_{1N}=V_{3N}>V_{2N}$	I ₁ =I ₂ =I ₃	Connection between P2 and P0 are reserved. And connection of CT on side "2" is reserved.				
	Forward 0.866				0	300	240								
	1				30	330	270								
	Delayed 0.866				60	0	300								
	Delayed 0.707				75	15	315								
25	Forward 0.707	0	60	30	285	225	165	W ₁ =Positive value W ₂ =Negative value W ₃ =Negative value	$V_{1N}=V_{2N}>V_{3N}$	I ₁ =I ₂ =I ₃	Connection between P3 and P0 are reserved. And connection of CT on side "2" is reserved.				
	Forward 0.866				300	240	180								
	1				330	270	210								
	Delayed 0.866				0	300	240								
	Delayed 0.707				15	315	255								
26	Forward 0.707	0	240	120	195	315	255	W ₁ =Negative value W ₂ =Positive value W ₃ =Negative value W ₁ =Negative value W ₂ =0 W ₃ =Negative value W ₁ =Negative value W ₂ =Negative value W ₃ =Negative value W ₁ =0 W ₂ =Negative value W ₃ =Negative value W ₁ =Positive value W ₂ =Negative value W ₃ =Negative value	$V_{1N}=V_{2N}=V_{3N}$	I ₁ =I ₂ =I ₃	Connection between P1 and P2 are reserved. And connection of CT on side "3" is reserved.				
	Forward 0.866				210	330	270								
	1				240	0	300								
	Delayed 0.866				270	30	330								
	Delayed 0.707				285	45	345								
27	Forward 0.707	0	240	120	315	75	15	W ₁ =Positive value W ₂ =Negative value W ₃ =Negative value W ₁ =Positive value W ₂ =0 W ₃ =Negative value W ₁ =Positive value W ₂ =Negative value W ₃ =Positive value W ₁ =Positive value W ₂ =0 W ₃ =Positive value W ₁ =Positive value W ₂ =Positive value W ₃ =Positive value	$V_{1N}=V_{2N}=V_{3N}$	I ₁ =I ₂ =I ₃	Connection between P2 and P3 are reserved. And connection of CT on side "3" is reserved.				
	Forward 0.866				330	90	30								
	1				0	120	60								
	Delayed 0.866				30	150	90								
	Delayed 0.707				45	165	105								
28	Forward 0.707	0	240	120	75	195	135	W ₁ =Positive value W ₂ =Positive value W ₃ =Positive value W ₁ =0 W ₂ =Positive value W ₃ =Positive value W ₁ =Negative value W ₂ =Positive value W ₃ =Positive value W ₁ =Negative value W ₂ =Positive value W ₃ =0 W ₁ =Negative value W ₂ =Positive value W ₃ =Positive value	$V_{1N}=V_{2N}=V_{3N}$	I ₁ =I ₂ =I ₃	Connection between P1 and P3 are reserved. And connection of CT on side "3" is reserved.				
	Forward 0.866				90	210	150								
	1				120	240	180								
	Delayed 0.866				150	270	210								
	Delayed 0.707				165	285	225								
29	Forward 0.707	0	330	30	135	255	195	W ₁ =Negative value W ₂ =Positive value W ₃ =Negative value W ₁ =Positive value W ₂ =Positive value W ₃ =Positive value W ₁ =Positive value W ₂ =0 W ₃ =Positive value W ₁ =Positive value W ₂ =Positive value W ₃ =Positive value	$V_{1N}<V_{2N}=V_{3N}$	I ₁ =I ₂ =I ₃	Connection between P1 and P0 are reserved. And connection of CT on side "3" is reserved.				
	Forward 0.866				150	270	210								
	1				180	300	240								
	Delayed 0.866				210	330	270								
	Delayed 0.707				225	345	285								

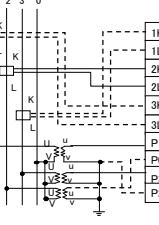
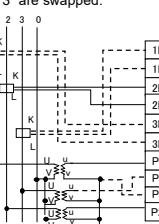
Display example (connection example for three-phase 4-wire)

No.	Power factor (input)	Phase angle display			At the average current (V1N=V2N=V3N, I1=I2=I3)						Wiring	
		$\angle V_{1N}$	$\angle V_{2N}$	$\angle V_{3N}$	$\angle I_1$	$\angle I_2$	$\angle I_3$	W1	W2	W3		
30	Forward 0.707	0	330	300	345	105	45	W1=Positive value W2=Negative value W3=Negative value	V1N=V3N>V2N	I1=I2=I3	Connection between P2 and P0 are reserved. And connection of CT on side "3" is reserved.	
	Forward 0.866				0	120	60					
	1				30	150	90					
	Delayed 0.866				60	180	120					
	Delayed 0.707				75	195	135					
31	Forward 0.707	0	60	30	285	45	345	W1=Positive value W2=Positive value W3=Positive value	V1N=V2N>V3N	I1=I2=I3	Connection between P3 and P0 are reserved. And connection of CT on side "3" is reserved.	
	Forward 0.866				300	60	0					
	1				330	90	30					
	Delayed 0.866				0	120	60					
	Delayed 0.707				15	135	75					
32	Forward 0.707	0	240	120	315	195	75	W1=W2=W3	V1N=V2N=V3N	I1=I2=I3	Connection between P1 and P2 are reserved. And CT side "1" and "2" are swapped.	
	Forward 0.866				330	210	90					
	1				0	240	120					
	Delayed 0.866				30	270	150					
	Delayed 0.707				45	285	165					
33	Forward 0.707	0	240	120	75	315	195	W1=W2=W3	V1N=V2N=V3N	I1=I2=I3	Connection between P2 and P3 are reserved. And CT side "1" and "2" are swapped.	
	Forward 0.866				90	330	210					
	1				120	0	240					
	Delayed 0.866				150	30	270					
	Delayed 0.707				165	45	285					
34	Forward 0.707	0	240	120	195	75	315	W1=W2=W3	V1N=V2N=V3N	I1=I2=I3	Connection between P1 and P3 are reserved. And CT side "1" and "2" are swapped.	
	Forward 0.866				210	90	330					
	1				240	120	0					
	Delayed 0.866				270	150	30					
	Delayed 0.707				285	165	45					
35	Forward 0.707	0	330	30	255	135	15	W1=Negative value W2=Negative value W3=Positive value	V1N<V2N=V3N	I1=I2=I3	Connection between P1 and P0 are reserved. And CT side "1" and "2" are swapped.	
	Forward 0.866				270	150	30					
	1				300	180	60					
	Delayed 0.866				330	210	90					
	Delayed 0.707				345	225	105					

No.	Power factor (input)	Phase angle display						At the average current ($V_{1N}=V_{2N}=V_{3N}$, $I_1=I_2=I_3$)						Wiring							
		Electric power display			Voltage display			Current display													
		$\angle V_{1N}$	$\angle V_{2N}$	$\angle V_{3N}$	$\angle I_1$	$\angle I_2$	$\angle I_3$	W_1	W_2	W_3	V_{1N}	V_{2N}	V_{3N}	I_1	I_2	I_3					
36	Forward 0.707	0	330	300	105	345	225	W ₁ =Negative value W ₂ =Positive value W ₃ =Positive value W ₁ =Negative value W ₂ =0 W ₃ =Positive value W ₁ =Negative value W ₂ =Negative value W ₃ =Positive value						V _{1N} =V _{3N} >V _{2N}	I ₁ =I ₂ =I ₃	Connection between P2 and P0 are reserved. And CT side "1" and "2" are swapped.					
	Forward 0.866				120	0	240														
	1				150	30	270														
	Delayed 0.866				180	60	300														
	Delayed 0.707				195	75	315														
37	Forward 0.707	0	60	30	45	285	165	W ₁ =Positive value W ₂ =Negative value W ₃ =Negative value W ₁ =0 W ₂ =0 W ₃ =Negative value W ₁ =Negative value W ₂ =Positive value W ₃ =Negative value						V _{1N} =V _{2N} >V _{3N}	I ₁ =I ₂ =I ₃	Connection between P3 and P0 are reserved. And CT side "1" and "2" are swapped.					
	Forward 0.866				60	300	180														
	1				90	330	210														
	Delayed 0.866				120	0	240														
	Delayed 0.707				135	15	255														
38	Forward 0.707	0	330	30	135	15	255	W ₁ =Negative value W ₂ =Positive value W ₃ =Negative value W ₁ =0 W ₂ =0 W ₃ =0 W ₁ =Negative value W ₂ =Negative value W ₃ =Positive value						V _{1N} <V _{2N} =V _{3N}	I ₁ =I ₂ =I ₃	Connection between P1 and P0 are reserved. And CT side "2" and "3" are swapped.					
	Forward 0.866				150	30	270														
	1				180	60	300														
	Delayed 0.866				210	90	330														
	Delayed 0.707				225	105	345														
39	Forward 0.707	0	330	300	345	225	105	W ₁ =Positive value W ₂ =Negative value W ₃ =Negative value W ₁ =Positive value W ₂ =0 W ₃ =Negative value W ₁ =Positive value W ₂ =Positive value W ₃ =Negative value						V _{1N} =V _{3N} >V _{2N}	I ₁ =I ₂ =I ₃	Connection between P2 and P0 are reserved. And CT side "2" and "3" are swapped.					
	Forward 0.866				0	240	120														
	1				30	270	150														
	Delayed 0.866				60	300	180														
	Delayed 0.707				75	315	195														
40	Forward 0.707	0	60	30	285	165	45	W ₁ =Positive value W ₂ =Negative value W ₃ =Positive value W ₁ =Positive value W ₂ =0 W ₃ =Positive value W ₁ =Positive value W ₂ =Positive value W ₃ =Negative value						V _{1N} =V _{2N} >V _{3N}	I ₁ =I ₂ =I ₃	Connection between P3 and P0 are reserved. And CT side "2" and "3" are swapped.					
	Forward 0.866				300	180	60														
	1				330	210	90														
	Delayed 0.866				0	240	120														
	Delayed 0.707				15	255	135														
41	Forward 0.707	0	330	30	15	255	135	W ₁ =Positive value W ₂ =Positive value W ₃ =Negative value W ₁ =0 W ₂ =Positive value W ₃ =Negative value W ₁ =Negative value W ₂ =Positive value W ₃ =Negative value						V _{1N} <V _{2N} =V _{3N}	I ₁ =I ₂ =I ₃	Connection between P1 and P0 are reserved. And CT side "1" and "3" are swapped.					
	Forward 0.866				30	270	150														
	1				60	300	180														
	Delayed 0.866				90	330	210														
	Delayed 0.707				105	345	225														

