MITSUBISHI ELECTRIC

Numerical Protection Relay

MELPRO™-D Series

GENERATOR PROTECTION RELAY

MODEL

CGP2-A41D1/CGP2-A42D1

INSTRUCTION MANUAL

■For the latest version of this instruction manual, please download from the URL below.

http://www.mitsubishielectric.co.jp/fa/download/search.do?mode=manual&kisyu=/pror

― Safety precautions ―

Before installation, operation, maintenance, and inspection, please be sure to read this instruction manual and all other attached documents thoroughly in order to work safely with the equipment. Please ensure that you fully understand the equipment, safety information, and precautions that need to be taken before working with the equipment.

Safety precautions are classified as “Danger” and “Caution.”

 Danger	The case where a dangerous situation can arise and there is the possibility that death or seriously injury can occur if the equipment is handled incorrectly.
 Caution	The case where a dangerous situation can arise and there is the possibility that moderate or minor injuries canl occur, or property damage can take place if the equipment is handled incorrectly.

Furthermore, even with items described as ⚠Caution, there is the possibility of serious consequences depending on the situation. All of the described contents are important. Therefore, be sure to comply with them.

[Transportation]

 Caution

- ●Transport the equipment in the correct orientation.
- ●Do not apply excessive shock and/or vibration as this could affect the performance and life of the product.

[Storage]

 Caution

- ●The storage environment shall comply with the following conditions (compliant with JEC2500-2010). Otherwise, there is a risk of reducing the performance and life of the product.
  - Ambient temperature –20 to +60 °C
    The state where dew condensation or freezing does not occur.
  - Relative humidity 30 to 80 % on daily average
  - Altitude 2000 m or lower
  - The equipment must not be exposed to abnormal vibration, shock, inclination, or magnetic fields.
  - The equipment must not be exposed to harmful smoke/gas, saline gas, water droplets or vapour, excessive dust or fine powder, explosive gas or fine powder, wind & rain.

[Installation, wiring work]

 Danger

- ●The equipment must be correctly grounded using the designated grounding terminals where they exist. Failure to do so may lead to the risk of electric shock, equipment failure, malfunction or failure to operate.
- ●Be sure to return all terminal covers, protection covers to their original positions once any work is complete. If they remain uncovered there is a risk of electrical shock.

Caution

- Ensure that the equipment is mounted and connected correctly. Otherwise, there are risks of failure, burning, or maloperation..
- Securely tighten the terminal connection screws. Otherwise, there are risks of failure and burning.
- For tightening torque of screws, refer to the following Table.

Place of use	Nominal dia.	Standard value of torque (steel screw)	Allowable range
Terminal block	M3.5	1.10 N•m (11.2 kgf•cm)	0.932 to 1.27 N•m (9.5 to 12.9 kgf•cm)
Panel mounting	M5.0	3.24 N•m (33 kgf•cm)	2.75 to 3.63 N•m (28 to 37 kgf•cm)

- Ensure that the equipment is connected correctly in accordance with the details shown on the connection terminals. Otherwise, there is the risk of failure, burning, malfunction, or maloperation.
- Ensure that the equipment is connected correctly in accordance with thephase sequence details shown on the connection terminals. Otherwise, there is the risk of failure, burning, malfunction, or maloperation.
- All power supplies to the equipment must be of suitable capacity and rated load to avoid the risk of malfunction and maloperation.
- The appropriate connectors must be used to ensure compatibility with the connector terminals to avoid the risks of failure or fire.

[Operating and Setting the equipment]

Danger

- The equipment must only be operated and handled by qualified personnel. Otherwise, there are risks of electric shock, injury, failure, malfunction, and maloperation.
- Handling and maintenance of the equipment must only be carried out after gaining a thorough understanding of the instruction manual. Otherwise, there is the risk of electric shock, injury, failure, malfunction, or maloperation.

Caution

- The equipment must be used within the following range limits (compliant with JEC2500-2010). Otherwise, there is a risk of reducing the performance and life of the product.
  - Variation range of control power supply voltage: Within –15% to +10% of the rated voltage
  - Frequency variation: Within ±5% of the rated frequency
  - Ambient temperature: 0 to +40°C (-10 to 50°C is allowable temporarily within few hours a day, but use under the state where dew condensation or freezing does not occur.)
  - Relative humidity: 30 to 80% on daily average
  - Altitude: 2000 m or lower
  - The state where abnormal vibration, shock, inclination, magnetic field are not applied
  - The state where it is not exposed to harmful smoke/gas, saline gas, water droplet or vapor, excessive dust or fine powder, explosive gas or fine powder, wind & rain
- While energized, do not tamper with or remove any components other than those which have been designated. Otherwise, there is a risk of failure, malfunction, or maloperation.
- While energized, do not draw out the internal unit (subunit). Otherwise, there is a risk of electric shock, injury, failure, malfunction, or maloperation.
- When changing the setting value during the energized state, ensure that all trip circuits are locked in order not to operate. Otherwise, there is a risk of malfunction.

[Maintenance and Inspection]

Danger

- The equipment must only be operated and handled by qualified personnel. Otherwise, there are risks of electric shock, injury, failure, malfunction, and maloperation.
- Handling and maintenance of the equipment must only be carried out after gaining a thorough understanding of the instruction manual. Otherwise, there is the risk of electric shock, injury, failure, malfunction, or maloperation.
- Do not touch any live parts, such as terminals, etc. Otherwise, there is a risk of electric shock.

Caution

- When replacing the equipment, use a product of same model, rating, and specifications. Otherwise, there is the risk of failure or fire.. If any other product is to be used, the manufacturer must be consulted.
- We recommend that any tests or inspections are carried out under the following conditions, as well as any additional conditions described in the instruction manual.

• Ambient temperature	20 ± 10°C
• Relative humidity	90% or less
• External magnetic field	80 A/m or less
• Atmospheric pressure	86 to 106 × 10^3 Pa
• Mounting angle	Regular direction ±2°
• Frequency	Rated frequency ±1%
• Waveform (in the case of AC)	Distortion factor 2% or less

$$\text{Distortion factor} = \frac{\text{Effective value of higher harmonics only}}{\text{Effective value of fundamental wave}} \times 100\ (\%)$$

• AC component (in the case of DC)	Ripple factor 3% or less

$$\text{Ripple factor} = \frac{\text{Max. value} - \text{Min. value}}{\text{Average value of DC}} \times 100\ (\%)$$

• Control power supply voltage	Rated voltage ±2%

- Do not exceed the overload capacity for voltage and current. Otherwise,equipment failure or fire could occur.
- Do not clean the equipment while energised. When the cover needs to be cleaned, make use of a damp cloth.

[Repair and modification]

Caution

- When carrying out repair and/or modification, please consult with the manufacturer in advance.of carrying out the work. We will not take any responsibility for any repair and/or modification (including software) which has been carried out without prior consent.

[Disposal]

Caution

- Disposal must take place in accordance with the applicable legislation

Guarantee

1. Guarantee period

The guarantee period of this product should be one year after delivery, unless otherwise specified by both parties.

2. Scope of guarantee

When any fault or defect is detected during the period of guarantee and such fault or defect is proved to be caused apparently at the responsibility of MITSUBISHI ELECTRIC CORPORATION, the defective unit concerned will be repaired or replaced with substitute with free of charge.

However, the fee for our engineer dispatching to site has to be covered by the user.

Also, site retesting or trial operation caused along with replacing the defect units should be out of scope of our responsibilities.

It is to be acknowledged that the following faults and defects should be out of this guarantee.

(1) When the faults or defects are resulted from the use of the equipment at the range exceeding the condition/environment requirements stated in the catalogue and manual.

(2) When the faults or defects are resulted from the reason concerning without our products.

(3) When the faults or defects are resulted from the modification or repair carried out by any other entity than MITSUBISHI ELECTRIC CORPORATION.

(4) When the faults or defects are resulted from a phenomenon which cannot be predicted with the science and technology put into practical use at the time of purchase or contract

(5) In case of integrating our products into your equipment, when damages can be hedged by the proper function or structure in the possession of your equipment which should be completed according to the concept of the de fact standard of industry.

(6) In case of that the faults or defects are resulted from un-proper application being out of instruction of MITSUBISHI ELECTRIC CORPORATION.

(7) In case that the faults or defects are resulted from force majeure such a fire or abnormal voltage and as an act of God such as natural calamity or disaster.

3. Exclusion of loss in opportunity and secondary loss from warranty liability

Regardless of the gratis warranty term, MITSUBISHI ELECTRIC CORPORATION shall not be liable for compensation of damages caused by any cause found not be the responsibility of MITSUBISHI ELECTRIC CORPORATION, loss in opportunity, lost profits incurred to the user by failures of MITSUBISHI ELECTRIC CORPORATION products, special damages and secondary damages whether foreseeable or not, compensation for accidents, and compensation for damages to products other than MITSUBISHI ELECTRIC CORPORATION products and other tasks.

4. Applications of products

(1) The user is requested to confirm the standards, the regulations and the restrictions which should be applied, in case of utilizing products described in this catalogue and another one in combination.

Also, the user is requested to confirm the suitability of our products to your applied system or equipment or apparatus by yourself.

MITSUBISHI ELECTRIC CORPORATION shall not be liable for any suitability of our products to your utilization.

(2) This MITSUBISHI ELECTRIC CORPORATION products described in the catalogue have been designed and manufactured for application in general industries, etc. Thus, application in which the life or an asset could be affected by special application such as medical system for life-sustaining, in nuclear power plants, power plants, aerospace, transportation devices(automobile, train, ship, etc.) shall be excluded from the application. In addition to above, application in which the life or an asset could be affected by potentially chemical contamination or electrical interference and also in which the circumstances and condition are not mentioned in this catalogue shall be excluded from the application.

Note even if the user wants to use for these applications with user's responsibility, the user to be requested to approve the specification of MITSUBISHI ELECTRIC CORPORATION products and to contact to the technical section of MITSUBISHI ELECTRIC CORPORATION prior to such applications.
If the user applies MITSUBISHI ELECTRIC CORPORATION products to such applications without any contact to our technical section, MITSUBISHI ELECTRIC CORPORATION shall not be liable for any items and not be insured, independently from mentioned in this clause.
(3) In using MITSUBISHI ELECTRIC CORPORATION product, the working conditions shall be that the application will not lead to a major accident even if any problem or fault occur, and that backup or duplicate system built in externally which should be decided depend on the importance of facility, is recommended.
(4) The application examples given in this catalogue are reference only and you are requested to confirm function and precaution for equipment and apparatus and then, use our products.
(5) The user is requested to understand and to respect completely all warning and caution items so that unexpected damages of the user or the third party arising out of un-correct application of our products would not be resulted.

5. Onerous repair term after discontinuation of product
(1) MITSUBISHI ELECTRIC CORPORATION shall accept onerous product repairs for 7(seven) years after production of the product is discontinued. (However, please consider the replacement of products after 15 years have been passed from ex-work of products.)
(2)Product supply (including repair parts) is not available after production is discontinued.

6. Changes in product specification
The specification given in the catalogue, manuals or technical documents are subject to change without prior to notice.

7. Scope of service
The technical service fee such as engineer dispatching fee is excluded in the price of our products.
Please contact to our agents if you have such a requirement.

Improvement on the reliability of protection function

Any parts and materials applied to the protection relay have limited life time which will bring the degradation to the relay.
The degree of degradation will be variable and depend on the purpose, period in use, applied circumstance and unevenness on the performance of each part.
MITSUBISHI ELECTRIC CORPORATION design the relay so as to realize that the recommended replaced duration is more than 15 years.
However, there may be some possibilities to occur some defects before reaching 15 years due to above mentioned the degree of degradation of parts and materials being depended on the condition in use.
To prevent unwanted operation or no operation of relay due to above reasons, it is recommended to apply the relay with self-diagnosis function and/or multiplexing relay system such as dual or duplex scheme.

Introduction

Thank for your purchasing MITSUBISHI ELECTRIC ***MELPRO***™ – D Series Digital Protection Relay.
Please read this instruction manual carefully to be familiar with the functions and performances enough to use the product properly.
It is necessary to forward this instruction manual to end users and a person in charge of maintenance.

In regard to the instruction manual for PC software, read the following document.

Title of document	Document No.
MELPRO-D Series Protection Relay PC-HMI Instruction Manual	JEP0-IL9504

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1. General description

Mitsubishi Electric ***MELPRO***™ – D Series is a digital protection relay product with a microprocessor for protection of high/extra-high voltage electric power systems.
With its improved functions, such as PLC (Programmable Logic Controller), data saving at the time when relay elements are operated, and measurement of input value, this series of protection relay allows stable and effective control and monitoring of electric power systems as well as high-reliable protection.

High accurate digital computation
The digital computation with high-speed sampling minimizes the effect of higher harmonics, etc., which enables high accurate protections. As this computation is implemented in software, stable operation without aging is obtained.

Advanced self-diagnosis function improves reliability
The relay continuously monitors electronic circuits from input to output so that it can detect internal component failure, which enables to improve reliability.

Measurement functions
The input values of the relay (e.g. current, voltage, phase and frequency) can be measured at a steady state, which is useful for energy-saving management. Measurement items differ depending on the types of the relay units.

Data saving functions
Various record functions as shown below are useful for fault investigations.
(1) The data savings of input value at the time when relay element are operated.
(2) The operation logs of the relay.

Programmable output contacts with PLC provide flexibility
The operation of output contacts can be set by combining the detection or definitive signals of the protection elements with PLC which incorporates logic circuit (e.g. OR, AND, NOT, and flip-flop) and timer (e.g. on-delay, off-delay, and one-shot). This is useful for easy designing of sequential circuits and reducing labor-hours of wiring.

Forced contact test enables checking of relay sequence
The output contacts can be forced to operate in the test menu, which enables checking of relay sequence easily.

Easy replacement
The cut-out dimensions of panel are the same as MULTICAP-C series or the old model of MELPRO-DASH series. Replacing an existing relay with this new type is easy. (There are some exceptions.)

Easy maintenance
The relay adopts draw-out unit mechanisms with automatic CT shorting at drawing, thereby making it easy to maintain the relay.

Diverse operation and reset characteristics
The relay incorporates various operation and reset characteristics including the standards of IEC 60255-3, which can be adopted to the protection of various types of electric systems.

Communication network (will be supported in the future)
The relay can build a network system which allows monitoring and control of measurement values, operation status, and setting changes, etc., from a remote location. This leads to labor-saving of maintenance.

2. Structure

2.1. Front view of relay

For the details about front panel, refer to Section 5.1.