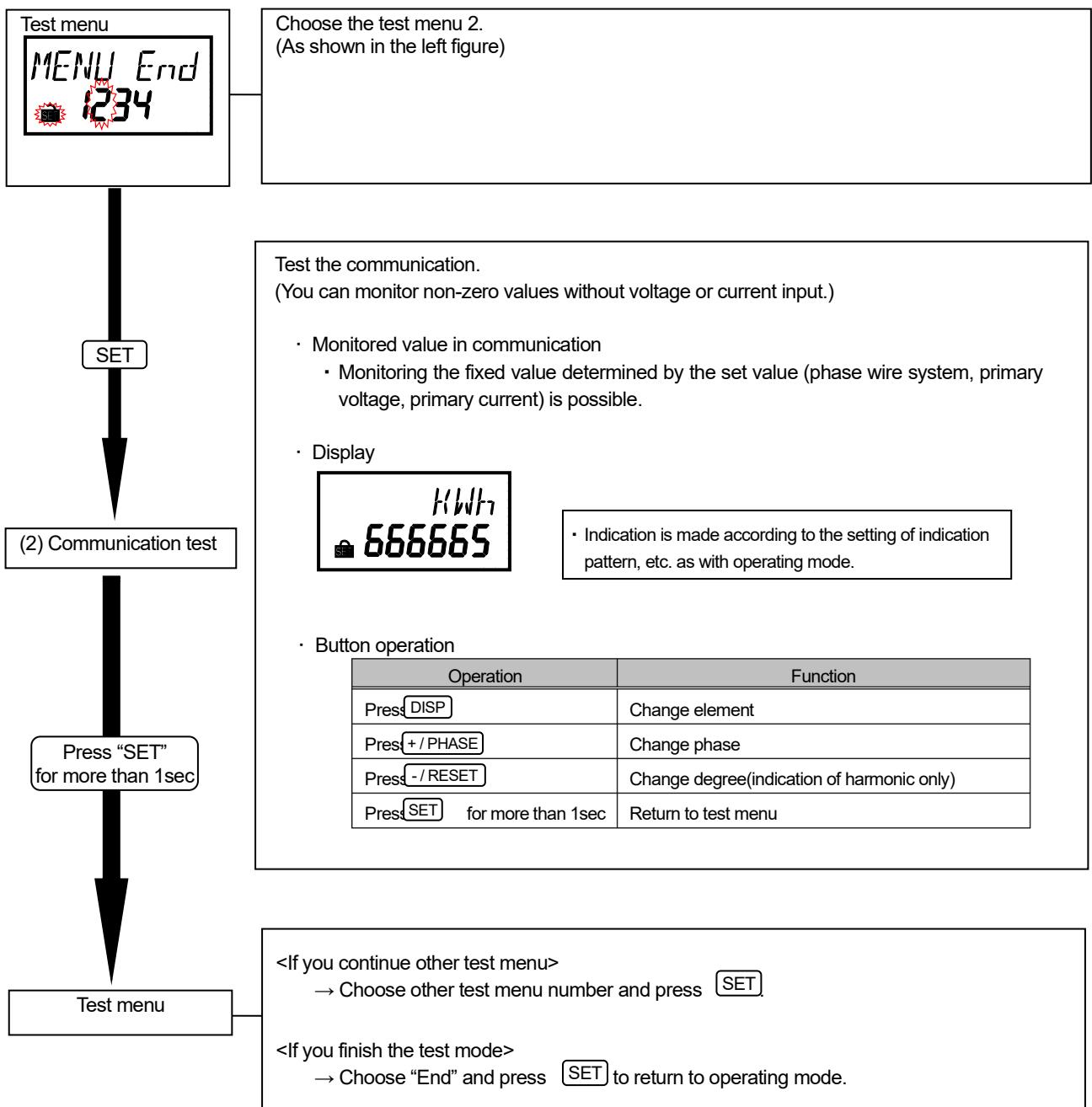
Display example (connection example for three-phase 4-wire)

----- Indicates improper connection

No.	Power factor (input)	Phase angle display					At the average current ($V_{1N}=V_{2N}=V_{3N}$, $I_1=I_2=I_3$)			Wiring				
		Electric power display			Voltage display		Current display							
		$\angle V_{1N}$	$\angle V_{2N}$	$\angle V_{3N}$	$\angle I_1$	$\angle I_2$	$\angle I_3$	W_1	W_2	W_3	V_{1N}	V_{2N}	V_{3N}	I_1
42	Forward 0.707	0	330	300	225	105	345	W ₁ =Negative value W ₂ =Negative value W ₃ =Positive value W ₁ =0 W ₂ =Negative value W ₃ =0 W ₁ =Positive value W ₂ =Negative value W ₃ =Negative value	$V_{1N}=V_{3N}>V_{2N}$	$I_1=I_2=I_3$	<p>Connection between P2 and P0 are reserved. And CT side "1" and "3" are swapped.</p> 			
	Forward 0.866				240	120	0							
	1				270	150	30							
	Delayed 0.866				300	180	60							
	Delayed 0.707				315	195	75							
42	Forward 0.707	0	60	30	165	45	285	W ₁ =Negative value W ₂ =Positive value W ₃ =Negative value W ₁ =Negative value W ₂ =Positive value W ₃ =0 W ₁ =Negative value W ₂ =Positive value W ₃ =Positive value	$V_{1N}=V_{2N}>V_{3N}$	$I_1=I_2=I_3$	<p>Connection between P3 and P0 are reserved. And CT side "1" and "3" are swapped.</p> 			
	Forward 0.866				180	60	300							
	1				210	90	330							
	Delayed 0.866				240	120	0							
	Delayed 0.707				255	135	15							

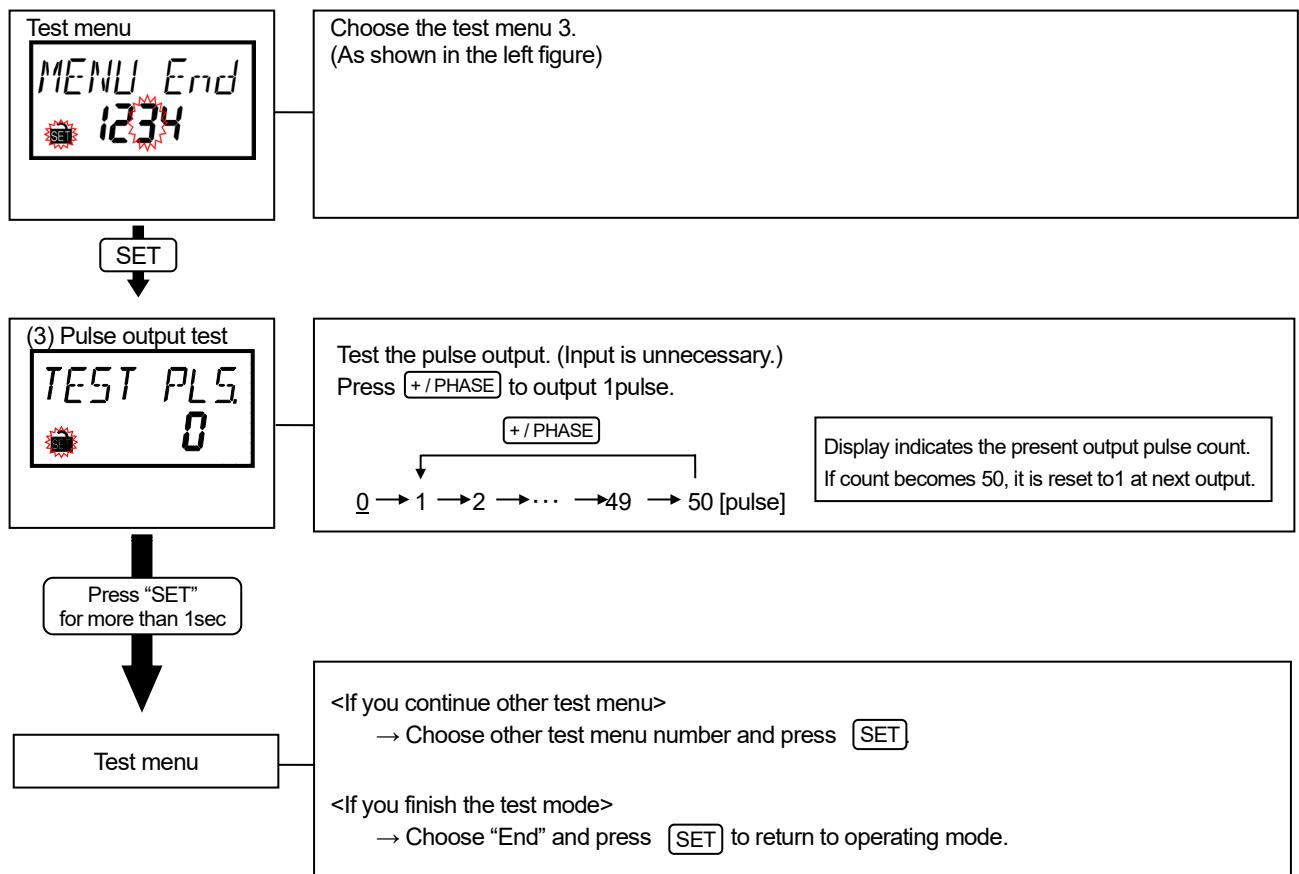
Test menu 2: Communication test

In test mode, the following operations can be possible.



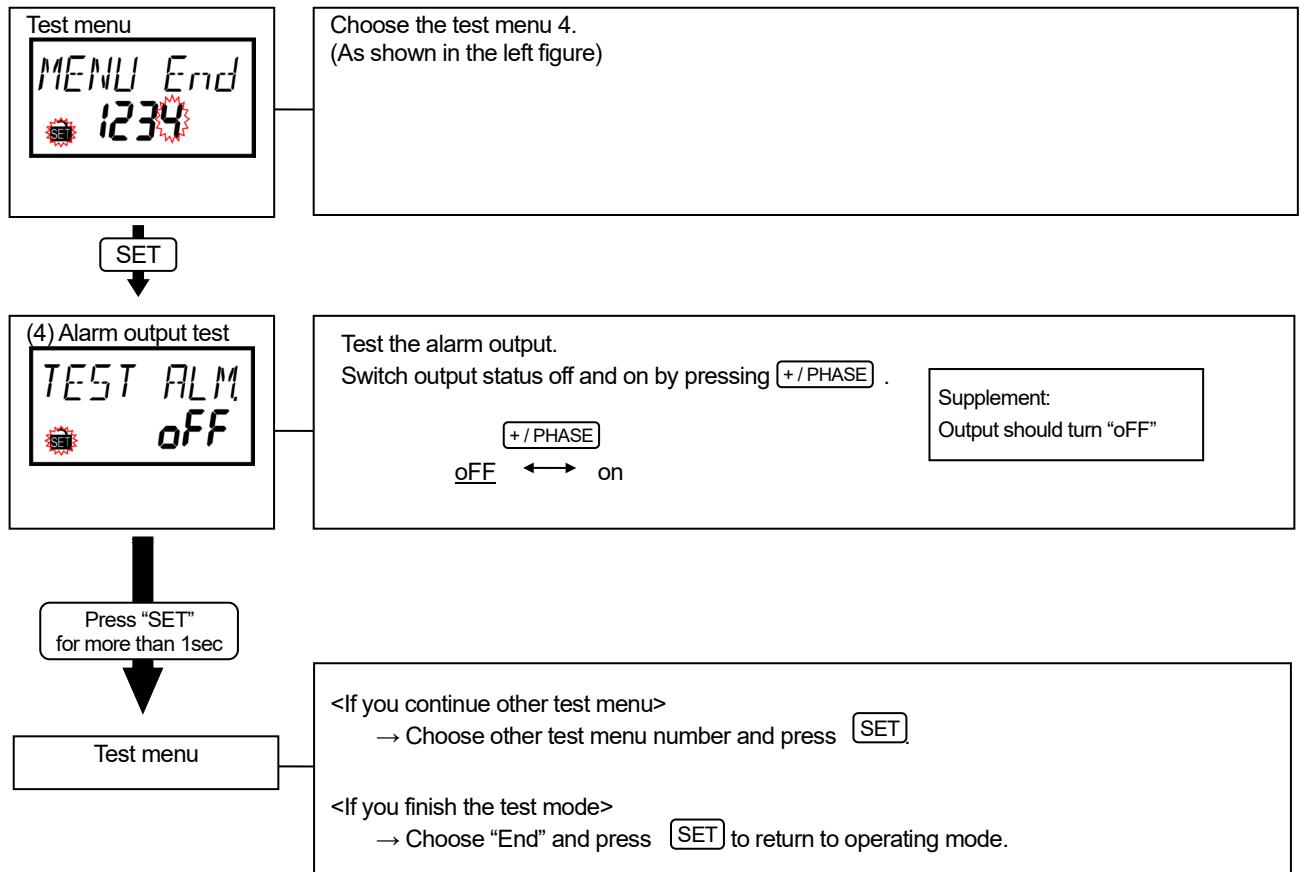
Test menu 3: Pulse output test

In test mode, the following operations can be possible.