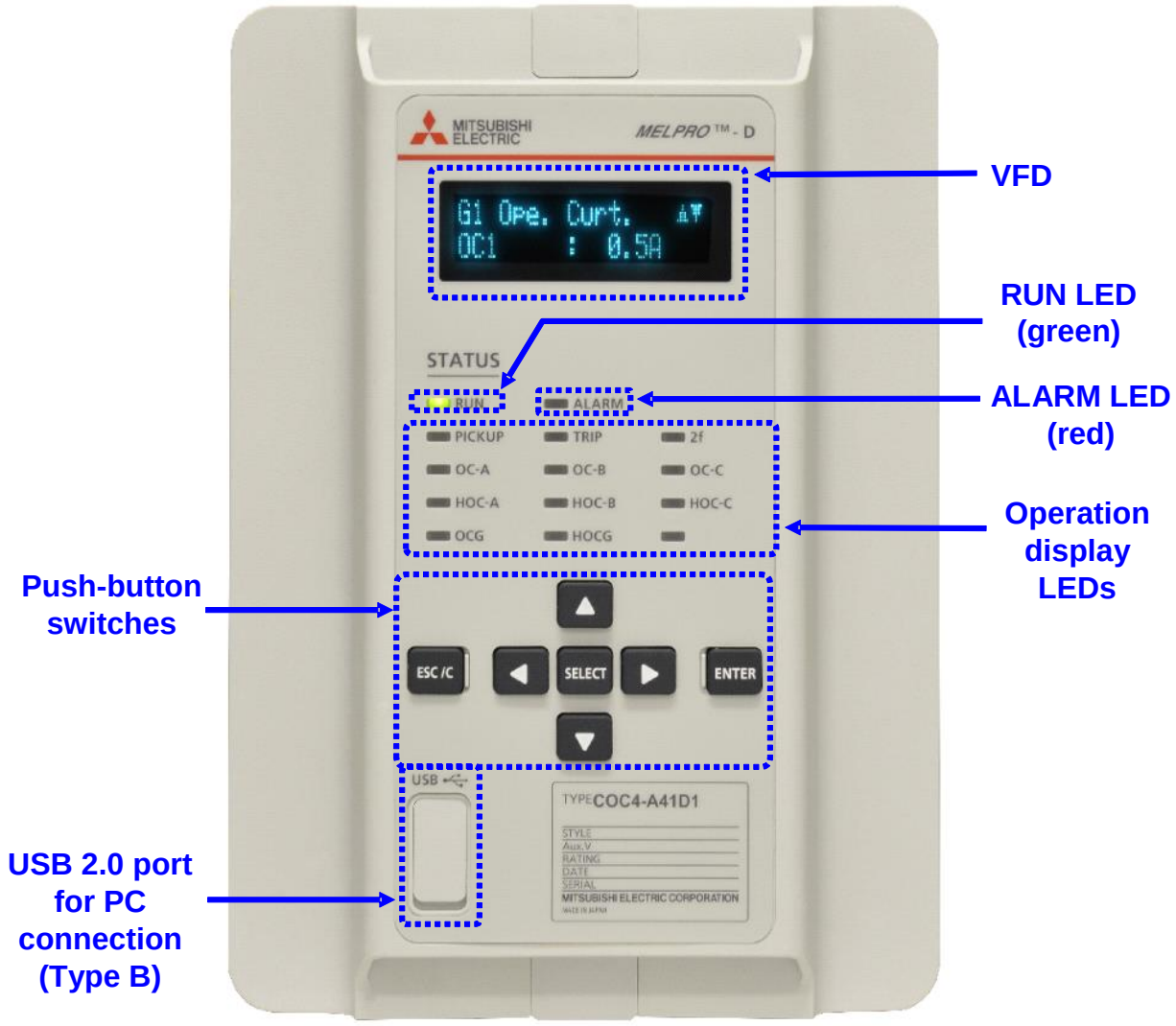


Fig. 2-1 Front view of relay

2.2. Terminal layout on the back of relay

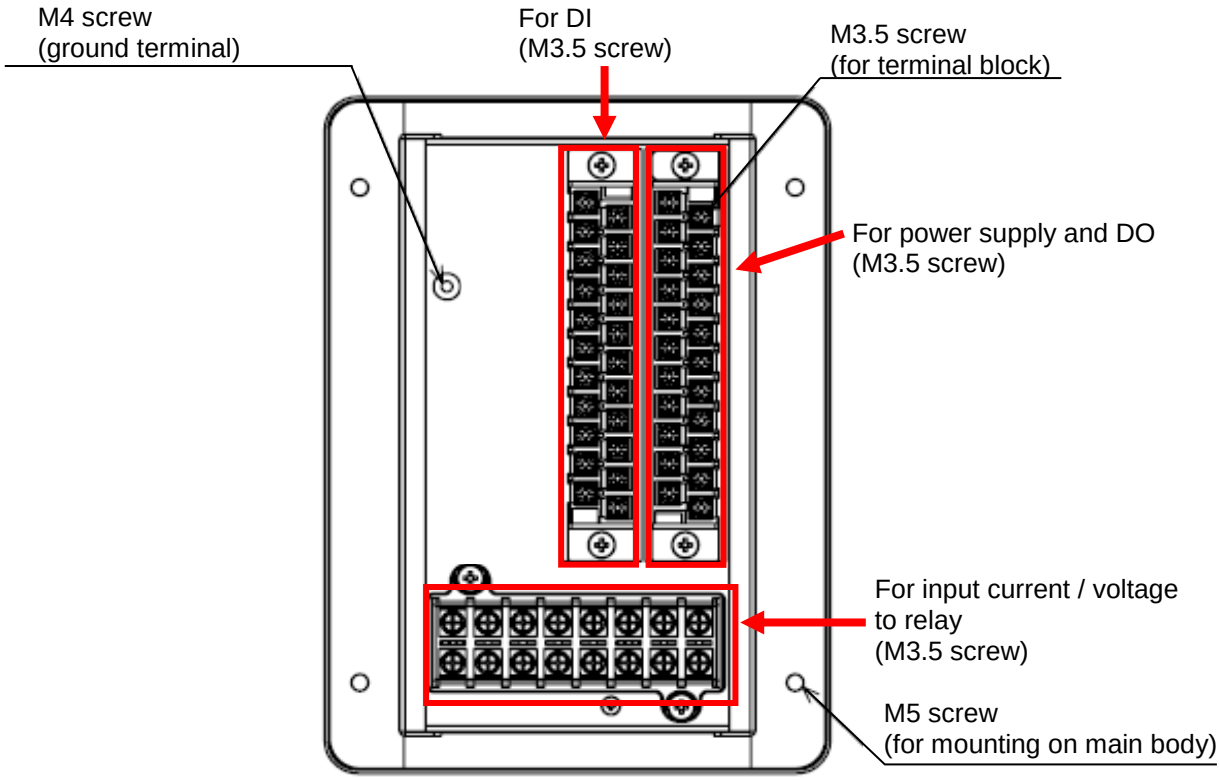


Fig. 2-2 Terminal layout on the back of relay

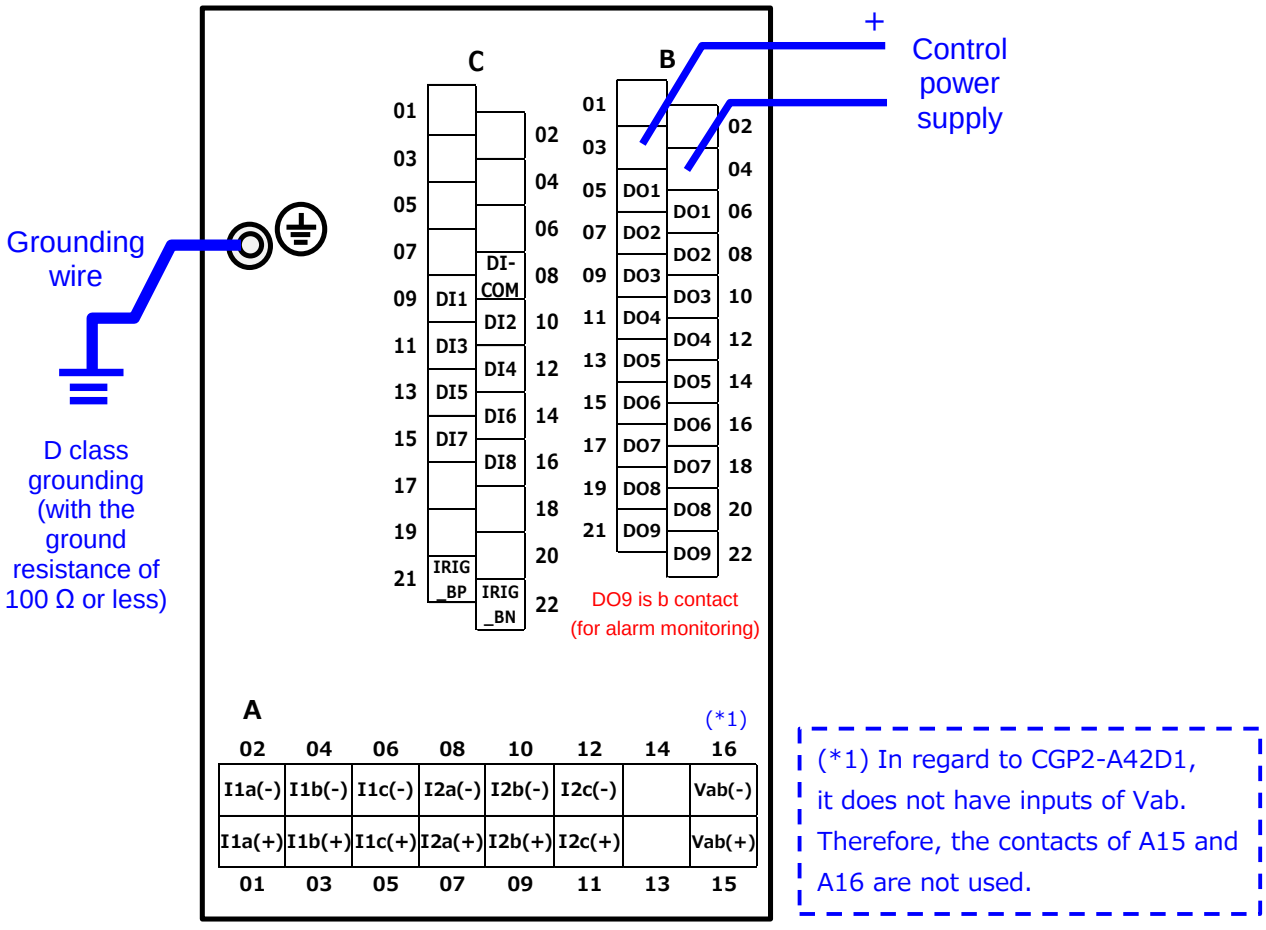


Fig. 2-3 Terminal number on the back of relay

2.3. Dimensions of relay and Cut-Out dimensions of panel

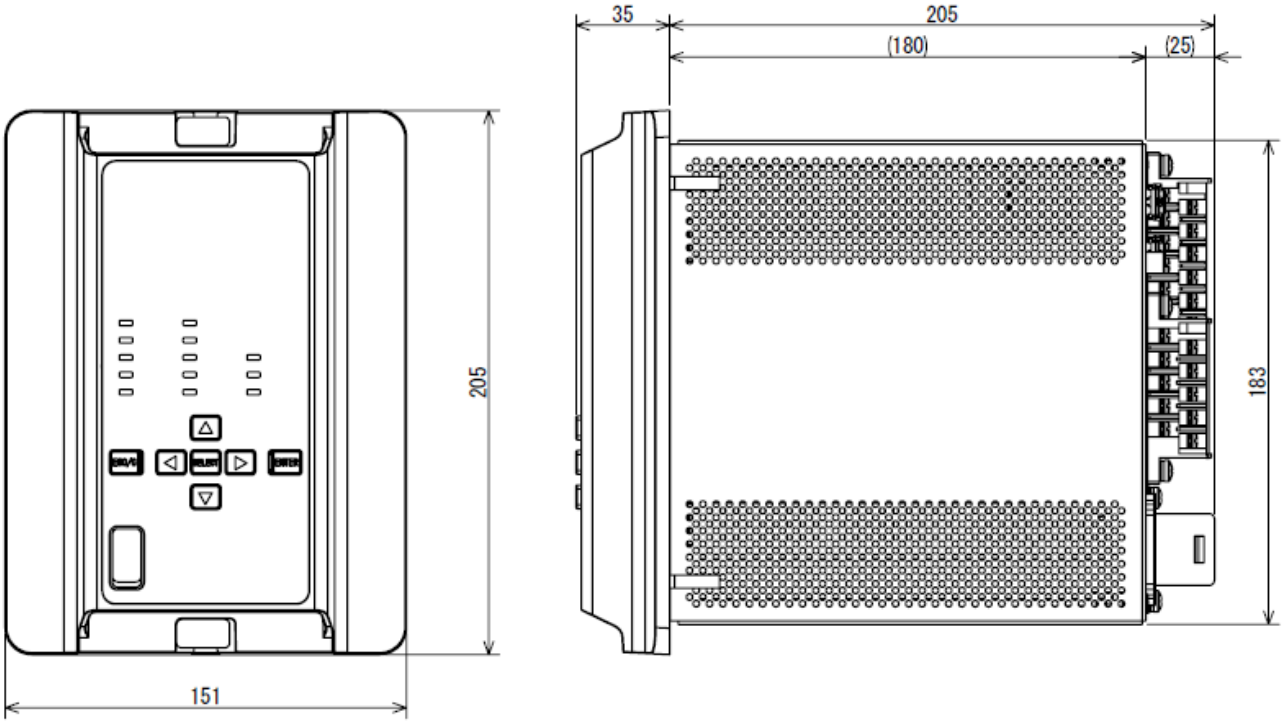


Fig. 2-4 Dimensions of relay

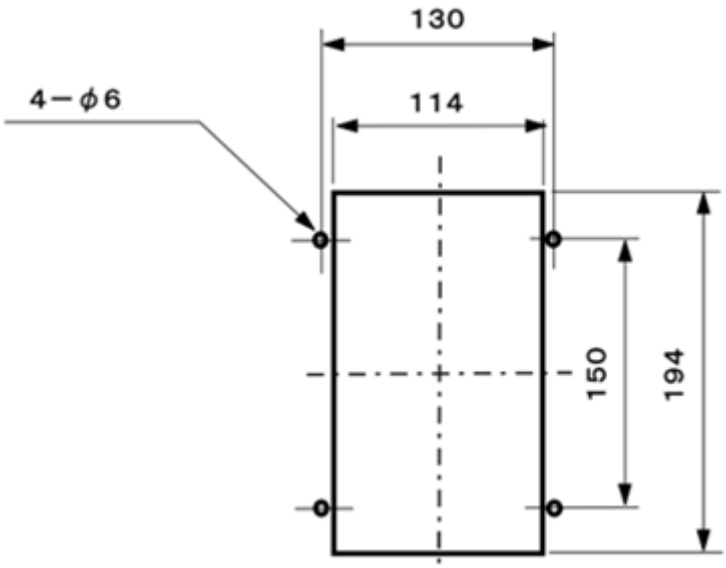


Fig. 2-5 Cut-Out dimensions of panel

2.4. External view of relay

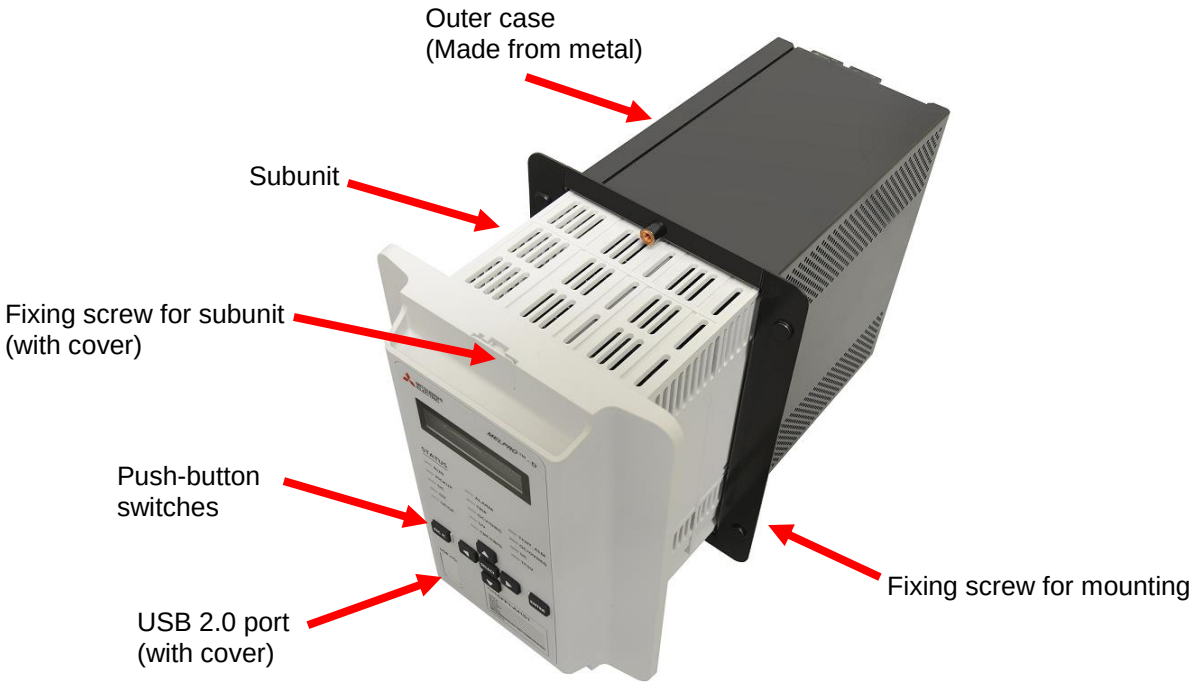


Fig. 2-6 External view of relay

3. Handling, Mounting

3.1. Unpacking

Usually this relay is packed in a case for transportation. However, it may occur that only the sub-unit is transported independently for the convenience at repair. In such a case, fully brush off the dust, dirt, etc. adhered to the sub unit after completion of unpacking, and further visually check that the parts mounted on the front panel or built in the sub unit are not damaged.

3.2. Transportation and storage

To carry the equipment within the place of use, handle it carefully so that the parts installed on the front panel of the sub-unit or built-in parts cannot be deformed or broken.

3.3. How to draw sub-unit out

The relay has draw-out construction to facilitate inspection and testing. Therefore, it is possible to draw out the sub-unit without disconnecting the external wiring

When drawing out the subunit, be sure to take the following steps to avoid the unwanted operation of primary equipment:

- Open control power supply of the relay (Note: Take care that the appropriate circuit is opened.)
- Shunt / Isolate the CT circuit
- Lock out the tripping circuit including breakers etc.
- Disconnect the main control circuits

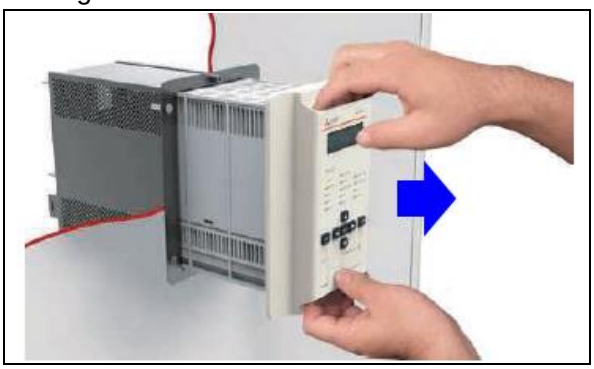
As an additional precaution, the CT circuit is provided with an automatic short-circuiting mechanism. This will ensure that the CT secondary circuit is not opened when the sub-unit is removed even if the CT circuits have not been shunted.

3.3.1. Procedures for drawing out subunit

(1) Removing screws

When drawing out the subunit from the outer case, open upper & lower screw covers at the front side of the subunit and detach both screws.

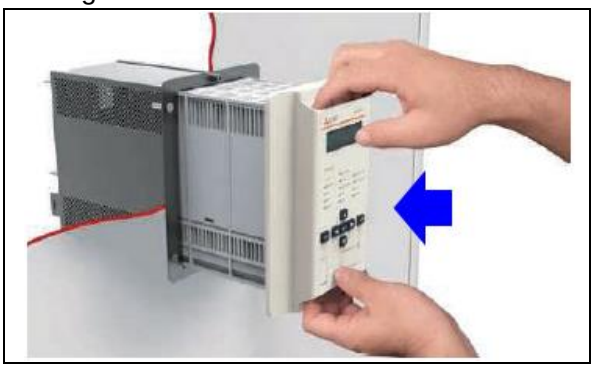
(2) Drawing out the subunit



Draw out subunit horizontally by using fingers on the upper & lower grooves of it.

3.3.2. Procedures for housing subunit

(1) Inserting the subunit

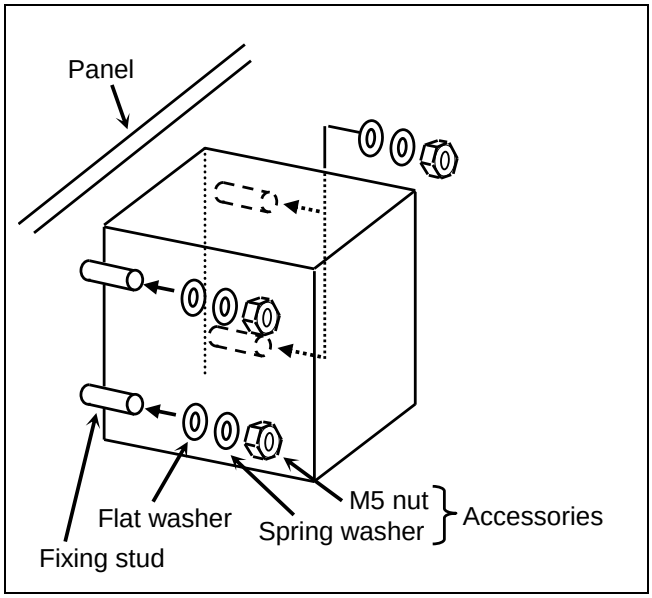


Insert subunit into the outer case horizontally by using fingers on the upper & lower grooves of it. Ensure that there is no gap between front side of the subunit and outer case.

(2) Fixing the screws

Tighten upper & lower screws and fix the subunit to the outer case.
After that, close screw covers.

3.4. Mounting

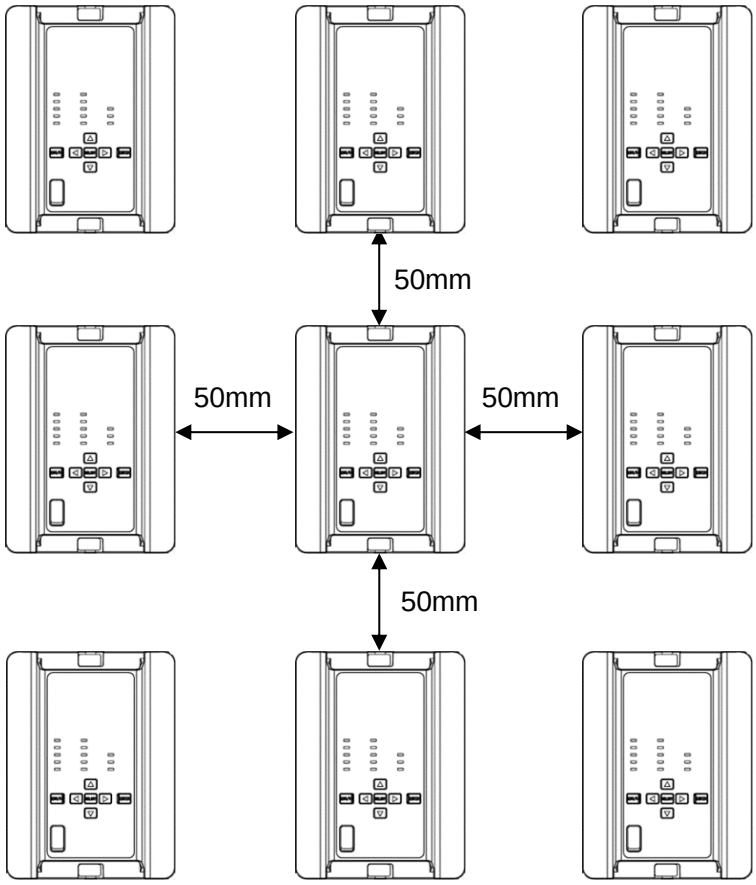


When inserting this relay into control panel, take care in order not to damage it.