Test menu 4: Alarm output test

In test mode, the following operations can be possible.



8. Operation

Operation procedure in operating mode

This unit indicates the measured value of each item in operating mode. (For the measured items which can be indicated, [page 57](#))

Operation procedure to change the measured item indicated is as follows:

	Operation	Details		
Change the indicated item	Press DISP	Indicated item is changed by every operation in following order:		
		Measuring item	Display example	unit
		Electric energy (Consumption)		kWh MWh
		Current	Current (phase 1) 	A
		Current demand	Current demand (phase 1) 	A
		Voltage	Voltage (1-2) 	V
		Electric power		kW MW
		Electric power demand		kW MW
		Reactive power		kVAR MVAR
		Apparent power		kVA MVA
		Power factor		%
		Frequency		Hz
		RMS value of harmonic current	RMS value of total harmonic current (phase 1) 	A
		Distortion rate of harmonic current	Distortion rate of total harmonic current (phase 1) 	%
		RMS value of harmonic voltage	RMS value of total harmonic voltage (phase 1) 	V
		Distortion rate of harmonic voltage	Distortion rate of total harmonic voltage (phase 1) 	%

Change the indicated item	Press DISP	Measuring item	Display example	unit	Note
		Reactive energy (consumption lag)	KVARh • 123456 MVARh • 123456	kvarh Mvarh	• Unit varies depending on the setting value (P.52).
		Electric energy (regeneration)	REG KWh • 123456 REG MWh • 123456	kWh MWh	• Unit varies depending on the setting value (P.52).
		Periodic electric energy	PR1 KWh • 123456 PR1 MWh • 123456	kWh MWh	Periodic electric energy is the electric energy while external contact input is ON. • Unit varies depending on the setting value (P.52). • Integrated electric energy (consumption) while contact input is "ON". • Indicated in only when contact / pulse input (P.23) is set to "CO.P." (skipped this display when set to "PLS").
		CO ₂ conversion setting	CO2 KG • 99999 CO2 t • 999999	kg t	• Unit varies depending on the setting value (P.52). • Indicated in only when Equivalent CO ₂ indication (P.24) is set to "on." (skipped this display when set to "oFF").
		Pulse count value	PULSE • 123456	-	• Indicated in only when contact / pulse input (P.23) is set to "PLS." (skipped this display when set to "CO.P.").
		Condition of contact input	CO.P. • off	-	• Indicated in only when contact / pulse input (P.23) is set to "CO.P." (skipped this display when set to "PLS").
		Operating time	OPTIME h • 999999	h	• Indicated in only when operating time indication (P.25) is set to "on." (skipped this display when set to "oFF").
		Date	20160101 • 00:00	-	• Indicated in only when the logging unit is connected.

Note: The display example above-mentioned is the example when measuring electric energy (consumption).

Change phase	Press + / PHASE	Phase is changed by every operation in following order:			
		Indicated item	Order of change		
		Present current value	1-phase → 2-phase → 3-phase → N-phase* → Average → 1-phase → ...		
		Present current demand value	1-phase → 2-phase → 3-phase → N-phase* → 1-phase → ...		
		Present voltage value	phase 12 → phase 23 → phase 31 → phase 1N* → phase 2N* → phase 3N* → Average → phase 12 → ...		
		Harmonic current	phase 1 → phase 2 → phase 3 → phase N* → phase 1 → ...		
		Harmonic voltage (except for 3P4W)	phase 12 → phase 23 → phase 12 → ...		
*: Indicated in three-phase 4-wire (3P4W) only. Supplement: Phase is not changed in the items except above regardless of phase wire system. For average current and average voltage, (P.51).					

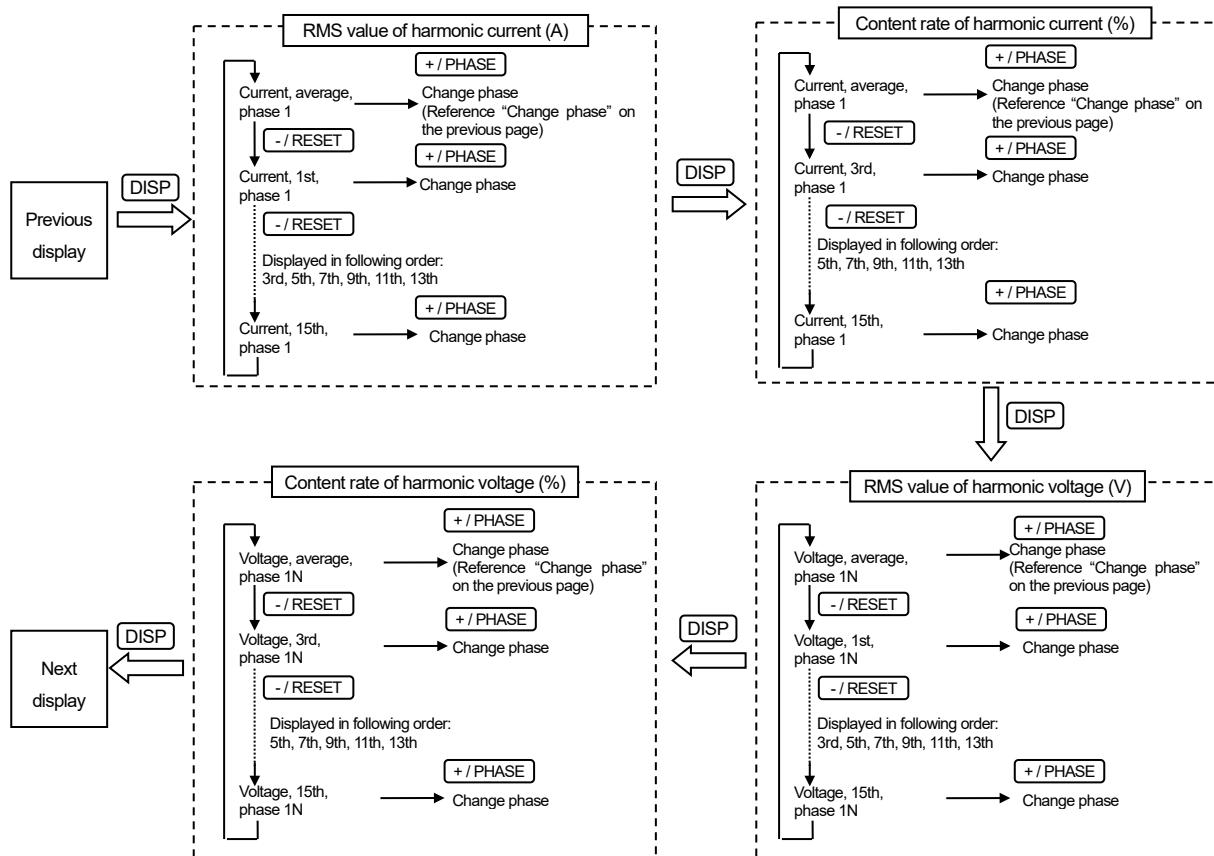
- **Indication of harmonic**

This unit can indicate the RMS value of harmonic, distortion rate and content rate. To indicate them, the indication setting of harmonic is needed in advance.
(For indication setting of harmonic, refer to p.24,25.)

- Measured element

Order	Harmonic current		Harmonic voltage	
	RMS value	Distortion rate (Content rate)	RMS value	Distortion rate (Content rate)
Total of harmonic	○	○	○	○
1st	○	-	○	-
3rd	○	○	○	○
5th	○	○	○	○
7th	○	○	○	○
9th	○	○	○	○
11th	○	○	○	○
13th	○	○	○	○
15th	○	○	○	○

- Transition diagram for indication of harmonic (change degree)



Supplement: Harmonic total is shown by "ALL".

· Indication of electric energy, reactive energy and periodic energy

- Indication format

The indication format of electric energy, reactive energy and periodic energy is as follows depending on the full load power:

$$\text{Full load power [kW]} = \frac{\alpha \times (\text{VT primary voltage}) \times (\text{CT primary current})}{1000}$$

$\alpha:$

1

2

$\sqrt{3}$

3

Single-phase, 2-wire

Single-phase, 3-wire

Three-phase, 3-wire

Three-phase, 4-wire

*1: VT primary voltage in single-phase 3-wire system is regarded as 110V.

*2: Using direct connection, replace VT primary voltage with direct voltage in calculation above.

*3: In three-phase 4-wire system, replace VT primary voltage or direct voltage with phase voltage in calculation above.

Full load power [kW]	Indication format	
	Digital indication	Unit
less than 12	8888.88	kWh kvarh
12 or more and less than 120	88888.8	
120 or more and less than 1200	888888	
1200 or more and less than 12000	8888.88	MWh Mvarh
12000 or more	88888.8	

· Indication of electric power, power demand, reactive power and apparent power

- Indication format

The indication format of electric power, power demand, reactive power and apparent power is as follows depending on the full load power:

(For the full load power, refer to above.)

Full load power [kW]	Indication format	
	Digital indication	Unit
less than 12	888.888	kW kvar kVA
12 or more and less than 120	8888.88	
120 or more and less than 1200	88888.8	
1200 or more and less than 12000	888888	
12000 or more	8888.88	MW Mvar MVA

· Indication of current and current demand

- Indication format

The indication style of current and current demand is as follows depending on the primary current:

Primary current [A]	Indication format	
	Digital indication	Unit
less than 40	888.888	A
40 or more and less than 400	8888.88	
400 or more and less than 4000	88888.8	
4000 or more	888888	

· Indication of voltage

- Indication style

The indication format of voltage is as follows depending on the primary voltage:

Primary voltage [V]	Indication format	
	Digital indication	Unit
less than 300	88888.8	V
300 or more	888888	

Caution: In three-phase 4-wire system, the indication of VT primary voltage and direct voltage depends on the phase voltage.

- **Indication of harmonic current and harmonic voltage**

- Indication format

To indicate harmonic current and harmonic voltage, the indication setting of them is needed in advance. The indication format of them is as follows depending on the full load power:

Measured element	Indication format	
	Digital indication	Unit
RMS value of harmonic current	same as current	same as current
Distortion rate of harmonic current (Content rate)	888.8	%
RMS value of harmonic voltage	same as voltage	same as voltage
Distortion rate of harmonic voltage (Content rate)	888.8	%

- **Indication of equivalent CO₂**

- Indication format

To indicate equivalent CO₂, the indication setting of it is needed in advance. The indication format of it is as follows depending on the full load power:

Full load power [kW]	Indication format	
	Digital indication	Unit
less than 12	8888.88	kg
12 or more and less than 120	88888.8	
120 or more and less than 1200	888888	
1200 or more and less than 12000	8888.88	t
12000 or more	88888.8	

How to use upper/lower limit alarm function

This device can set the upper/lower limit alarm value for each measured value individually.

<Monitoring items>

Upper limit alarm items	Current demand, phase N current demand, Voltage, Electric power demand, Power factor, Pulse count
Lower limit alarm items	Current demand, Voltage, Electric power demand, Power factor,

<Alarm setting>

- Upper limit value Set the upper limit of measured value. For setting value and setting range, [p.26,27](#)
- Lower limit value Set the lower limit of measured value. For setting value and setting range, [p.26,27](#)
- Alarm delay time Set the value in case you want to remove the inrush current of the load, etc. from the objects of monitoring. Alarm does not occur when the measured value goes below the upper limit or goes over the lower limit within the configured time. For setting value and setting range, [page 27](#).
- Alarm reset method Alarm recovery operation is different according to the alarm reset method.