After inserting, fix this relay with washers and nuts which are supplied with the product.

Section 2.3 explains Cut-Out dimensions of panel.

3.5. Distance between two devices

If you install more than one relay devices in a control panel, please leave 50 mm between one device and another.



4. Connection

4.1. Precautions for wiring work

(1) Multiplexing

Important facilities should be provided with fail-safe measures such as dual or duplex system in order to improve reliability of the facilities.

(2) Effects of external surge

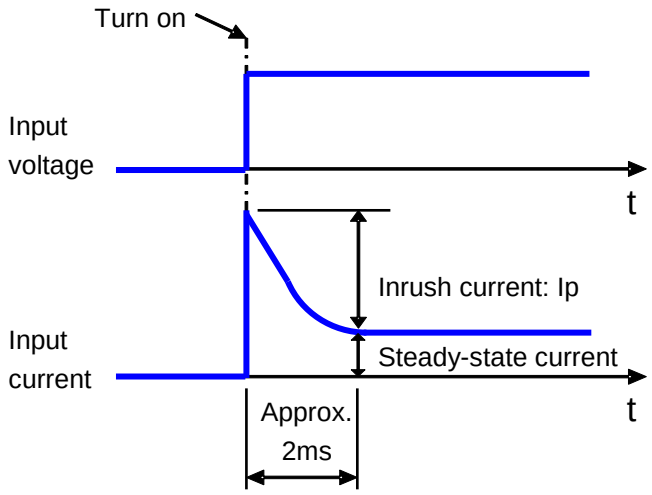
Some types of surge with a certain condition may negatively affect the relay. If so, take it into account to install surge absorbers. (MF type surge absorbers made by Mitsubishi Electric, for example.)

(3) Guarantee of control power supply against power interruption

The control power supply of the relay is not guaranteed against power interruption. When you do not have an uninterruptible power supply (UPS), please purchase it that is made by Mitsubishi Electric or commercially available. When you select UPS, please confirm rated values, ambient temperature, and other service conditions.

(4) Inrush current of control power supply

Since inrush current may flow in the relay when the control power supply is turned on as shown in the figure below, make consideration of this point when selecting the breaker for the control power supply circuit.



Input voltage	Inrush current: Ip
DC100V	Approx. 20A or less
DC220V	Approx. 55A or less
AC100V	Approx. 25A or less
AC220V	Approx. 65A or less

Fig. 4-1 Inrush current of control power supply

(5) Self-diagnosis output circuit

In order to be able to continue monitoring even if the built-in power fuse is blown, the self-diagnosis output circuit adopts normally-closed contact which is excited (opened) at the time of normal condition of monitoring. Therefore, connect the timer to the external wiring. For details, refer to Fig. 4-2.

(6) Trip circuit

There are two kinds of output contacts for the trip circuits and the control circuits. Please keep in mind that the output contacts for control circuits cannot be used for the trip circuit. (If used, the contact may burn.)

Connect the pallet contact (52a) of the circuit breaker to the trip circuit.

(7) Ground circuit

Be sure to earth the ground terminal located on the back of the relay with D class grounding method whose ground resistance is 100 Ω or less.

(8) ZCT circuit

It is necessary to reduce surge or noise which is entered into the relay as much as possible, thus the connection from ZCT to the relay should be done with 2 core shielded cable whose cross-sectional area is 0.75 ~ 1 mm^2. The shield of the cable should be connected to the ground terminal of the relay or that of the cubicle.

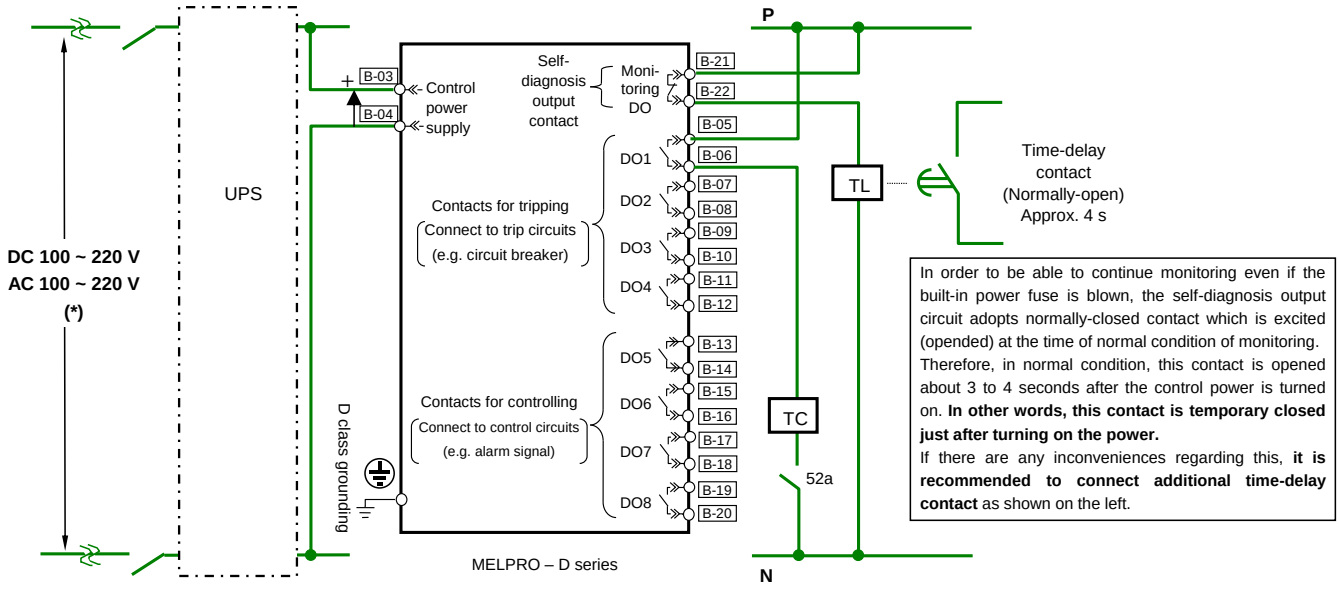
The burden should be less than 5Ω as a round-trip (e.g. about 100 meters one way for 0.75 mm^2 cable).