Reset method	Alarm recovery operation
Auto-reset (Auto)	Reset the alarm automatically if the measured value goes below the upper limit or goes over the lower limit.
Self-retention (HoLd)	The alarm is held after the measured value goes below the upper limit or goes over the lower limit. Alarm is cleared by alarm reset.

For setting, [page 27](#). For alarm reset operation, [page 55](#).

<Alarm occurrence / recovery condition>

Alarm item	Alarm reset method	Alarm status		Alarm occurrence / recovery condition
Current demand Phase N current demand Voltage Electric power demand Power factor	Auto-reset (Auto)	Upper limit monitoring	Occurrence	Measured value > configured upper limit (Alarm delay time is available)
			Recovery	Measured value ≤ configured upper limit
		Lower limit monitoring	Occurrence	Measured value < configured lower limit (Alarm delay time is available)
			Recovery	Measured value ≥ configured lower limit
	Self-retention (HoLd)	Upper limit monitoring	Occurrence	Measured value > configured upper limit (Alarm delay time is available)
			Retention	Measured value ≤ configured upper limit
			Recovery	Measured value ≤ configured upper limit AND Alarm reset
		Lower limit monitoring	Occurrence	Measured value < configured lower limit (Alarm delay time is available)
		Retention	Measured value ≥ configured lower limit	
		Recovery	Measured value ≥ configured lower limit AND Alarm reset	
Pulse count	Auto-reset (Auto)	Upper limit monitoring	Occurrence	Measured value ≥ configured upper limit
		Recovery	Measured value < configured upper limit	
	Self-retention (HoLd)	Upper limit monitoring	Occurrence	Measured value ≥ configured upper limit
			Retention	Measured value < configured upper limit
			Recovery	Measured value < configured upper limit

Caution: Measured value of pulse count is integrated, so you can reduce it (i.e. clear it to zero) by the preset operation of pulse count only. For the preset operation of pulse count, [page 56](#).

<Alarm indication at alarm status>

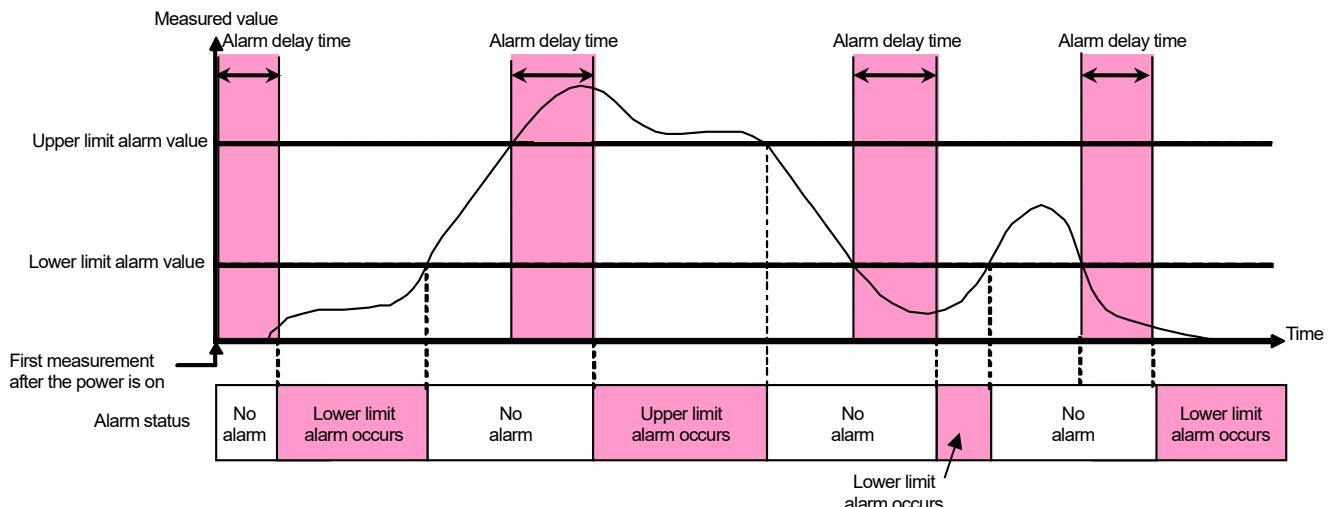
	No alarm	Alarm occurrence		Alarm retention	
		When indicating the alarm-occurrence phase	When indicating the other phase	When Indicating the alarm-occurrence phase	When indicating the other phase
Digital indication	Turn ON	Flash (*1)	Turn ON	Flash (*2)	Turn ON
Measured element, Unit, Phase	Turn ON	Flash (*1)	Flash (*1)	Flash (*2)	Flash (*2)

*1: Flash (250ms ON / 250ms OFF)

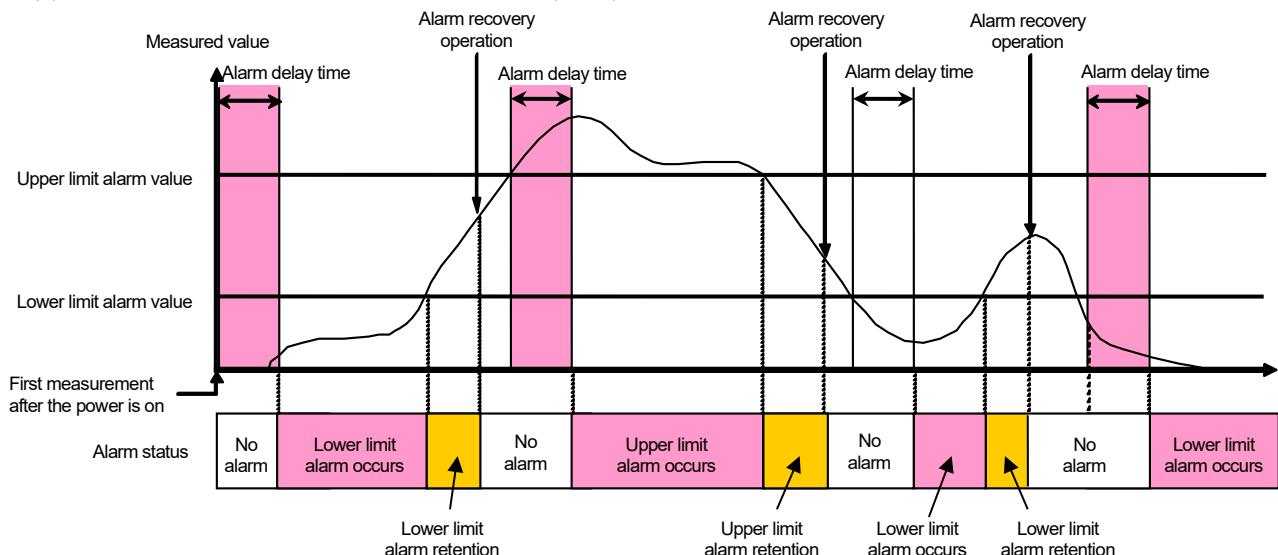
*2: Flash (500ms ON / 500ms OFF)

< Examples of alarm occurring (except for the upper limit of pulse count) >

(1) When the alarm reset method is "Auto-reset (Auto)".



(2) When the alarm reset method is "Self-retention (HoLd)".



Operations of alarm reset

Operations of alarm reset

Alarm recovery operation is different according to the alarm reset method.

Alarm reset method	Alarm recovery operation
Auto-reset (Auto)	Reset the alarm automatically if the measured value goes below the upper limit or goes over the lower limit.
Self-retention (HoLd)	The alarm is held after the measured value goes below the upper limit or goes over the lower limit. Clear the alarm as below after the value goes below the upper limit or goes over the lower limit. <ul style="list-style-type: none"> In the present value display of operating mode, press - / RESET button for two seconds to clear the alarm. <p>(Alarm clear is effective even in other than the alarm-occurrence phase.)</p>

Preset and all data reset

You can reset all the integrated measured values or some of them to zero. (such as electric energy, operating time, etc.)

- The integrated measured values you can reset to zero are as follows:

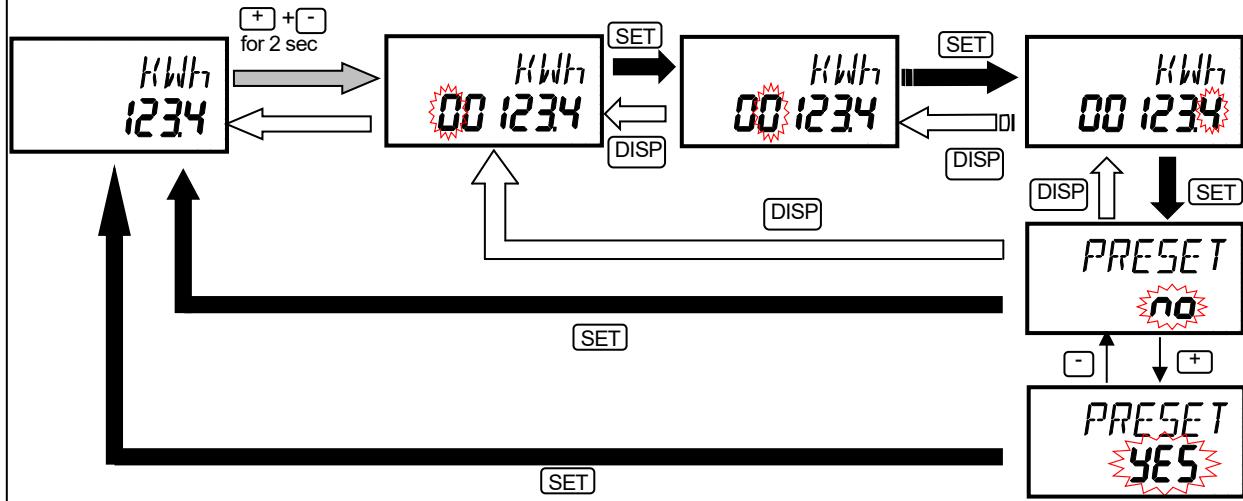
Electric energy (consumption, regeneration), Reactive energy, Periodic energy, Pulse count, Equivalent CO₂, Operation time

- Preset (Data reset of selected value)

- In each integrated value display of operating mode, press both **[+ / PHASE]** and **[- / RESET]** at the same time for more than two seconds to transition to preset mode.
- Preset procedure is as follows:

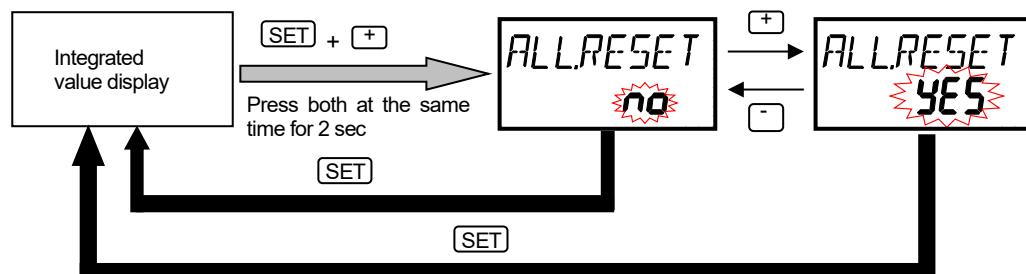
Operation of preset display

- Press **[+ / PHASE]** or **[- / RESET]** to choose the value at flashing digit.
- Press **SET** for the setting digit (flashing digit) to shift to lower.
- Press **DISP** for the setting digit (flashing digit) to shift to upper.
- Press **SET** at the lowest digit to transition to preset confirmation display as below.
- In preset confirmation display, choose "yES" to reset value, then back to the integrated value display.
- In preset confirmation display, choose "no" to cancel resetting value, then back to the integrated value display.
- Preset display transition example (Electric energy (consumption))



- All data reset

- In each integrated value display of operating mode, press both **SET** and **[+ / PHASE]** at the same time for more than two seconds to transition to all-data-reset display as below.
- In all-data-reset display, choose "yES" to reset all the integrated values to zero, then back to the integrated value display.
- In all-data-reset display, choose "no" to cancel resetting, then back to the integrated value display.
- All data reset display transition



9. Device operation

Measured items

The table below shows whether indication and output are performed or not for each measured item.

• … Data which are indicated and output

- … Data which are not indicated or output

Measured item		Details	EMU4-FD1-MB				
			1P2W	1P3W	3P3W	3P4W	
Current		phase 1	•	•	•	•	
		phase 2	-	•	•	•	
		phase 3	-	•	•	•	
		phase N	-	-	-	•	
		Average	•	•	•	•	
Current demand *moving average for the set period of current demand is indicated		phase 1	•	•	•	•	
		phase 2	-	•	•	•	
		phase 3	-	•	•	•	
		phase N	-	-	-	•	
Voltage		phase 12	•	•	•	•	
		phase 23	-	•	•	•	
		phase 31	-	•	•	•	
		phase 1N	-	-	-	•	
		phase 2N	-	-	-	•	
		phase 3N	-	-	-	•	
Average line voltage			•	•	•	•	
Electric power			•	•	•	•	
Electric power demand *moving average for the set period of current demand is indicated			•	•	•	•	
Reactive power			•	•	•	•	
Apparent power			-	-	-	•	
Power factor			•	•	•	•	
Frequency			•	•	•	•	
Harmonic current	RMS	Total 1st 3rd - 15th	phase 1	•	•	•	
			phase 2	-	-	•	
			phase 3	-	•	•	
			phase N	-	-	•	
	Distortion ratio	Total 3rd - 15th	phase 1	•	•	•	
			phase 2	-	-	•	
			phase 3	-	•	•	
			phase N	-	-	•	
Harmonic voltage	RMS	Total 1st 3rd - 15th	phase 1N	-	-	•	
			phase 2N	-	-	•	
			phase 3N	-	-	•	
			phase 12	•	•	-	
			phase 23	-	•	-	
	Distortion ratio	Total 3rd - 15th	phase 1N	-	-	•	
			phase 2N	-	-	•	
			phase 3N	-	-	•	
			phase 12	•	•	-	
			phase 23	-	•	-	
Electric energy		Consumption	•	•	•	•	
		Regeneration	•	•	•	•	
		Consumption (extended) (*1)	•	•	•	•	
		Regeneration (extended) (*1)	•	•	•	•	
Reactive energy		Consumption lag	•	•	•	•	
		Consumption lag (extended) (*1)	•	•	•	•	
External input	Pulse input	Pulse count	•	•	•	•	
	Contact input	Periodic electric energy	•	•	•	•	
Operating time			•	•	•	•	
Equivalent CO2 (*2)			•	•	•	•	

*1: Output is supported, but indication is not supported.

*2: Indication is supported, but communication is not supported.

✓ **Supplement** -----

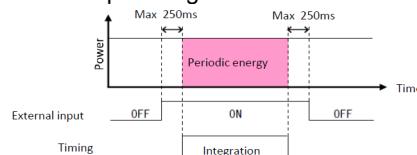
The table below shows how to calculate the average value.

Item	Phase-wire system	Calculating formula
RMS current value (Average)	Single-phase 2-wire	RMS current value (Average) = phase 1 current
	Single-phase 2-wire Three-phase 3-wire	RMS current value (Average) = (phase 1 current + phase 3 current) / 2
	Three-phase 4-wire	RMS current value (Average) = (phase 1 current + phase 2 current + phase 3 current) / 3
RMS voltage value (Average)	Single-phase 2-wire	RMS voltage value (Average) = voltage V12
	Single-phase 2-wire Three-phase 3-wire	RMS voltage value (Average) = (voltage V12+ voltage V23) / 2
	Three-phase 4-wire	RMS voltage value (Average) = (voltage V12 + voltage V23+ voltage V31) / 3

Restrictions of measured data

F/W version is displayed in five seconds after the power loading to this device.
 Measurement and communication do not performed in a few seconds after the configuration or the change of the rating to it.
 Behaviors during operation are as follows:

Measured item	Behaviors of this device	
	Display part indication	Communication data
Current	Indicate "0A" if RMS value is under 0.4% range of rating. Indicate upper indication limit value if RMS value is over it.	Same as on the left
Current demand	Indicate upper indication limit value if RMS value is over it.	Same as on the left
Voltage (*1)	Indicate "0V" if RMS value is under 11V. Indicate upper indication limit value if RMS value is over it.	Same as on the left
Power Power demand Reactive power Apparent power	Indicate "0W", "0var" or "0VA" if indicated voltage values of all phases are 0V or indicated current values of them are 0A. Indicate upper indication limit value if the measured value is over it.	Same as on the left
Power factor	Indicate "100.0%" if indicated voltage values of all phases are 0V or indicated current values of them are 0A	Same as on the left
Frequency	Voltage condition: Indicate "—" if voltage V12 (voltage V1N for 3P4W) is 0V.	0
	Frequency condition: Indicate "—" if frequency is under 44.5Hz.	44.5
RMS value of harmonic current	Voltage condition: Indicate "—" at all phase if voltage V12 (voltage V1N for 3P4W) is under 11V. Indicate "0A" at all phase if voltage V12 (voltage V1N for 3P4W) is under 40V.	0
	Frequency condition: Indicate "—" at all phases if frequency is under 44.5Hz.	0
Content rate of harmonic current (modulation distortion)	Voltage condition: Indicate "—" at all phase if voltage V12 (voltage V1N for 3P4W) is under 11V. Indicate "0.0%" at all phase if voltage V12 (voltage V1N for 3P4W) is under 40V.	0
	Frequency condition: Indicate "—" at all phases if frequency is under 44.5Hz.	Outside-channel error
RMS value of harmonic voltage	Voltage condition: Indicate "—" at all phase if voltage V12 (voltage V1N for 3P4W) is under 11V. Indicate "0V" at all phase if voltage V12 (voltage V1N for 3P4W) is under 40V.	0
	Frequency condition: Indicate "—" at all phases if frequency is under 44.5Hz.	0
Content rate of harmonic voltage (modulation distortion)	Voltage condition: Indicate "—" at all phase if voltage V12 (voltage V1N for 3P4W) is under 11V. Indicate "0.0%" at all phase if voltage V12 (voltage V1N for 3P4W) is under 40V.	0
	Frequency condition: Indicate "—" at all phases if frequency is under 44.5Hz.	0
Pulse count	When use of upper / lower limit alarm = oFF or upper / lower limit alarm element ≠ pulse count (upper limit), counting restarts from 0 when 999999 have been exceeded. When use of upper / lower limit alarm = on and upper / lower limit alarm element = pulse count (upper limit), it is fixed to 999999 when 999999 have been exceeded.	Same as on the left
Operating time (*2)	Indicate "999999h" if operating time is over 999999h.	Same as on the left
Periodic electric energy	For contact input ON/OFF, integrated value may deviate up to 250 ms less in time at the start or stop of integration.	Same as on the left



*1: In single-phase, three-wire system, indicate "0V" if RMS value is under 22V.

*2: Operation time is reference value.

10. Reference

This chapter explains the ways of dealing when you think the unit is in failure, Q&A, etc.

In case you think the unit is in failure

If an abnormal sound, bad-smelling smoke, fever break out from this unit, switch it off promptly and don't use it. If you think the unit is in failure, check the following before sending for repair.

Obtained value is incompatible with other values.

- Integrated electric energy value is not measured though current value is indicated.
- Obtained values are different from other measuring instruments.

Check the polarity of connection between a CT and the terminals of this unit.

Check the settings of phase wire system, primary voltage and primary current.
Wrong settings may cause the incorrect measurement.

Check whether the short circuit or disconnection is present.

Obtained values are different from other measuring instruments. (over tolerance)

Check that the measuring instrument used for comparison indicates a correct RMS value. This unit indicates an RMS value.

If the measuring instrument used for comparison measures an average value instead of RMS value, distortion caused by harmonic etc. in the current of the circuit to be measured causes a significant difference of values.

About error number

In case the display part indicates the error number as below, adopt measures indicated in the table below.
If the unit does not resume after measures, it may be in failure. Contact our sales representative near you.

(Example) Error No.005



Error No.	Kind of Error	Measures
002	FRAM error	Press the reset button until the display (LED) turns off. or Restore auxiliary power supply.
003	Memory error	
004	Timeout error	
005	Outside-set-value error	Press SET button
009	Communication module error	Make sure that the communication module is connected properly, then turn on the power again auxiliary.

After-sales service

If you have any questions or the product is broken down, contact our sales representative near you. (For details, refer to the end of this manual.)

- Gratis warranty is effective until the earlier of 1 year after the date of your purchase or 18 months after manufacturing.
- The gratis warranty shall apply if the product fails even though it is being used properly in the conditions, with the methods and under the environments in accordance with the terms and precautions described in the catalogs, the instruction manual, caution label on the product, etc.
- Repair shall be charged for the following cases even during the gratis warranty period.
 - Failures occurring due to your improper storage or handling, carelessness or fault.
 - Failures due to faulty workmanship
 - Failures due to faults in use and undue modification
 - Failures due to accidental force such as a fire, abnormal voltage, etc. and force majeure such as an earthquake, wind, flood, etc.
 - Failures due to matters unpredictable based on the level of science technology at the time of product.
- Our company shall not be liable to compensate for any loss arising from events not attributable to our company, opportunity loss and lost earning of the customer due to failure of the product, and loss, secondary loss, accident compensation, damage to other products besides our products and other operations caused by a special reason regardless of our company's predictability

Q&A

General

Q	To what degree is the unit durable against overvoltage and over current?
A	Durability is as follows: Momentary*: Up to 10 times as high as rated current and 2 times as high as rated voltage. *Momentary means: Energizing 9 times for 0.5 seconds at 1-minute intervals, and then 1 time for 5 seconds. Continuous: Up to 1.2 times as high as rated voltage and rated current.
Q	Can the unit be used as an electric energy meter?
A	This unit cannot be used for deal and proof of electric energy measurement stipulated in the measurement law.
Q	Are errors in wiring verifiable easily?
A	They are verifiable by the indication for discrimination support function for improper connection. (☞ p.37-46)
Q	If a load such as welding equipment exists, a current flows only for a short period (e.g. 2 cycles). Is measurement possible?
A	The electrical amount such as current, voltage, electric power, power factor, frequency, harmonic voltage and harmonic current is measured in a cycle of 250 ms period. So it is impossible to measure the current accurately for a short period. The amount of electricity and reactive power amount are measured separately from the momentary data described above, using a sampling period of about 4kHz continuously without intermittence. Therefore, it is possible to measure the load for a short period.
Q	Obtained values may be different from other measuring instruments. Why is it so?
A	There are various possible causes. Check the following first, please: (1) Check for wiring errors. (2) Check for the settings. (phase wires, primary voltage and primary current) (3) Check for the short circuit on the secondary side of the current transformer (CT). (4) Check that the measuring instrument used for comparison indicates a correct RMS value. This unit indicates an RMS value. If the measuring instrument used for comparison measures an average value instead of RMS value, distortion caused by harmonic etc. in the current of the circuit to be measured causes a significant difference of values.