4.2. Terminal layout

Regarding to the terminal layout, refer to Section 2.2. The screw size of each terminal is M3.5. Recommended wire size is 2mm^2 or less.

4.3. External connection

4.3.1. Connection example of control circuit



(*) Refer to Section 4.1-(3) "Guarantee of control power supply against power interruption".

Fig. 4-2 Connection example of control power supply and self-diagnosis output circuit.

4.3.2. Connection example of input circuit

This figure shows concept of the connection to the relay. Therefore, the position or condition of CT, VT, and other devices sometimes differs from the actual state.

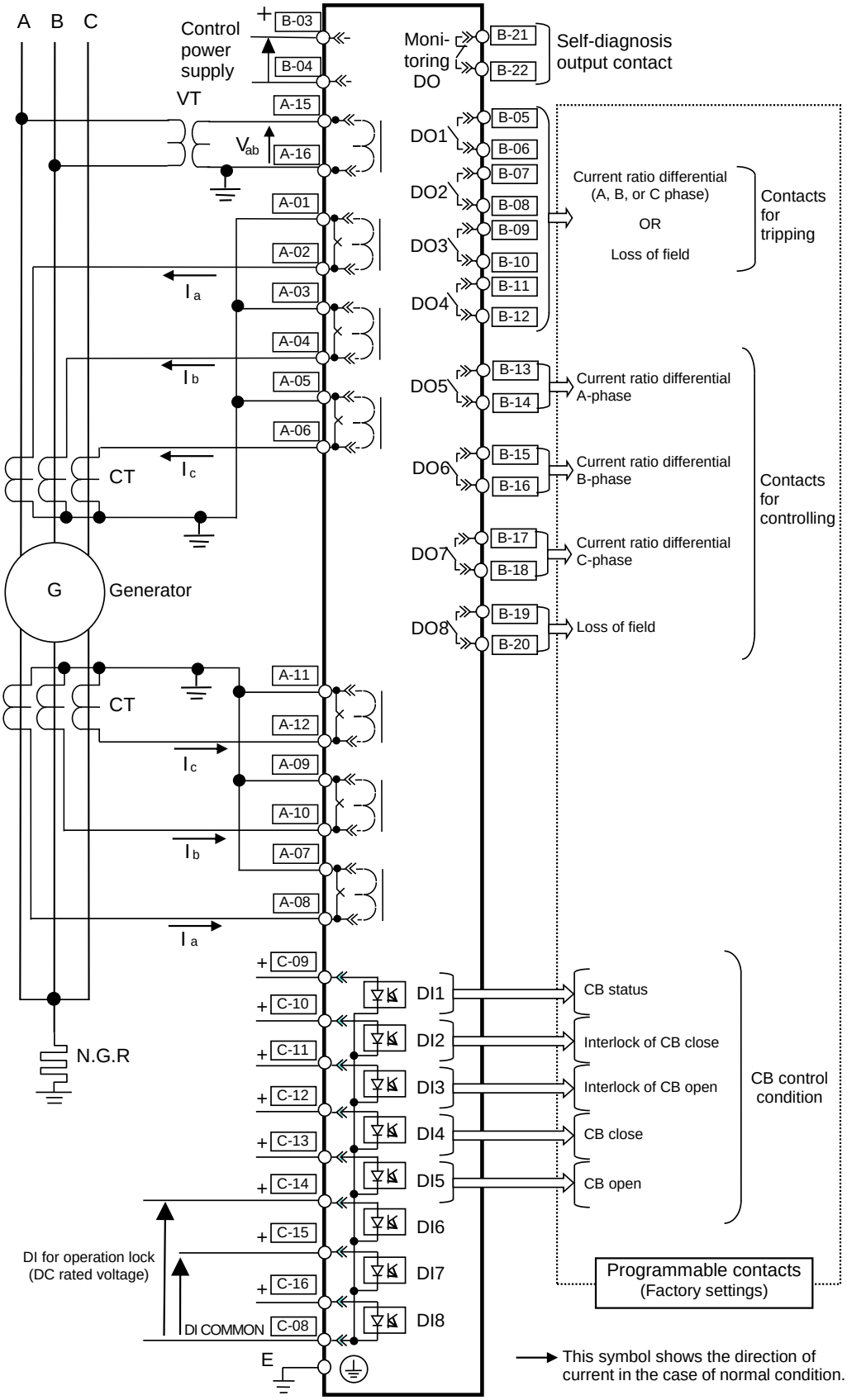


Fig. 4-3 CGP2-A41D1 Example of AC input circuit

In the case of normal condition of generator (which flows through-current), the current flows into the lower number terminal of the relay on the output side of generator and flows from the lower number terminal of the relay on the neutral point side of generator.

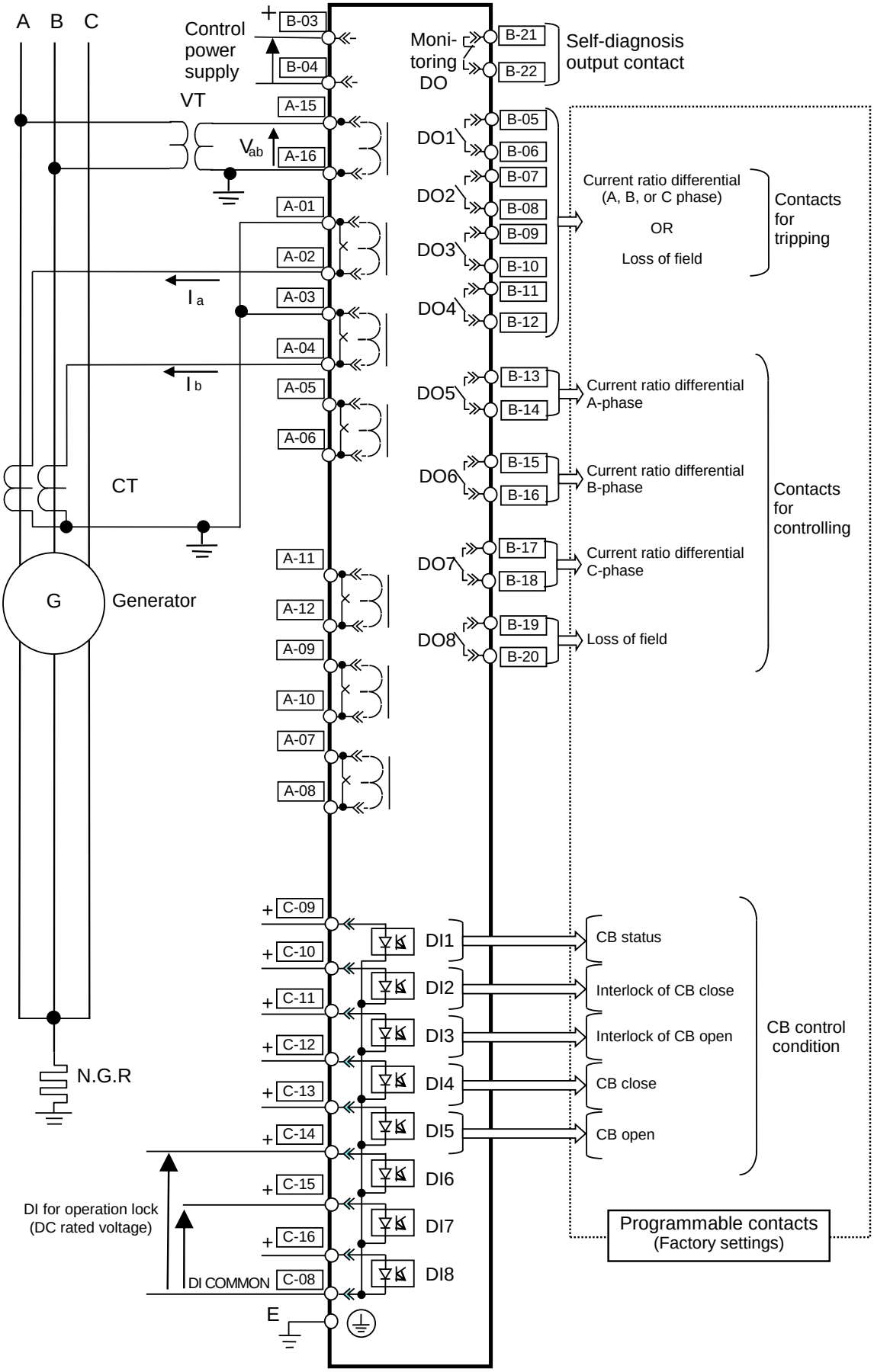


Fig. 4-4 CGP2-A41D1 Example of AC input circuit
(In the case of using only LOF element on A and B phase)

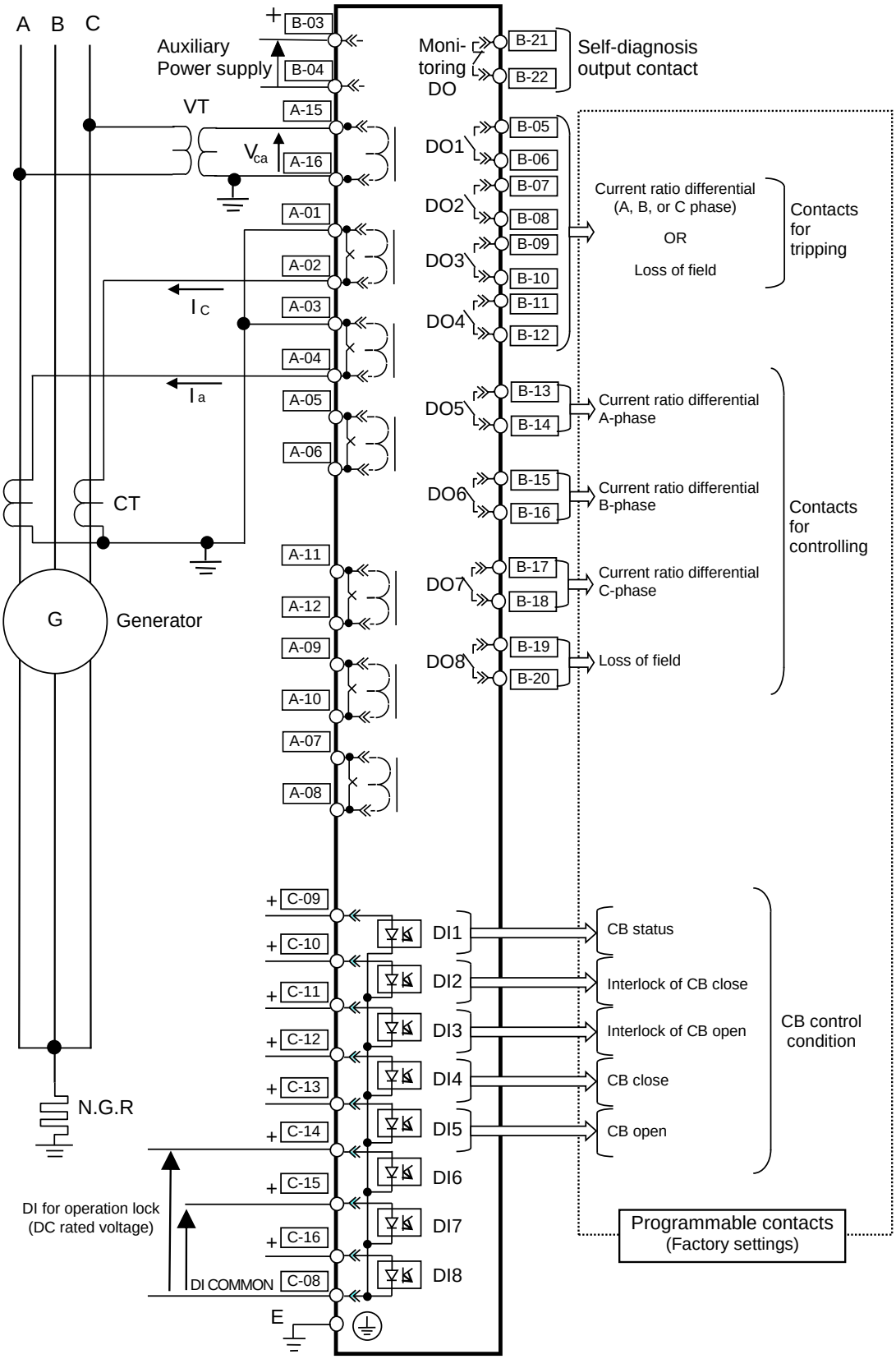


Fig. 4-5 CGP2-A41D1 Example of AC input circuit

(In the case of using only LOF element on A and C phase)

Note: This relay calculates LOF element from current inputs of [A-01 ~ A-02], [A-03 ~ A-04] and voltage inputs of [A-15 ~ A-16] and phase relation of them.

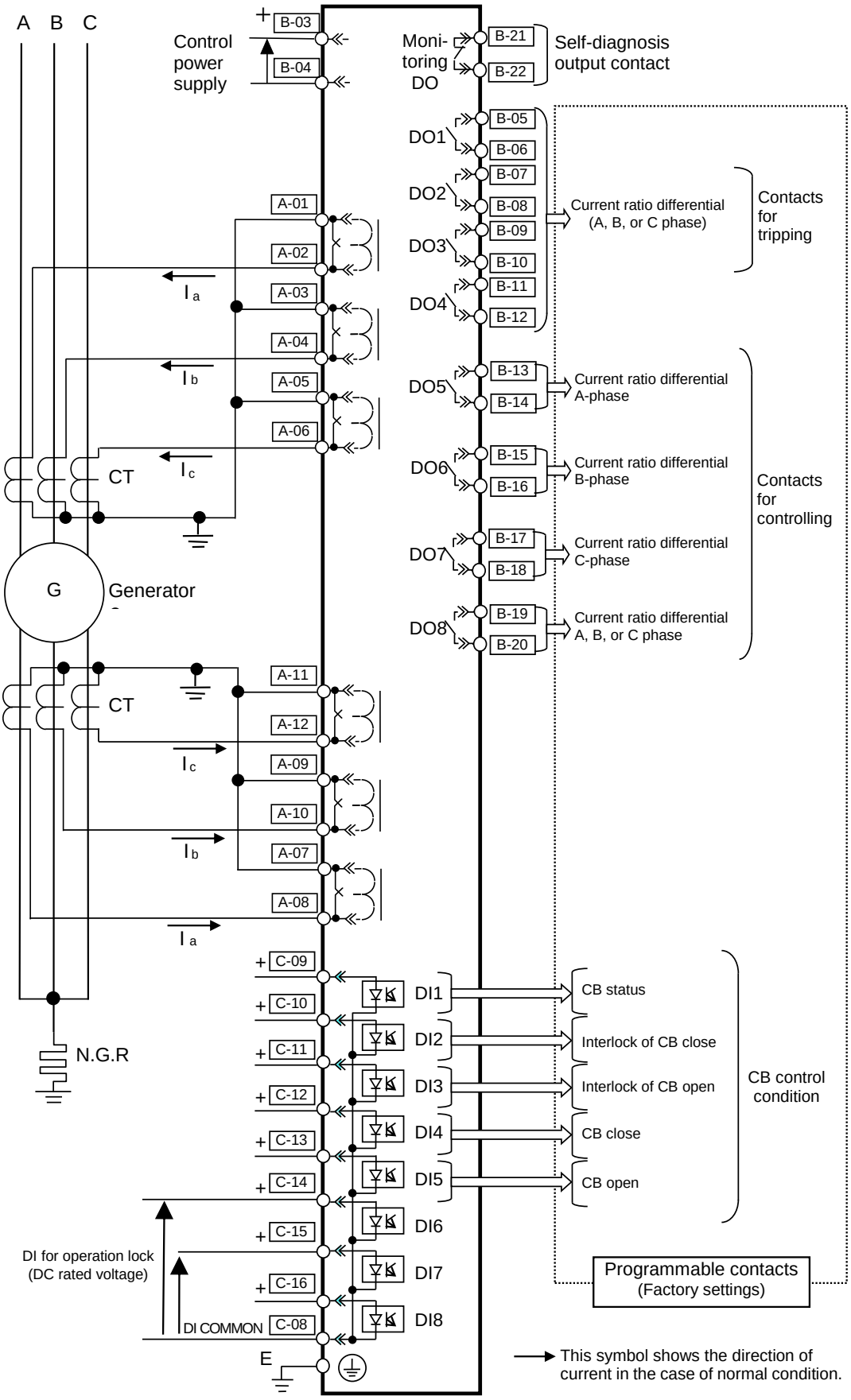


Fig. 4-6 CGP2-A42D1 Example of AC input circuit

In the case of normal condition of generator (which flows through-current), the current flows into the lower number terminal of the relay on the output side of generator and flows from the lower number terminal of the relay on the neutral point side of generator.