· Q&A about specifications

Q	What does “Allowable tolerance” mean?
A	In terms of the amount of electricity, it means a range of tolerances in reading values. For example, when the reading value is “10 kWh,” a tolerance is ± 0.05 kWh. In terms of measured elements other than the amount of electricity, it means a tolerance to the full scale (refer to page 65). For a current, when a rated current is set to 5 A, $\pm 0.5\%$ of 5 A is a tolerance.
Q	Is accuracy of a CT and a VT included?
A	Accuracy of a CT and a VT is not included in accuracy of the unit. A maximum value of tolerance is obtained by summing tolerance of the unit and that of a CT and a VT.
Q	To what degree an area of micro current is measured?
A	A current value is measured from the area exceeding 0.4% of the rated current. In an area below 0.4%, measurement result is indicated as “0” (zero). However, in that case, still, the amount of electricity is being measured. Even if the indicated value is “0,” measurement value will increase in continuing measurement for a long time. The amount of electricity is measured with a load that is about 0.1% or more of all load power.
Q	Is measurement of inverter circuit possible?
A	Measuring the secondary side of the inverter is impossible due to the large fluctuation of frequency. Make measurement on the primary side of the inverter. However, since a current waveform on the primary side of the inverter has a distortion containing the harmonic components, a slight error occurs.

· Q&A about connection

Q	Does polarity exist in connection between a CT and the unit?
A	Yes. Make connections so that the polarity of the secondary terminals of a CT and terminal symbols of this unit agree with each other. If polarity is incorrect, the current value is measurable, but the electric power and the electrical energy cannot be measured correctly.
Q	Are there any key points in avoiding errors in wiring?
A	Check polarity of a CT. And also, check the wiring between the secondary side of a CT and this unit are connected correctly for the 1-side circuit, 2-side circuit, and 3-side circuit. Besides, check that voltage inputs for voltage transform unit are connected correctly among P1, P2, P3, and P0.

· Q&A about setting

Q	Is the setting required?
A	At least, settings of phase wires, primary current and primary voltage are required. Specify settings in accordance with a circuit to be connected.

11. Requirement for the compliance with EMC Directives

EMC Directives prescribe both "Emission (electromagnetic interference): Do not radiate strong electromagnetic waves outside" and "Immunity (electromagnetic susceptibility): Do not be influenced by electromagnetic waves from outside".

This section compiles the precautions for the compliance of the system incorporating the energy measuring unit (target model: EMU4-FD1-MB) with the EMC Directives. The following description is based on the requirement of the regulations and the standards we understand, but we do not guarantee to comply with the directives above for the whole system built in accordance with this description. The manufacturer of the system finally needs to evaluate the way of the compliance with EMC Directives and whether the system complies with them or not.

(1) Harmonized standard for EMC Directives: EN61326-1:2013

(a) Compatibility condition for harmonized standard

The energy measuring unit is the open type device (i.e. the device incorporated in other device), and needs to be installed in the conductive control panel. The unit is tested with installed in the control panel for the emission and the immunity out of the test items for the standard.

(2) Condition for installation in the control panel

(a) Control panel

- Control panel needs to have conducting property.
- When bolting the top panel, bottom panel etc. of the control panel, mask the grounding part of the panel so as not to be painted.
- In inner panel, keep the conductivity in as large area as possible by masking the bolting part to the main panel to keep the electric contact to main panel.
- Ground the main panel by the thick wire so as to keep high impedance even for high-frequency wave.

(b) Installation of power line and ground line

- Set up the ground point to the control panel near the energy measuring unit, and ground the frame GND terminal of the unit to the ground terminal of the control panel (PE) by as thick and short wires as possible. (wire length is 30cm or shorter)

(c) Cable

· power line

Attach ferrite cores to power line. Ferrite cores used in our testing is below.

KITAGAWA INDUSTRIES CO.,LTD., GRFC-10

- External input signal line, External output signal line

Wiring of each connection wire should satisfy the following conditions.

■ For wiring inside buildings, the wiring length should not exceed 30 m.

■ Do not route wiring from the inside of the building to the outside of the building.

12. Specifications

Common specifications

Item		Specifications
Model		EMU4-FD1-MB
Phase-wire system		Single-phase 2-wire / Single-phase 3-wire / Three-phase 3-wire / Three-phase 4-wire(Change of setting)
Rating	Voltage circuit	Single-phase 2-wire / Three-phase 3-wire (DELTA) AC110V,220V (STAR) AC110V,220V,440V(*1)
	Single-phase 3-wire	AC110V (b/w 1- and 2-phase, 2- and 3-phase), AC220V (b/w 1- and 3-phase)
	Three-phase 4-wire	Min: 63.5V/110V AC, Max: 277V/480V AC(*2)
	Current circuit	5AAC or 1AAC (Change of setting)
Frequency		50Hz / 60Hz (Auto-detect)
Auxiliary power supply rating		100 - 240V AC (+10%, -15%) 50Hz-60Hz, 10VA, Transient overvoltage 4,000V
Transient overvoltage		Measuring circuit: CAT III, Auxiliary power supply: CAT III.
Measurable circuit count		1 circuit
Consumption VA	Voltage circuit	Each phase 0.1VA (at 110V AC), 0.2VA (at 220V AC), 0.4VA (at 440V AC)
	Current circuit	Each phase 0.1VA
	Auxiliary power supply circuit	At 110V AC: 9VA At 220V AC: 10VA
Allowable tolerance		Current, voltage, electric power, reactive power, apparent power, power factor, frequency : ±0.5%(*3) Electric energy : class0.5S (IEC62053-22) Reactive energy : class2.0 (IEC62053-23) Harmonic current, harmonic voltage : ±2.5%(*3)
Data update interval		250msec *Integrated values of electric energy and reactive energy are always accumulated (following up the short-cycled load fluctuation)
Range of demand time setting		0, 10s, 20s, 30s, 40s, 50s, 1 - 15min (1min intervals), 20min, 25min, 30min
External input	Input signal	
	Function	
	Setting to "pulse input" : Pulse count (0 - 999,999 counts)	
	Setting to "contact input" : Contact monitoring only Setting to "contact input" : Contact monitoring and energy measuring at work (when contact is on)	
	Isolation	
	Rated input voltage and current	
	Input condition	Pulse Pulse ON time: 30ms or longer Pulse OFF time: 30ms or longer Chattering time: 3ms or shorter
		Contact Contact ON time: 30ms or longer Contact OFF time: 30ms or longer Chattering time: 3ms or shorter
External output	Output signal	
	Function	
	Upper limit monitoring of current demand, Lower limit monitoring of current demand, Upper/Lower limit monitoring of voltage, Upper limit monitoring of power demand, Lower limit monitoring of power demand, Upper limit monitoring of power factor, Lower limit monitoring of power factor, Upper limit monitoring of pulse count	
	Selectable from either auto-reset or self-retention	
	Isolation	
Pulse output	Rated switching voltage and current	
	Output element	35V DC, 75mA
		24V AC, 75mA (power factor = 1)
	Output signal	Non-voltage Form A contact, 1 output -Unit of pulse (kWh / pulse): 0.001 / 0.01 / 0.1 / 1 / 10 / 100
	Isolation	By semiconductor relay
Output pulse width		0.1 – 0.15s
Compensation for power failure	Stored items	Setting values, Electric energy (consumption, regeneration), reactive energy, periodic electric energy, pulse count value, Operating time (stored in the nonvolatile memory)

Item		Specifications
Standard		EMC: EN-61326-1: 2013 UL: UL61010-1 LVD: EN-61010-1: 2010
Usage environment	Operating temperature	-5 - +55°C (Daily average temperature is 35°C or lower)
	Operating humidity	30 - 85%RH (No condensation)
	Storage temperature	-10 - +60°C
	Operating altitude	2000m or below
Commercial frequency withstand voltage		b/w all terminals (except for communication circuit and frame GND terminal) and casing: 2000V AC, 1min
		b/w all terminals of current input, voltage input / auxiliary power : 2000V AC, 1min
		b/w all terminals of current input, voltage input, auxiliary power and all terminals of digital / pulse input, pulse / alarm output, communication: 2000V AC, 1min
Insulation resistance		10MΩ or more at the same part above (500V DC)
Appropriate wire	Terminals of auxiliary power circuit and voltage input	stranded wire: AWG26-14(0.13~2.0mm ²) single wire : AWG26-14(Φ 0.41~1.62mm)
	Terminals of current input	stranded wire: AWG18-14(0.82~2.0mm ²) *4 single wire : AWG18-14(Φ 1.03~1.62mm)
	Terminals of input/output	stranded wire: AWG22-14(0.33~2.0mm ²) single wire : AWG22-14(Φ 0.65~1.62mm)
Tightening torque	Screws for terminals of auxiliary power circuit and voltage input	0.8 - 1.0N·m
	Screws for terminals of current input and input/output	0.5 - 0.6N·m
	Screws for installation to the panel	0.63N·m
Mass		0.3kg
External dimensions (unit: mm)		75 (W) x 90 (H) x 75 (D) (expect for the protruding portions) (Maximum dimension including the protruding portions: 79 (W) x 90 (H) x 75 (D))
Product life expectancy		10 years (under usage environmental condition indicated above)
Possible combination optional unit for UL		EMU4-LM, EMU4-CM-C, EMU4-CM-CIFB, EMU4-CM-MT

*1: 110V, 220V, 440V AC can be connected to this unit directly. For the circuit over this voltage, transformer (VT) is necessary (Primary voltage of VT can be set up to 6600V, and secondary voltage of VT can be set up to 220V as optional setting). Star- delta connection and delta-star connection transformer of cannot measure definitely to be out of phase. Please use a transformer of the same connection.

*2: 63.5/110V – 277/480V AC can be connected to this unit directly. For the circuit over this voltage, transformer (VT) is necessary (Primary voltage of VT can be set up to 6600V, and secondary voltage of VT can be set up to 220V as optional setting). Star- delta connection and delta-star connection transformer of cannot measure definitely to be out of phase. Please use a transformer of the same connection.

*3: Accuracy of A, V, W, var, VA, PF, Hz, HI and HV is specified according to the maximum scale value at standard test condition. (Maximum scale values lists below.)

A,HI	V,HV	W, var, VA	PF	Hz
5A	1P2W:600V 1P3W:300V 3P3W:600V 3P4W:600V	1P2W: 2000W (440V × 5A × 1=2200W →2000) 1P3W: 1000W (110V × 5A × 2=1100W →1000) 3P3W: 4000W (440V × 5A × √3=3810W →4000) 3P4W: 4000W (277V × 5A × 3=4155W →4000)	1	65Hz

*4: If the diameter of the wire is small, the conductor resistance of the wire will be high and the consumption VA of the wire will increase.

Decide wire diameter and wire length so that it does not exceed the rated burden of CT to be connected.

Item	Specifications	
Communication method	RS-485 2wires half duplex	
Protocol	MODBUS RTU mode	
Synchronization method	Asynchronous	
Transmission wiring type	Multi-point bus (either directly on the trunk cable, forming a daisy-chain)	
Baud rate	2400, 4800, 9600, 19200, 38400bps	(default: 19200bps)
Data bit	8bit	
Stop bit	1, 2bit	(default: 1bit)
Parity bit	ODD,EVEN,NONE	(default: EVEN)
Slave address	1~255 (But 0 is impossible of authorization for a broadcast address. 248-255 is Reserve)	(default: 1)
Response time	1s or shorter from completion of receiving query data to response transmission	
Communications distance	Maximum 1200m	
Connectable devices	Maximum 31 devices	
Termination resistor	120Ω 1/2W	
Recommended cable	SPEV(SB)-MPC-0.2 × 1P (Mitsubishi cable industries)	

■MODBUS® communication data Multiplying factor

The multiplying factor of electric energy, reactive energy and periodic energy is as follows depending on the full load power

$$\text{Full load power [kW]} = \frac{\alpha \times (\text{VT primary voltage}) \times (\text{CT primary current})}{1000}$$

$$\left. \begin{array}{ll} \alpha: 1 & \text{Single-phase, 2-wire} \\ 2 & \text{Single-phase, 3-wire} \\ \sqrt{3} & \text{Three-phase, 3-wire} \\ 3 & \text{Three-phase, 4-wire} \end{array} \right\}$$

*1: VT primary voltage in single-phase 3-wire system is regarded as 110V.

*2: Using direct connection, replace VT primary voltage with direct voltage in calculation above.

*3: In three-phase 4-wire system, replace VT primary voltage or direct voltage with phase voltage in calculation above.

Full load power [kW]	Multiplying factor
less than 12	×0.01
12 or more and less than 120	×0.1
120 or more and less than 1200	×1
1200 or more and less than 12000	×10
12000 or more	×100

The multiplying factor of electric power, power demand, reactive power and apparent power is as follows depending on the full load power

(For the full load power, refer to above.)

Full load power [kW]	Multiplying factor
less than 12	×0.001
12 or more and less than 120	×0.01
120 or more and less than 1200	×0.1
1200 or more and less than 12000	×1
12000 or more	×10

The multiplying factor of current and current demand is as follows depending on the primary current

Primary current [A]	Multiplying factor
less than 40	×0.001
40 or more and less than 400	×0.01
400 or more and less than 4000	×0.1
4000 or more	×1

The Multiplying factor of voltage and harmonic voltage is as follows depending on the primary voltage:

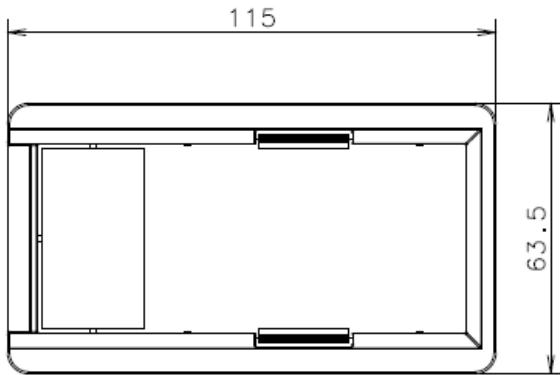
Caution: In three-phase 4-wire system, the Multiplying factor of VT primary voltage

and direct voltage depends on the phase voltage.

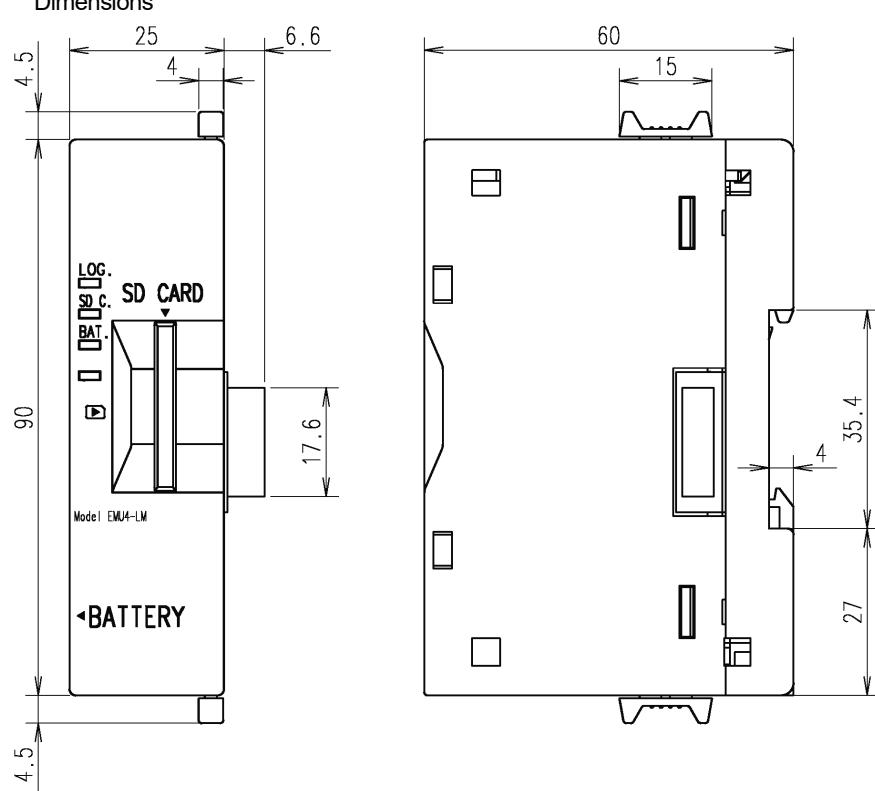
Primary voltage [V]	Multiplying factor
less than 300	×0.1
300 or more	×1

13. Option devices

(1) Part for installation to panel
- Attachment for installation to panel EMU4-PAT
Dimensions