5. Human machine interface

There are three ways to set and operate the relay:

(1) Operation from the front panel

(2) Operation from a locally connected PC

This chapter describes about “(1) Operation from the front panel” by pushbuttons and the indication display. The operation method (2) is described in a separate volume. Please refer to the following document.

Title of document	Document No.
MELPRO-D Series Protection Relay PC-HMI Instruction Manual	JEP0-IL9504

5.1. Pushbutton switches and indication display

This section describes the pushbuttons and indication display on the front panel.

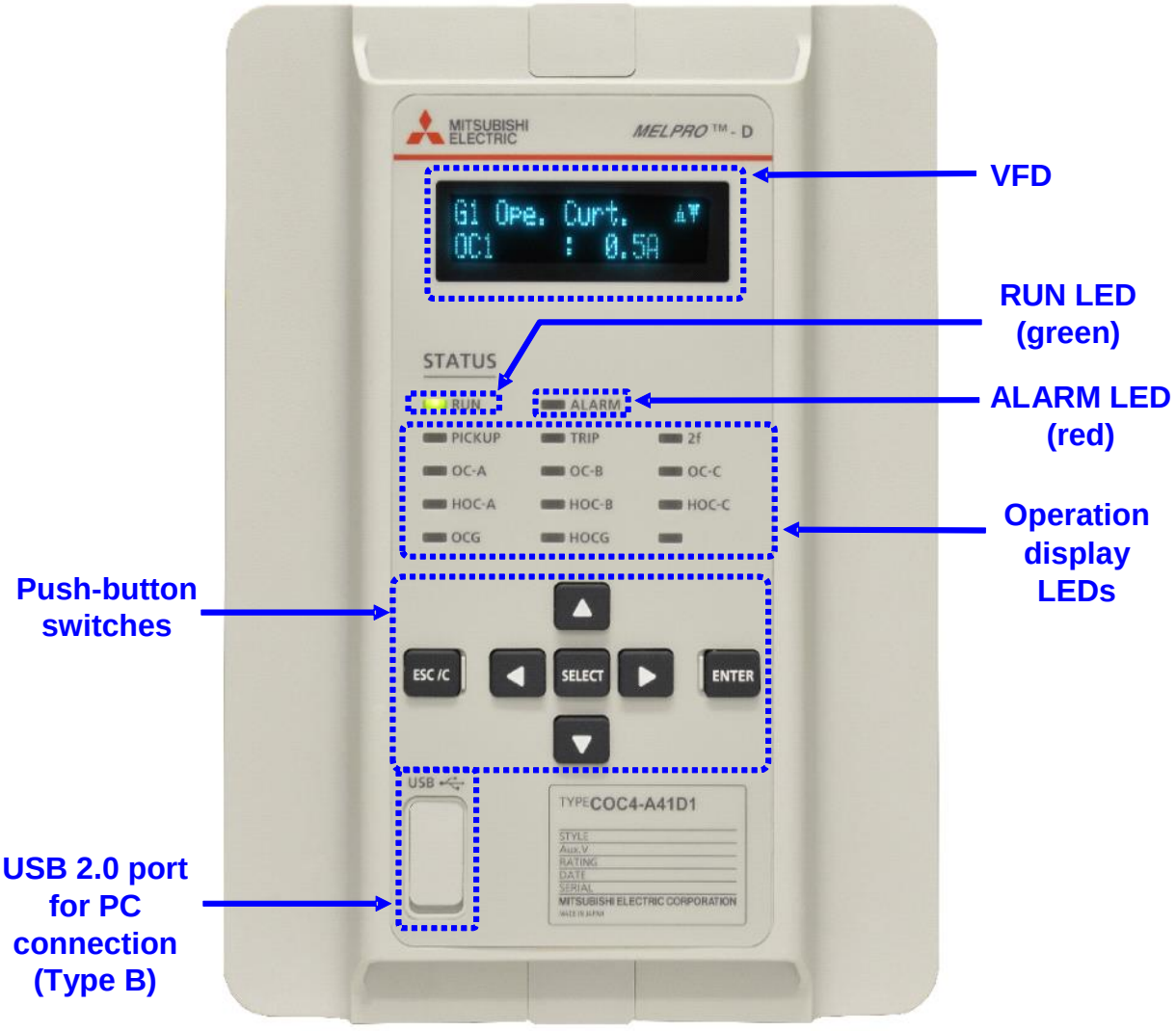


Fig. 5-1 Front view of relay

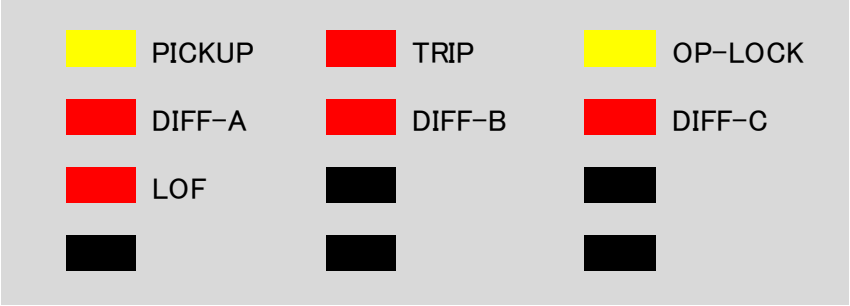


Fig. 5-2 Operation display LEDs of CGP2-A41D1

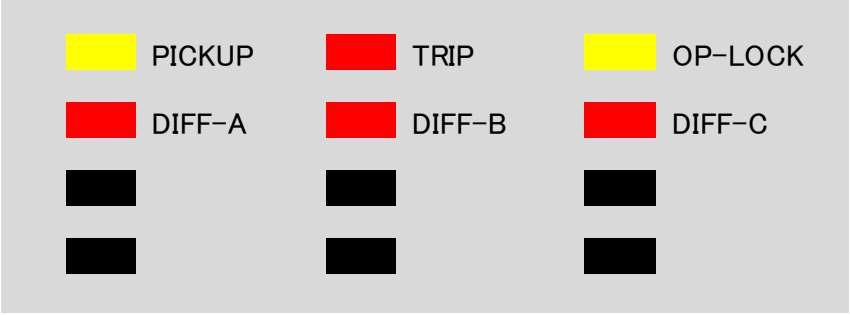


Fig. 5-3 Operation display LEDs of CGP2-A42D1

Table 5-1 Description of front panel

Name				Description
VFD (Vacuum Fluorescent Display) (18 characters x 2 lines)				Shows various menus and values of the DISPLAY/SETTING mode. If you has not operated any push buttons for more than 30 minutes, the VFD is automatically turned off. In the METERING menu, you can expand the character size.
RUN LED			Green	Shows the result of constant supervision. Illuminated for a normal condition. When this LED light is turned off, the relay functions are not working.
ALARM LED			Red	Shows the result of constant supervision. Illuminated for an abnormal condition.
Operation display LED		PICKUP	Yellow	Illuminated for detection of protection element (OR of all elements). This LED will be turned off after resetting.
		TRIP	Red	Illuminated when the definitive signal (TRIP signal) of protection element is issued (OR of all elements). (*)
		OP-LOCK	Yellow	Illuminated when the operation lock function is operated. This LED will be turned off after resetting.
	CGP2-A41D1	DIFF-A	Red	Illuminated when the definitive signal of current ratio differential element on A phase is issued. (*)
		DIFF-B	Red	Illuminated when the definitive signal of current ratio differential element on B phase is issued. (*)
		DIFF-C	Red	Illuminated when the definitive signal of current ratio differential element on C phase is issued. (*)
		LOF	Red	Illuminated when the definitive signal of loss of field element is issued. (*)
	CGP2-A42D1	DIFF-A	Red	Illuminated when the definitive signal of current ratio differential element on A phase is issued. (*)
		DIFF-B	Red	Illuminated when the definitive signal of current ratio differential element on B phase is issued. (*)
		DIFF-C	Red	Illuminated when the definitive signal of current ratio differential element on C phase is issued. (*)
Pushbutton switch		SELECT		• Moves to the menu one level lower • Confirms selection of input item • Confirms input value • Reconfirms after pressing ENTER in SETTING mode
		ENTER		• Starts operation in SETTING mode
		ESC/C		• Turns off VFD • Turns off operation indicator LEDs by holding down (for 3s or longer)
		◀		• Moves to the menu one level higher • Moves to digit on the left in the value input screen • Discards the input value in the input screen and moves to the menu one level higher
		▶		• Moves to digit on the right in the value input screen
		▼ ▲		• Moves to the menu above/below • Increments/decrements the input value in the value input screen
USB2.0 port				For PC connection (Commercial USB cable is available)

(*) The LED continues lighting after resetting the protection element. You can turn the LED off by pushing ESC/C button if the trouble has been resolved.

5.2. List of menus

The operation mode includes the DISPLAY and SETTING modes, which respectively have different menus. Table 5-2 lists the menus available in the respective modes.

Table 5-2 List of menu

○: DISPLAY only Θ: DISPLAY and SETTING -: Not shown

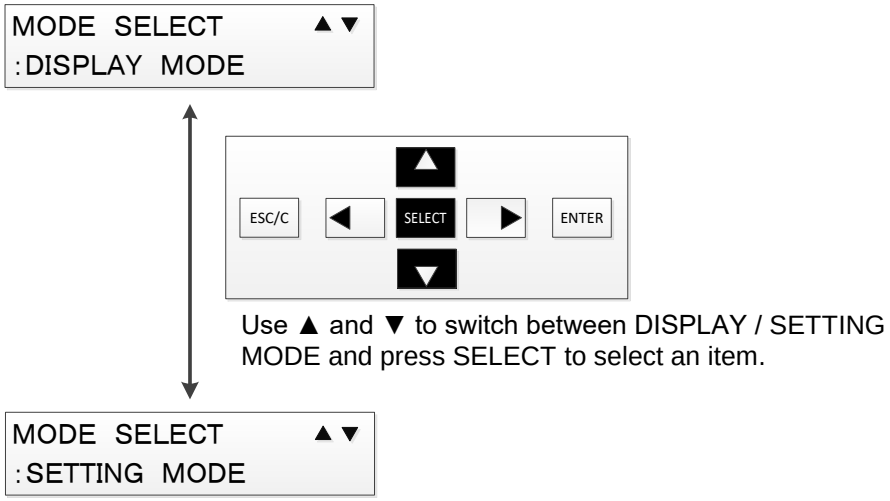
Menu		Operation mode	
		DISPLAY	SETTING
Status (STATUS)	Clock (CLOCK)	○	-
	Measured analog value (METERING)	○	-
	DI/DO status (DIGITAL I/O)	○	-
	Trip counter (TRIP COUNTER)	○	-
	Device name (DEVICE NAME)	○	-
Record (RECORD)	Fault record (FAULT RECORD)	○	-
	Event record (EVENT RECORD)	○	-
	Access record (ACCESS RECORD)	○	-
	Alarm record (ALARM RECORD)	○	-
Setting (SETTING)	Active group (ACTIVE WG)	○	Θ
	Group 1 setting (G1)	○	Θ
	Group 2 setting (G2)	○	Θ
Control (CONTROL)	Control mode (CTRL MODE)	○	Θ
	CB control (CB CONTROL)	-	Θ
Configuration (CONFIG)	Communication setting (COMMUNICATION)	○	Θ
	Clock adjustment (CLOCK ADJUST)	-	Θ
	Analog value display switching (METERING)	○	Θ
	Trip counter (TRIP COUNTER)	○	Θ
	Disturbance record (DISTURBANCE)	○	Θ
	DI voltage (DI VOLTAGE)	○	Θ
	Password use/unuse (PASSWORD USE)	-	Θ
	Password registration (PASSWORD REGIST)	-	Θ
Test (TEST)	DO contact test (CONTACT TEST)	-	Θ
	Test mode (MODE)	-	Θ
	LED/VFD lighting test (LED/VFD TEST)	-	Θ
Clear record (RECORD-CLR)	Clear fault record (FAULT REC CLEAR)	-	Θ
	Clear alarm record (ALARM REC CLEAR)	-	Θ
	Clear event record (EVENT REC CLEAR)	-	Θ

5.3. Operation method

This section describes the operations for mode selection and various menus.

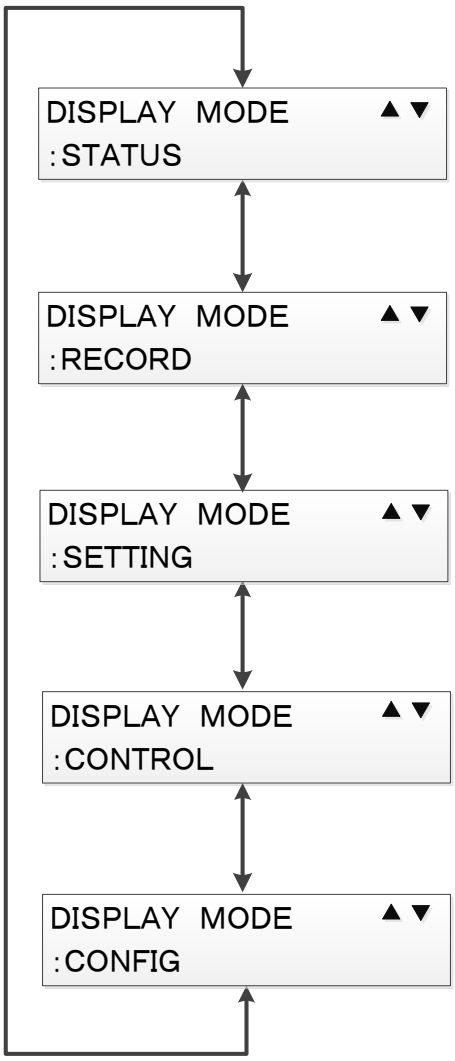
5.3.1. DISPLAY/SETTING mode selection

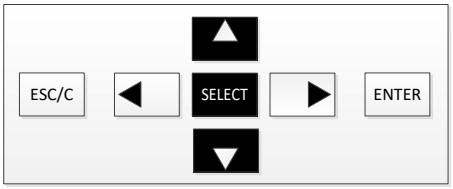
Press a key except for ESC/C when VFD is OFF to show the DISPLAY/SETTING mode selection screen. The DISPLAY and SETTING modes offer different sets of menus available.
For the details about the menus in the respective modes, see Table 5-2.