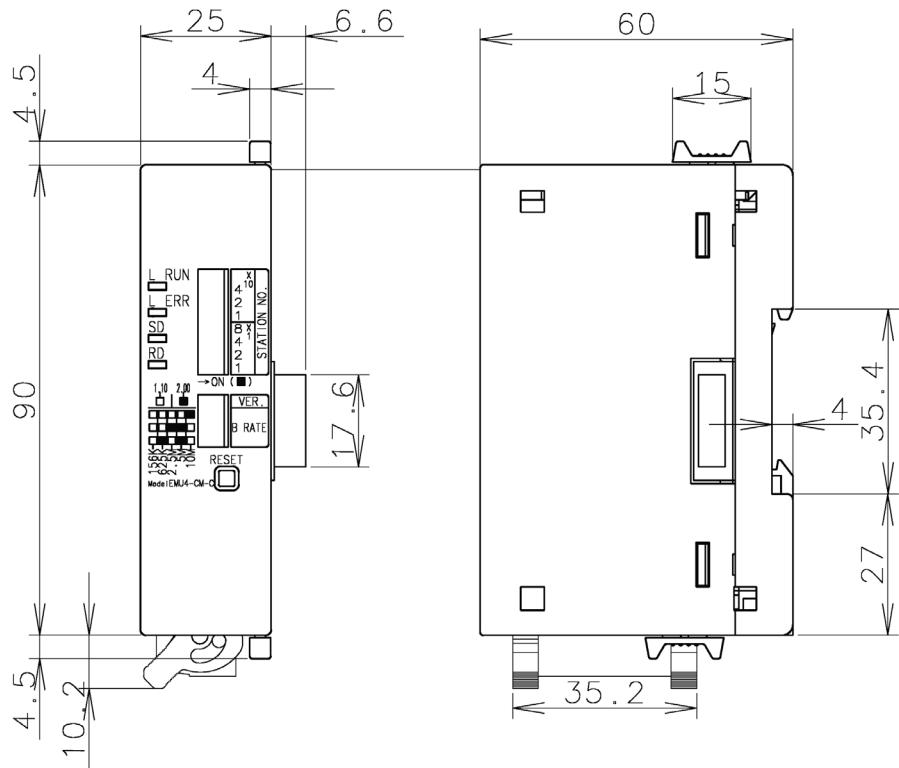


(2) Option unit
- Logging unit: EMU4-LM
Dimensions



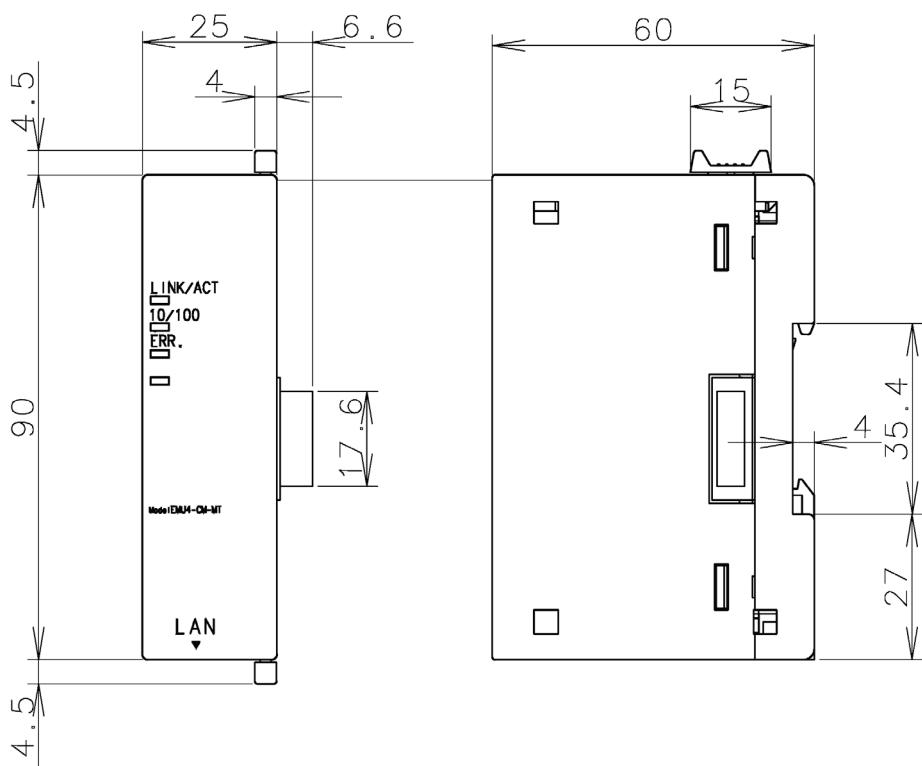
- CC-Link communication unit: EMU4-CM-C

Dimensions

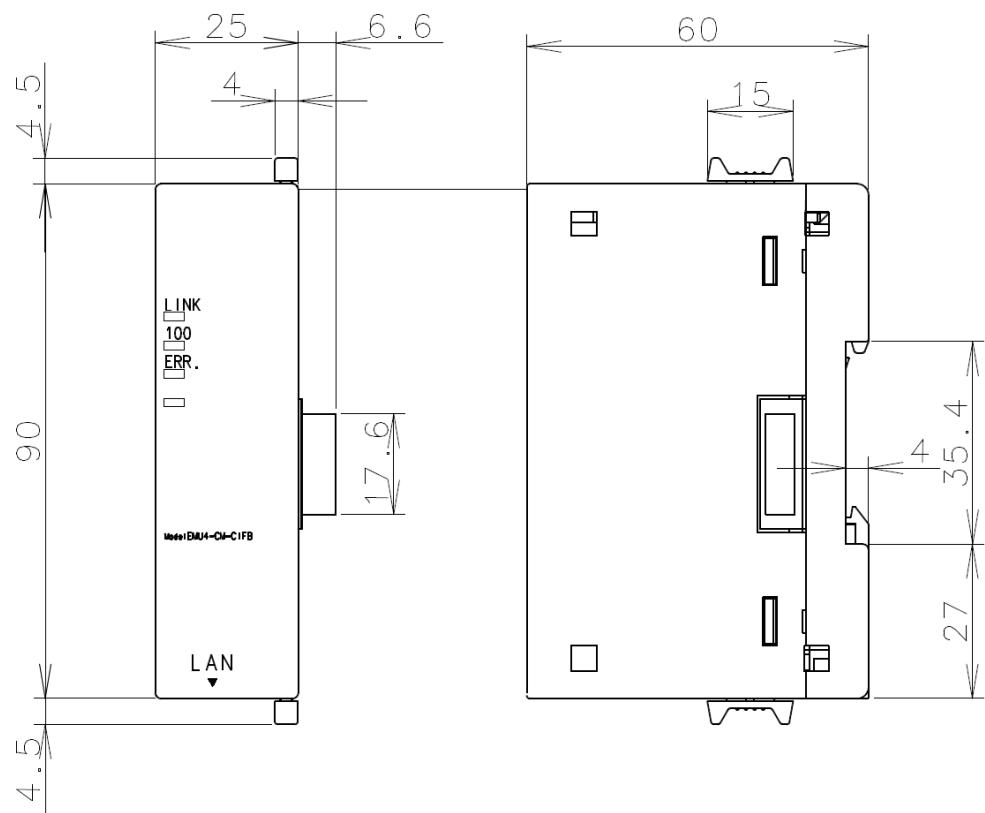


- MODBUS®TCP communication unit: EMU4-CM-MT

Dimensions



Dimensions

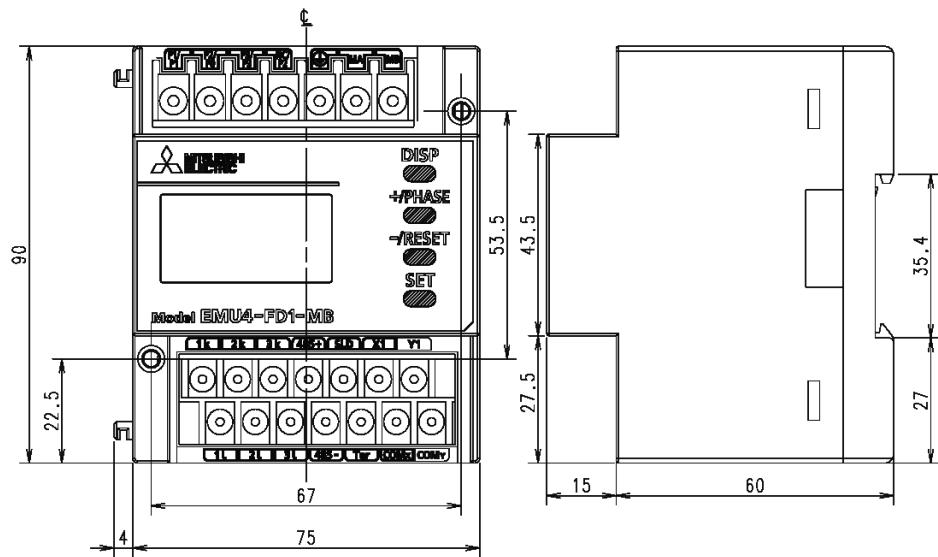


For specifications, please refer to each manual.

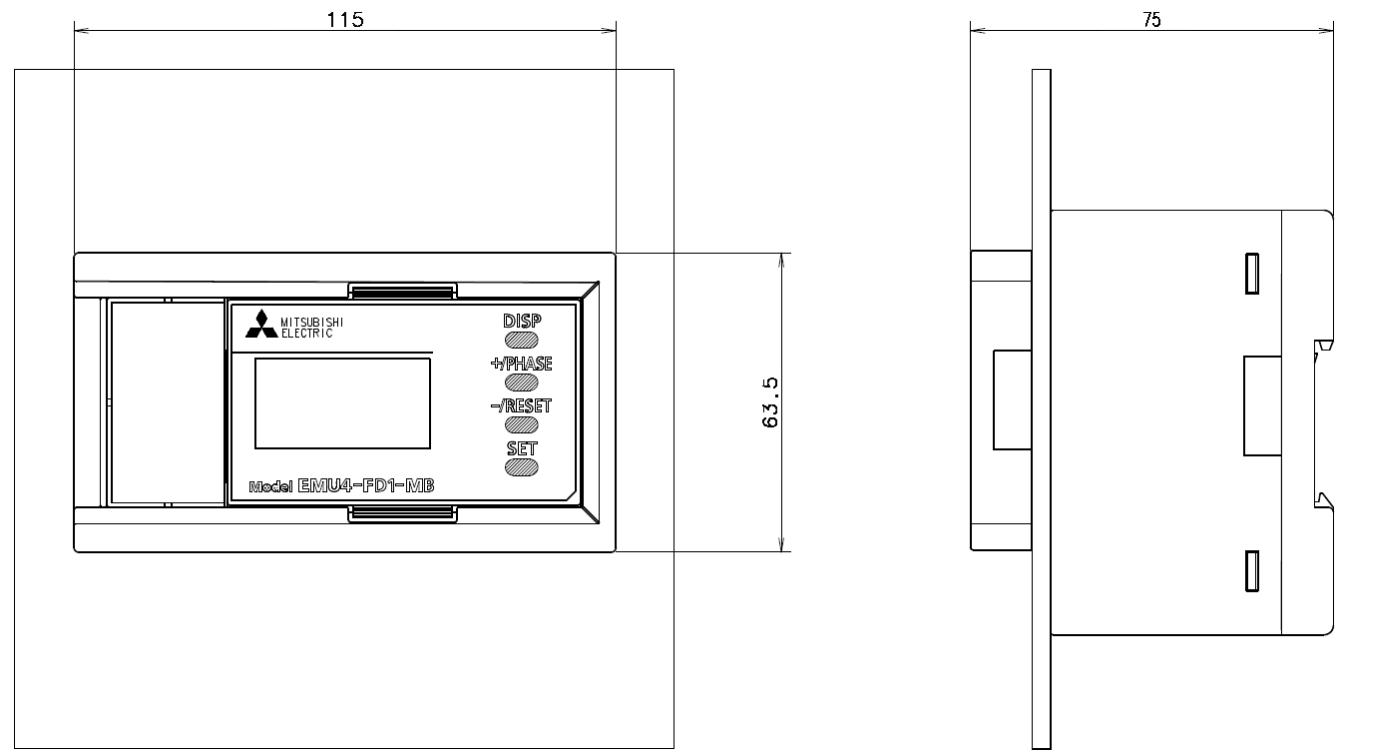
14. External dimensions

Unit: mm

- EMU4-FD1-MB



- When installing the attachment



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Energy Measuring Unit

■ Service Network

Country/Region	Corporation Name	Address	Telephone
Australia	Mitsubishi Electric Australia Pty. Ltd.	348 Victoria Road, Rydalmere, N.S.W. 2116, Australia	+61-2-9684-7777
Algeria	Mec Casa	Rue i N 125 Hay-Es-Salem, 02000, W-Chlef, Algeria	+213-27798069
Bangladesh	PROGRESSIVE TRADING CORPORATION ELECTRO MECH AUTOMATION& ENGINEERING LTD.	HAQUE TOWER,2ND FLOOR,610/11,JUBILEE ROAD, CHITTAGONG, BANGLADESH SHATABDI CENTER, 12TH FLOOR, SUITES:12-B, 292, INNER CIRCULAR ROAD, FAKIRAPOL, MOTIJHEEL, DHAKA-1000, BANGLADESH	+88-31-624307 +88-02-7192826
Belarus	Tehnikon	Oktiabrskaya 19, Off. 705, BY-220030 Minsk, Belarus	+375 (0)17 / 210 46 26
Belgium	Koning & Hartman B.V.	Woluwestraat 31, BE-1800 Vilvoorde, Belgium	+32 (0)2 / 2570240
Brazil	Mitsubishi Electric do Brasil Comercio e Servicos Ltda.	Avenida Adelino Cardana, 293 - 21º Andar, Bevilhava, Barueri, SP, Brasil, CEP 06401-147	+55-11-4689-3000 +855-23-997-725
Cambodia	DHINIMEX CO.,LTD	#245, St. Tep Phan, Phnom Penh, Cambodia	+855-23-997-725
Central America	Automation International LLC	7050 W. Palmetto Park Road Suite #15 PMB #555, Boca Raton, FL 33433	+1-561-237-5228
Chile	Rhona S.A. (Main office)	Vte. Agua Santa 4211 Casilla 30-D (P.O. Box) Vina del Mar, Chile	+56-32-2-320-600
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Colombia	Proelectro Representaciones S.A.	Carrera 42 N° 75 - 367 Bodega 109, Itagüí, Medellin, Antioquia, Colombia	+57-4-4441284
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India	Meltrade Ltd. Mitsubishi Electric India Private Limited Mitsubishi Electric India Private Limited Pune Sales Office Mitsubishi Electric India Private Limited FA Center	Fertő utca 14. HU-1107 Budapest, Hungary 2nd Floor Tower A&B, Cyber Greens, DLF Cyber City, DLF Phase-III, Gurgaon - 122 022 Haryana, India ICC-Devi Gaurav Technology Park, Unit no. 402, Fourth Floor, Survey no. 191-192 (P), Opp. Vallabh Nagar Bus Depot, Pune - 411018, Maharashtra, India 204-209, 2nd Floor, 31FIVE, Corporate Road, Prahladnagar, Ahmedabad 380015,Gujarat, India	+36 (0)1-431-9726 +91-124-4630300 +91-20-68192100 +91-79677-77888
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Ireland	Mitsubishi Electric Europe B.V.	Westgate Business Park, Ballymount, IRL-Dublin 24, Ireland	+353 (0)1-4198800
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Laos	AROUNKIT CORPORATION IMPORT- EXPORT SOLE CO.,LTD	SAPHANMO VILLAGE, SAYSETHA DISTRICT, VIENTIANE CAPITAL, LAOS	+856-20-415899
Lebanon	Comptoir d'Electricite Generale-Liban	Cebaco Center - Block A Autostrade Dora, P.O. Box 11-2597 Beirut - Lebanon	+961-1-240445
Lithuania	Rifas UAB	Tinku 29A, LT-5300 Panevezys, Lithuania	+370 (0)58-522-728
Malaysia	Mittric Sdn Bhd	No. 5 Jalan Pemberita U1/49, Temasya Industrial Park, Glenmarie 41050 Shah Alam, Selangor, Malaysia	+603-5569-3748
Malta	Flexible Automation System Sdn Bhd	60, Jalan USJ 10/1B, UEP Subang Jaya 47620 Selangor Darul Ehsan, Malaysia	+603-5633-1280
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Myanmar	SCIEHIE MAROC	KM 7.2 NOUVELLE ROUTE DE RABAT AIN SEBAA, 20600 Casablanca, Maroco	+212 661 45 15.96
Nepal	Watt&Volt House	NO137/139 Botahtaung Pagoda Road, Botahtaung Town Ship 11161, Yangon, Myanmar	+95-(0)1-202589
Netherlands	Peace Myanmar Electric Co.,Ltd.	KHA 2-65, Volt House Dillibazar Post Box:2108,Kathmandu,Nepal	+977-1-4411330
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Arab Countries & Cyprus	Comptoir d'Electricite Generale-International-S.A.L.	Cebaco Center - Block A Autostrade Dora P.O. Box 11-1314 Beirut - Lebanon	+961-1-240430
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Peru	Rhona S.A. (Branch office)	Avenida Argentina 2201, Cercado de Lima	+51-1-464-4459
Philippines	MELCO Factory Automation Philippines Inc.	128, Lopez Rizal St., Brgy. Highway Hills, Mandaluyong City, Metro Manila, Philippines	+63-(0)2-256-8042
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Slovenia	PROCONT, Presov	Kupelna 1/ SK - 08001 Presov, Slovakia	+421 (0)51 - 7580 611
South Africa	SIMAP	Jana Derku 1671, SK - 91100 Trenčín, Slovakia	+421 (0)32 743 04 72
Spain	Inea RBT d.o.o.	Stegne 11, SI-1000 Ljubljana, Slovenia	+386 (0)1-513-8116
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