5.3.2. DISPLAY mode menu operations

This subsection describes the menu operations in the DISPLAY mode.
The menu screen has five selectable items. Use the Up and Down keys to select the item and press SELECT.
For the details about the menus available in the DISPLAY mode, see Table 5-2.

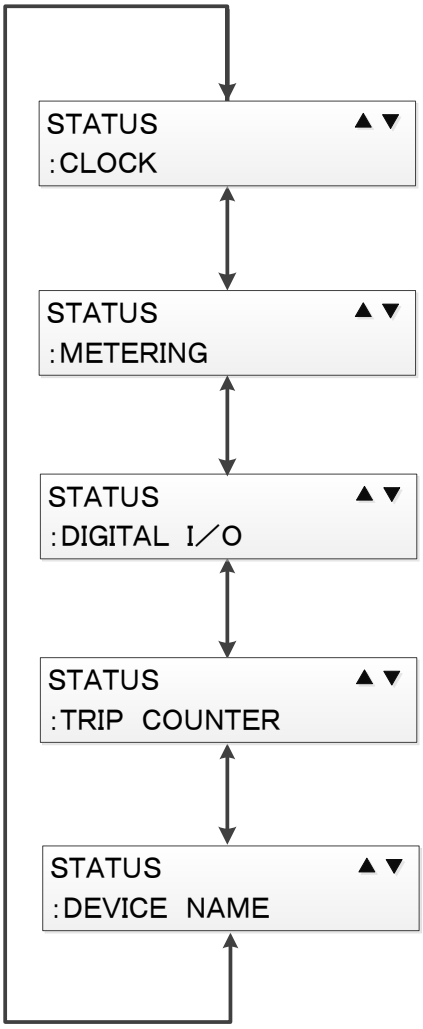


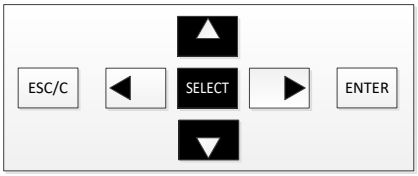


Use ▲ and ▼ to switch between items and press SELECT to select an item.

5.3.2.1. Status (STATUS) menu

This subsection describes the Status (STATUS) menu.
The Status menu shows the current time, measured value, DI/DO status, trip counter, device name and Software version.





Use ▲ and ▼ to switch between items and press SELECT to select an item.

5.3.2.1.1. Clock (CLOCK) menu

[Operation path] DISPLAY MODE > STATUS > CLOCK

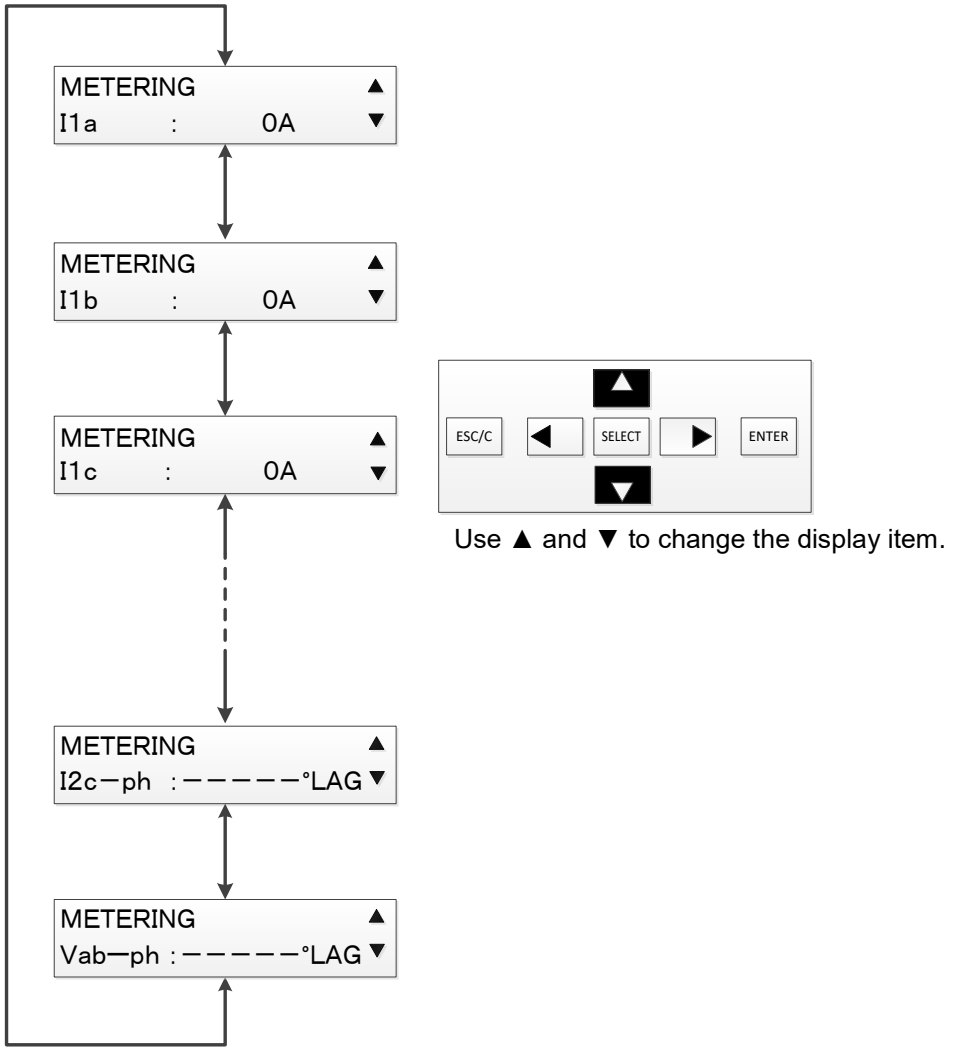
The clock (CLOCK) menu allows viewing of the current time and synchronization type.

The text in the upper right part of the screen indicates the synchronization type for the time shown.
(Part showing “LOCAL” in figure above)

5.3.2.1.2. Measured analog value (METERING) menu

[Operation path] DISPLAY MODE > STATUS > METERING

The Measured analog value (METERING) menu allows viewing of the current measured value.
The Configuration menu can specify the measured value of the primary or secondary value of CT/VT.
For the setting procedure, see 5.3.4.3.3.



Note: This is an example.

By pressing SELECT, you can expand the character size of the measured value.
Pressing SELECT again goes back to the original state.

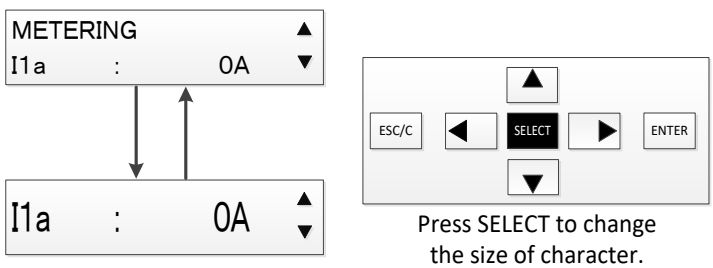


Table 5-3 Measured value display items

・CGP2-A41D1

No.	Signal name	Unit (primary/secondary)	No.	Signal name	Unit (primary/secondary)
1	I1a	A / A	10	Vab	kV / V
2	I1b	A / A	11	I1a-ph	°LAG / °LAG
3	I1c	A / A	12	I1b-ph	°LAG / °LAG
4	I2a	A / A	13	I1c-ph	°LAG / °LAG
5	I2b	A / A	14	I2a-ph	°LAG / °LAG
6	I2c	A / A	15	I2b-ph	°LAG / °LAG
7	Ida	A / A	16	I2c-ph	°LAG / °LAG
8	Idb	A / A	17	Vab-ph	°LAG / °LAG
9	Idc	A / A			

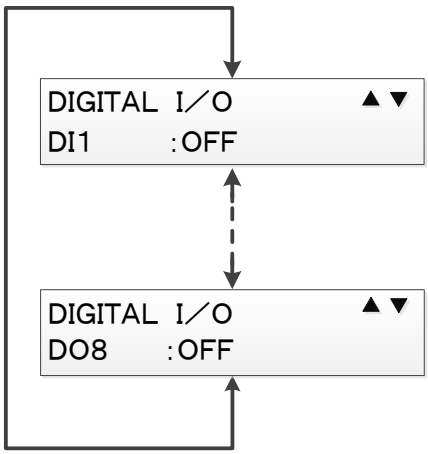
・CGP2-A42D1

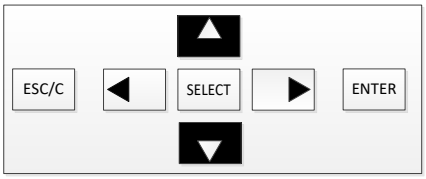
No.	Signal name	Unit (primary/secondary)	No.	Signal name	Unit (primary/secondary)
1	I1a	A / A	10	I1a-ph	°LAG / °LAG
2	I1b	A / A	11	I1b-ph	°LAG / °LAG
3	I1c	A / A	12	I1c-ph	°LAG / °LAG
4	I2a	A / A	13	I2a-ph	°LAG / °LAG
5	I2b	A / A	14	I2b-ph	°LAG / °LAG
6	I2c	A / A	15	I2c-ph	°LAG / °LAG
7	Ida	A / A			
8	Idb	A / A			
9	Idc	A / A			

5.3.2.1.3. DI/DO status (DIGITAL I/O) menu

[Operation path] DISPLAY MODE > STATUS > DIGITAL I/O

The DI/DO status (DIGITAL I/O) menu allows viewing of the current DI/DO.





Use ▲ and ▼ to change the display item

Table 5-4 DI/DO status display items

No.	Signal name	No.	Signal name
1	DI1	9	DO1
2	DI2	10	DO2
3	DI3	11	DO3
4	DI4	12	DO4
5	DI5	13	DO5
6	DI6	14	DO6
7	DI7	15	DO7
8	DI8	16	DO8

5.3.2.1.4. Trip counter (TRIP COUNTER) menu

[Operation path] DISPLAY MODE > STATUS > TRIP COUNTER

The Trip counter (TRIP COUNTER) menu allows viewing of the number of trips.

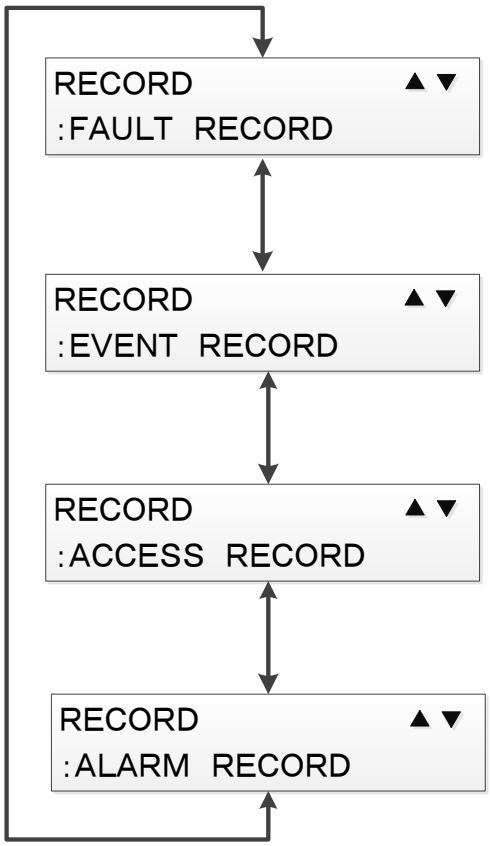
5.3.2.1.5. Device name (DEVICE NAME) menu

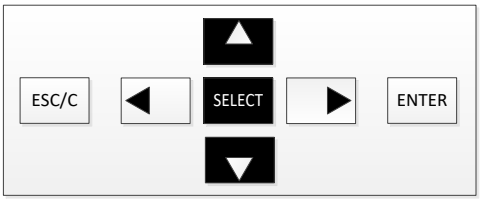
[Operation path] DISPLAY MODE > STATUS > DEVICE NAME

The Device name (DEVICE NAME) menu allows viewing of the device name.

5.3.2.2. Record (RECORD) menu

This subsection describes the operation logs in the Record (RECORD) menu.
The Record menu allows viewing four types of log data.
(Fault record, Event record, Access record and Alarm record)



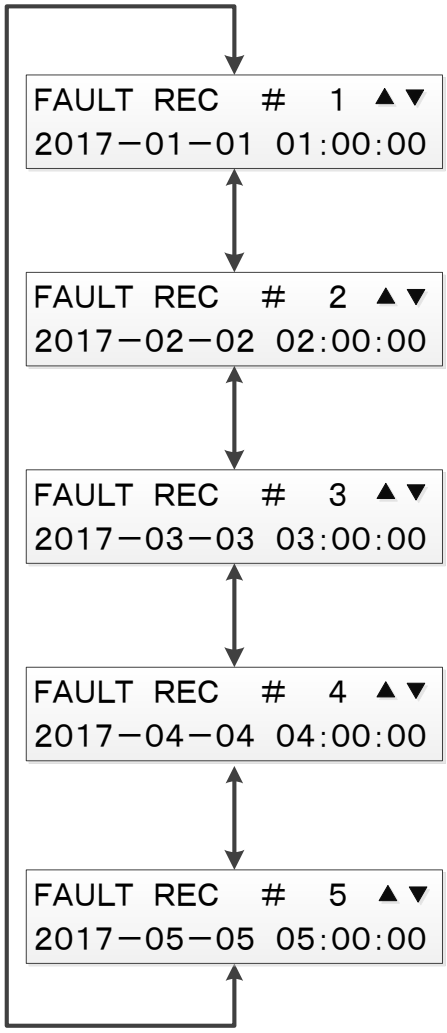


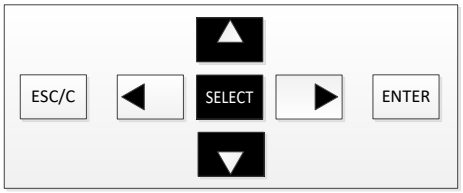
Use ▲ and ▼ to switch between items and press SELECT to select an item.

5.3.2.2.1. Fault record (FAULT RECORD) menu

[Operation path] DISPLAY MODE > RECORD > FAULT RECORD

The Fault record (FAULT RECORD) menu allows viewing of the time, operating values and operating elements when the fault is detected. Fault records of up to five phenomena are stored and the respective fault record can be viewed. For selecting record for display, use the Up and Down keys to select the date of the fault record and press SELECT.

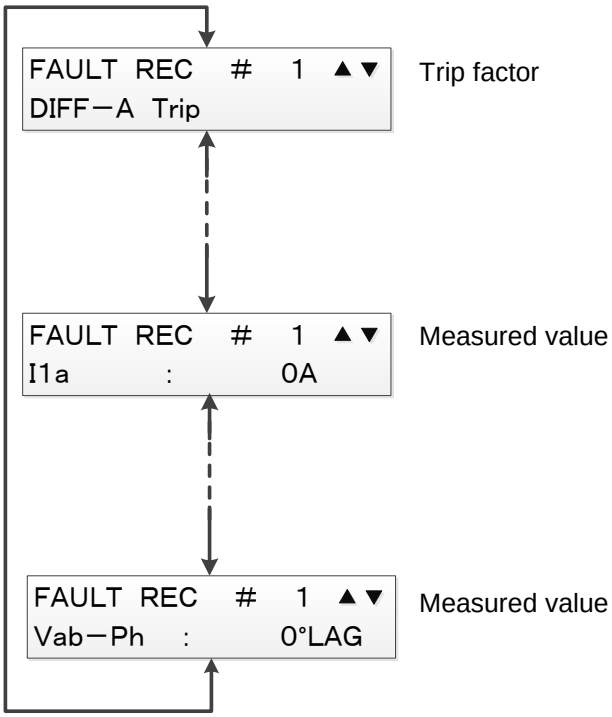




Use ▲ and ▼ to switch between items and press SELECT to select an item.

Note: This is an example.

After a fault record is selected, use the Up and Down keys to view the trip factors and measured values.



Note: This is an example.

Table 5-5 Elements of fault records (CGP2-A41D1)

Element name displayed
DIFF-A Trip
DIFF-B Trip
DIFF-C Trip
LOF Trip

Table 5-6 Elements of fault records (CGP2-A42D1)

Element name displayed
DIFF-A Trip
DIFF-B Trip
DIFF-C Trip

Table 5-7 Measured values of fault records (CGP2-A41D1)

No.	Signal name	Unit
1	I1a	A
2	I1b	A
3	I1c	A
4	I2a	A
5	I2b	A
6	I2c	A
7	Vab	kV
8	Ida	A
9	Idb	A
10	Idc	A
11	I1a-ph	°LAG
12	I1b-ph	°LAG
13	I1c-ph	°LAG
14	I2a-ph	°LAG
15	I2b-ph	°LAG
16	I2c-ph	°LAG
17	Vab-ph	°LAG

Table 5-8 Measured values of fault records (CGP2-A42D1)

No.	Signal name	Unit
1	I1a	A
2	I1b	A
3	I1c	A
4	I2a	A
5	I2b	A
6	I2c	A
7	Ida	A
8	Idb	A
9	Idc	A
10	I1a-ph	°LAG
11	I1b-ph	°LAG
12	I1c-ph	°LAG
13	I2a-ph	°LAG
14	I2b-ph	°LAG
15	I2c-ph	°LAG

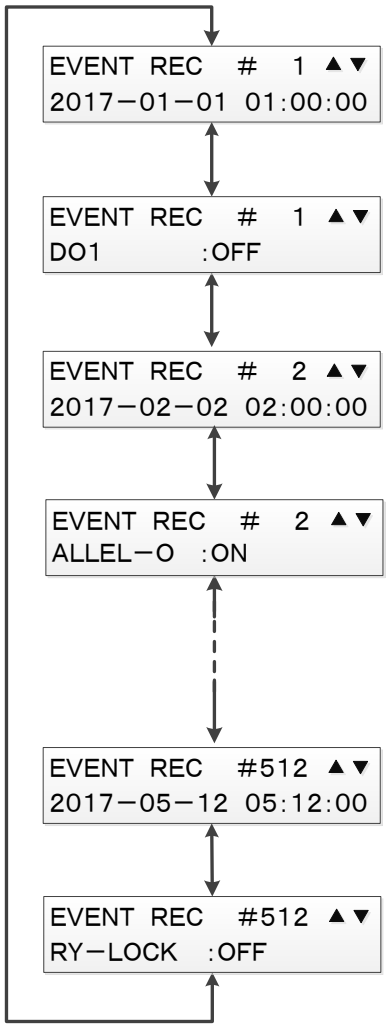
5.3.2.2.2. Event record (EVENT RECORD) menu

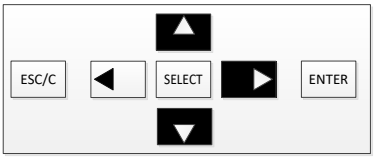
[Operation path] DISPLAY MODE > RECORD > EVENT RECORD

The Event record (EVENT RECORD) menu allows viewing of event records saved.
Event records of up to 512 events are stored and the respective event record can be viewed.
Press the Up and Down keys to switch the indication on the screen as below.

Date of occurrence > Record description > Date of occurrence...

Press the Right key to display from the current event record to the past 10th record.





Use ▲ and ▼ to change the display item.
Use ► to move from the record currently shown to the date of the tenth record into past.

Note: This is an example.

Table 5-9 List of event record (CGP2-A41D1)

Event name	
DI1	Status of DI1
DI2	Status of DI2
DI3	Status of DI3
DI4	Status of DI4
DI5	Status of DI5
DI6	Status of DI6
DI7	Status of DI7
DI8	Status of DI8
DO1	Status of DO1
DO2	Status of DO2
DO3	Status of DO3
DO4	Status of DO4
DO5	Status of DO5
DO6	Status of DO6
DO7	Status of DO7
DO8	Status of DO8
TCNT_ALM	Alarm of trip counter
CBa1	Status of CB
INT_LK_OP	Interlock signal (OPEN)
INT_LK_CL	Interlock signal (CLOSE)
CTL_OP_OK	Possible to CB open control
CTL_CL_OK	Possible to CB close control
CB_CTL_OK	Success of CB control
CB_CTL_NG	Failure of CB control
OP_TS	CB open control (local)
CL_TS	CB close control (local)
MANU_CLS	Command of CB close
MANU_OPN	Command of CB open
CB_LR	Local or Remote
CTL_BLOP1	Prohibition of open
CTL_BLCL1	Prohibition of close
43INT_FLG	Use / Non-use setting of interlock
VL4000000	Choice failure
RES_STS00	Success of control
RES_STS02	Lack of control / Prohibition of operation
RES_STS05	Control of the same direction
RES_STS0A	Failure of interlock condition
RES_STS10	Time out
CL_DI	DI command of close
OP_DI	DI command of open
P_INT_LK1	Interlock of close-side
P_INT_LK2	Interlock of open-side
CB_DI_CTL	Active status of DI for CB control
ALARM	Abnormal condition of constant supervision (serious failure)
ALARM-L	Abnormal condition of constant supervision (minor failure)

RY-LOCK	Locking of relay
SV-LK	Locking of supervision
TCNT-LK	Locking of trip counter
ALLEL-O	OR of all “definitive signal AND operation lock signal”
DS_TRIG	Pulse signal from start-up until the end of data saving (Except for pre-fault time)
DIFF-A	Definitive signal of DIFF A-phase or forced operation from PC-HMI
DIFF-B	Definitive signal of DIFF B-phase or forced operation from PC-HMI
DIFF-C	Definitive signal of DIFF C-phase or forced operation from PC-HMI
LOF	Definitive signal of LOF or forced operation from PC-HMI

Table 5-10 List of event record (CGP2-A42D1)

Event name	
DI1	Status of DI1
DI2	Status of DI2
DI3	Status of DI3
DI4	Status of DI4
DI5	Status of DI5
DI6	Status of DI6
DI7	Status of DI7
DI8	Status of DI8
DO1	Status of DO1
DO2	Status of DO2
DO3	Status of DO3
DO4	Status of DO4
DO5	Status of DO5
DO6	Status of DO6
DO7	Status of DO7
DO8	Status of DO8
TCNT_ALM	Alarm of trip counter
CBa1	Status of CB
INT_LK_OP	Interlock signal (OPEN)
INT_LK_CL	Interlock signal (CLOSE)
CTL_OP_OK	Possible to CB open control
CTL_CL_OK	Possible to CB close control
CB_CTL_OK	Success of CB control
CB_CTL_NG	Failure of CB control
OP_TS	CB open control (local)
CL_TS	CB close control (local)
MANU_CLS	Command of CB close
MANU_OPN	Command of CB open
CB_LR	Local or Remote
CTL_BLOP1	Prohibition of open
CTL_BLCL1	Prohibition of close
43INT_FLG	Use / Non-use setting of interlock
VL4000000	Choice failure
RES_STS00	Success of control
RES_STS02	Lack of control / Prohibition of operation
RES_STS05	Control of the same direction
RES_STS0A	Failure of interlock condition
RES_STS10	Time out
CL_DI	DI command of close
OP_DI	DI command of open
P_INT_LK1	Interlock of close-side
P_INT_LK2	Interlock of open-side
CB_DI_CTL	Active status of DI for CB control
ALARM	Abnormal condition of constant supervision (serious failure)
ALARM-L	Abnormal condition of constant supervision (minor failure)

RY-LOCK	Locking of relay
SV-LK	Locking of supervision
TCNT-LK	Locking of trip counter
ALLEL-O	OR of all “definitive signal AND operation lock signal”
DS_TRIG	Pulse signal from start-up until the end of data saving (Except for pre-fault time)
DIFF-A	Definitive signal of DIFF A-phase or forced operation from PC-HMI
DIFF-B	Definitive signal of DIFF B-phase or forced operation from PC-HMI
DIFF-C	Definitive signal of DIFF C-phase or forced operation from PC-HMI

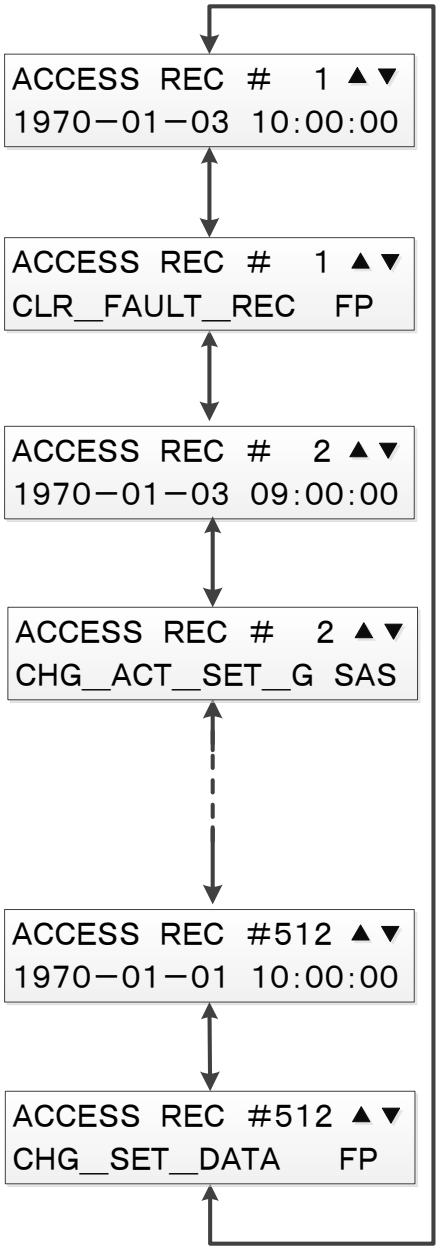
5.3.2.2.3. Access record (ACCESS RECORD) menu

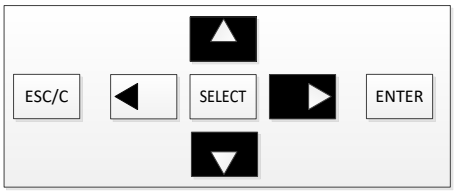
[Operation path] DISPLAY MODE > RECORD > ACCESS RECORD

The Access record (ACCESS RECORD) menu allows viewing of the saved access records.
Access records of up to 512 accesses are stored and the records for the respective accesses can be viewed.
Press the Up and Down keys to switch the indication on the screen as below.

Date of occurrence > Record description > Date of occurrence...

Press the Right key to display from the current access record to the past 10th record.





Use ▲ and ▼ to change the display item.
Use ► to move from the record currently shown to the date of the tenth record into past.

Note: This is an example.

Access record description registered (operator)

Display item	Operation description
RY	Front panel
PC	PC-HMI
AUT	Automatic cancelation on device

Access record description registered (operation description)

Display item	Operation description
CHG_ACT_SET_G	Change of active setting group
CHG_DI_VOLTAGE	Change of configuration of DI voltage
CHG_DIST_REC_T	Change of configuration of disturbance record
CHG_USE_PASSWD	Change of password use setting
CHG_PASSWD	Change of password
CHG_USB_CONN	Change of USB connection channel
CHG_TRIP_CNTR	Change of trip counter
CHG_DEV_NAME	Change of device name
CHG_CFG_METER	Change of configuration of analog measurement status display
CHG_CFG_ENERGY	Change of configuration of electric energy
CHG_TIMEMANAGE	Change of configuration of time management
CHG_CTRL_MODE	Change of CB control mode
CHG_CONTACT_T	Change of configuration of DO contact test
CHG_PLC_DATA	Change of PLC data
CHG_SET_DATA	Change of relay setting
CLR_FAULT_REC	Clearing of fault/disturbance record
CLR_ALARM_REC	Clearing of alarm record
CLR_EVENT_REC	Clearing of event record
ADJ_CLOCK	Adjustment of system clock
ACT_TST_MODE	Activation of test mode
DEACT_TST_MODE	Deactivation of test mode
RESET_LED	LED reset
STA_CONTACTTST	Start of DO contact test
STP_CONTACTTST	Stop of DO contact test
LOCK_SV	Lock of self-diagnosis
UNLOCK_SV	Unlock of self-diagnosis
STA_I/F_TST	Start of forced operation
STP_I/F_TST	Stop of forced operation
OPERATE_CB	Operation of CB control (open / close)

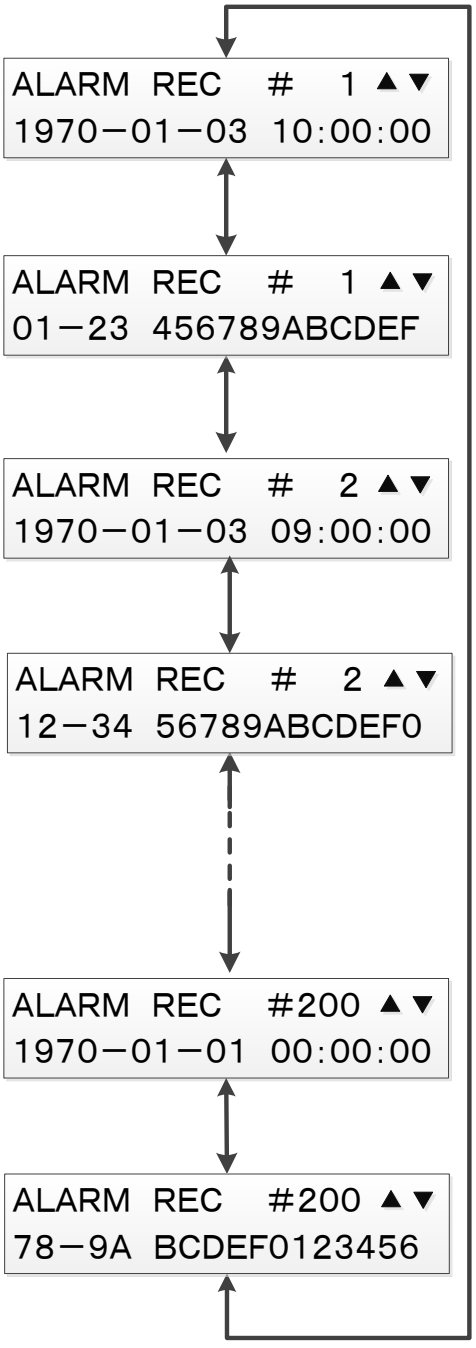
5.3.2.2.4. Alarm record (ALARM RECORD) menu

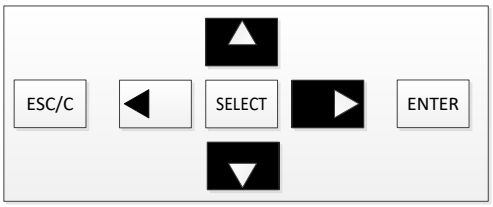
[Operation path] DISPLAY MODE > RECORD > ALARM RECORD

The Alarm record (ALARM RECORD) menu allows viewing of the saved alarm records.
Alarm records of up to 200 alarms are stored and the records for the respective alarms can be viewed.
Press the Up and Down keys to switch the indication on the screen as below.

Date of occurrence > Record description > Date of occurrence...

Press the Right key to display from the current alarm record to the past 10th record.





Use ▲ and ▼ to change the display item.
Use ► to move from the record currently shown to the date of the tenth record into past.

Note: This is an example.

5.3.2.3. Setting (SETTING) menu

The Setting menu can be selected in either DISPLAY or SETTING mode but the DISPLAY mode only allows viewing of the setting values.
The setting values can be changed only in the SETTING mode.

For operations for the Setting menu, see 5.3.4.1.

5.3.2.4. Control (CONTROL) menu

The Control menu can be selected in either DISPLAY or SETTING mode but the DISPLAY mode only allows viewing of the setting of Control mode.
In the SETTING mode, both Control mode and CB control can be shown and set.

For operations for the Control menu, see 5.3.4.2.

5.3.2.5. Configuration (CONFIG) menu

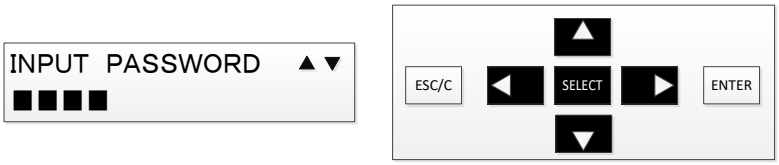
The Configuration menu can be selected in either DISPLAY or SETTING mode. Clock adjustment (CLOCK ADJUST), Password use/unuse (PASSWORD USE) and Password registration (PASSWORD REGIST) can be selected only in the SETTING mode.
For other settings, the DISPLAY mode allows only viewing of the setting values.
The setting values can be changed only in the SETTING mode.

For operations for the Configuration menu, see 5.3.4.3.

5.3.3. Password input screen

If the password use/unuse setting is “USE,” a four-digit password is requested when the SETTING mode is selected.

* For the password use/unuse setting, see 5.3.4.3.7.
For how to set the password input, see 5.3.4.3.8.



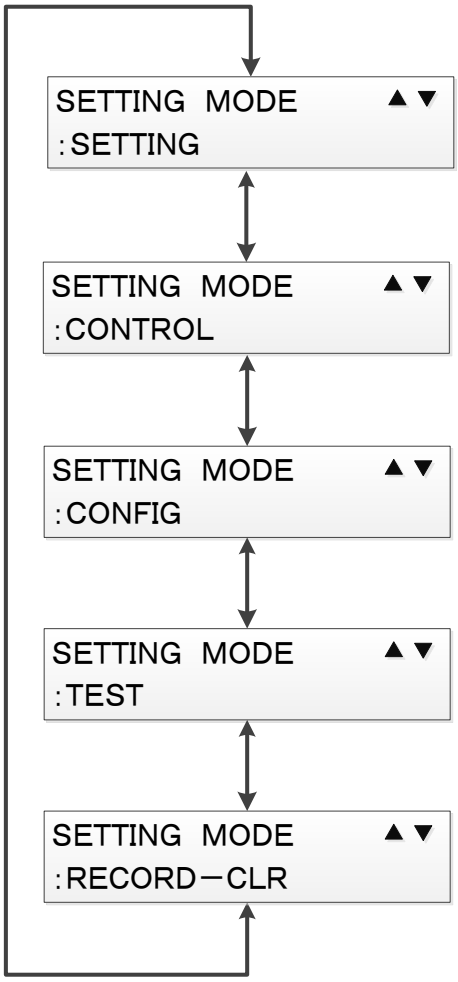
Use ▲ and ▼ to change the value of the each digit selected.
Pressing SELECT confirms the value for the digit entered and moves the cursor to the next digit on the right.

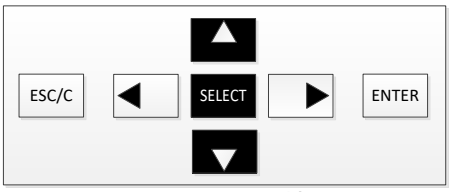
If the password input is wrong, a screen as shown below appears.

The main menu appears when the correct password has been input.

5.3.4. SETTING mode menu operations

This subsection describes the SETTING mode menu.
The menu screen has five selectable items. Use the Up and Down keys to select the item and press SELECT. For the details about the menus available in the SETTING mode, see Table 5-2.

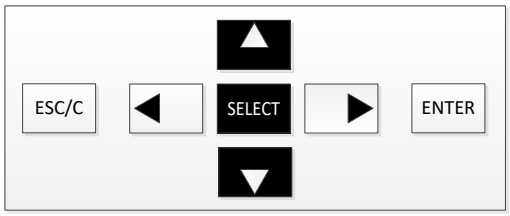




Use ▲ and ▼ to switch between items and press SELECT to select an item.

5.3.4.1. Setting (SETTING) menu

The Setting (SETTING) menu allows viewing/changing of the active setting group and viewing/changing of the group setting values.
The Setting menu can be selected in either DISPLAY or SETTING mode but the setting values can be changed only in the SETTING mode.
(The DISPLAY mode allows only viewing of the setting values.)



Use ▲ and ▼ to switch between items and press SELECT to select an item.

5.3.4.1.1. Active group (ACTIVE WG) menu

[Operation path] SETTING MODE > SETTING > ACTIVE WG

The Active group (ACTIVE WG) menu allows changing of the active group numbers setting.
(Active group numbers can be changed only in the SETTING mode.
The DISPLAY mode allows only viewing of the current group numbers.)

```
ACTIVE WG
          :G1
```

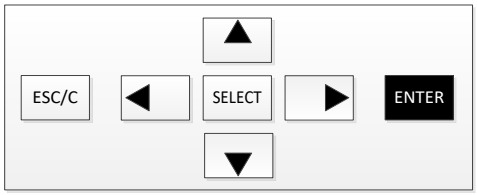
To change the active group number, in the Active group menu, press SELECT.
A cursor appears, which allows the selection of a group number with the Up and Down keys.
Select the group number to change and press SELECT to confirm the change.

```
ACTIVE WG
          :■1
```

Use ▲ and ▼ to switch between group Nos. and press SELECT to confirm the change

Press ENTER to show the confirmation screen below. Press SELECT to initiate the change to the group number selected.
When the new active group setting is not required, press the Left key to return the display back.

```
CHANGE ACTIVE WG?
YES=SELECT  NO=◀
```



Press ENTER to show the screen on the left.

The next message shows the Successful or Unsuccessful change of active group number.
Pressing SELECT brings the display back to the Setting menu.

```
SETTING
HAVE CHANGED
```

Message for a successful change of the active group

```
SETTING
FAILED TO CHANGE
```

Message for an unsuccessful change of the active group

The cancel message will appear by pressing the Left key in the Active group menu.
Pressing SELECT exits the Active group menu without changing the active group and brings the display back to the Setting menu.
Pressing the Left key brings the display back to the Active group menu.

```
CANCEL ACTIVE WG?
YES=SELECT  NO=◀
```

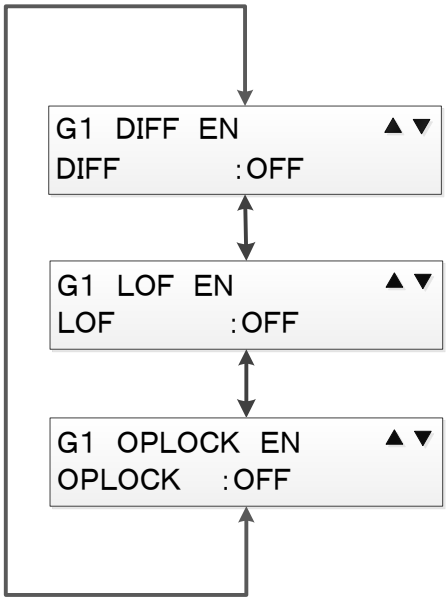
5.3.4.1.2. Group 1 setting (G1) and Group 2 setting (G2) menus

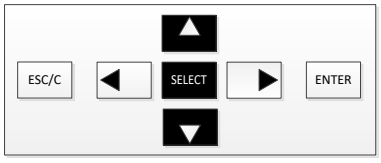
[Operation path] SETTING MODE > SETTING > G1(G2)

The Group 1 setting (G1) and Group 2 setting (G2) menus allow viewing and changing of the setting values for the respective group settings.
(Setting values can be changed only in the SETTING mode. The DISPLAY mode allows only viewing of the setting values)
The operation procedure for changing group settings is explained by changing G1 (for example).

1. First, select the setting value group in the Setting menu to change and press SELECT.

2. The Group setting menu appears.
   Select the protective element to change with pressing the Up and Down key, and press SELECT.

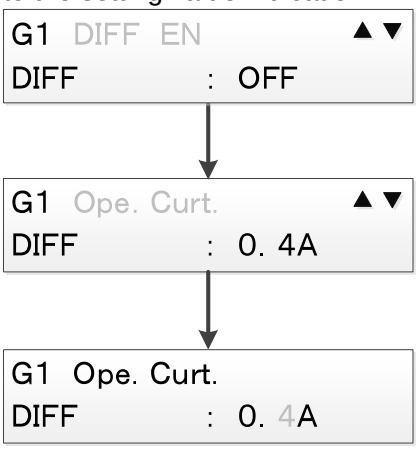




Use ▲ and ▼ to select an element and press SELECT to confirm.

Note: This is an example.

3. The cursor moves to the setting parameter indication.
Use the Up and Down keys to select the setting parameter to be changed and press SELECT. The cursor moves to the setting value indication.



Cursor moves to the setting parameter indication.

Select the setting parameter to change and press SELECT.

Cursor moves to the setting value indication.

4. Use the Left and Right keys to select the digit to change and use the Up and Down keys to set the value.

For setting a value as shown on the left,
use ◄ and ► to select the digit to change,
and ▲ and ▼ to set the value.
Press SELECT to confirm the change.

5. When the value has been changed, press SELECT to move the cursor to the setting parameter indication.

Cursor moves to the setting parameter indication.

6. Complete setting of all parameters in the element to change by repeating steps 2 to 5 above.

7. Press the Left key to return the cursor back to the protective element indication.
Complete setting of any other protective elements to change by repeating steps 1 to 6 above.

8. When the all necessary change of the setting values has been completed, press ENTER.
A confirmation message of the setting value changes appears as shown in the figure below. After confirmation of correct settings, press SELECT. If discarding the setting value changes, press the Left key.

Press SELECT to change the setting.
Press ◄ to discard the change.

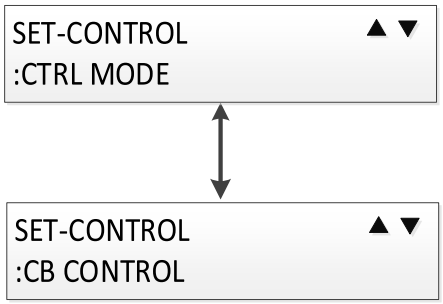
The following messages are shown respectively to check the successful or unsuccessful setting change, The display returns back to the Setting menu by pressing SELECT while either of the messages below.

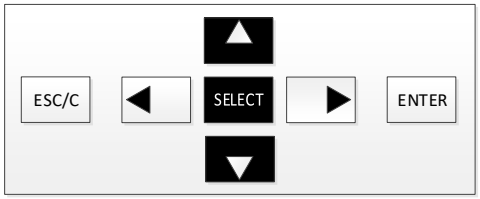
Message for successful changes of setting value

Message for unsuccessful changes of setting value

5.3.4.2. Control (CONTROL) menu

The Control (CONTROL) menu allows viewing/changing of Control mode and CB control.
The Control menu can be selected in either DISPLAY or SETTING mode but the DISPLAY mode only allows viewing of the setting of Control mode.
In the SETTING mode, both Control mode and CB control can be shown and set.





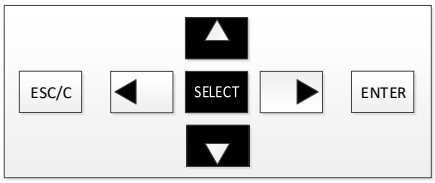
Use ▲ and ▼ to switch between items and press SELECT to select an item.

5.3.4.2.1. Control mode (CTRL MODE) menu

[Operation path] SETTING MODE > CONTROL > CTRL MODE

The Control mode (CTRL MODE) menu allows setting of the Local/remote control, Interlock selection and Circuit breaker operation blocking.
(Note that they can be set only in the SETTING mode. The DISPLAY mode only allows viewing of the settings.)

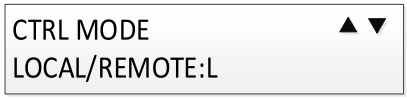
1. Use the Up and Down keys to show the control mode item to change and press the SELECT key for selection.



Use▲ and▼ keys to switch between items and press the SELECT key to select an item.

2. The cursor moves to the setting value. Use the Up and Down keys to change the setting value.
(The setting value below shows a selection setting. For a numeric value setting, use the Left and Right keys to change the digit for setting.)

3. Press the SELECT key to change the setting value.



4. Repeat steps 1 to 3 until there are no more items you want to change.

5. Press the ENTER key, and a message appears to confirm application of the control mode settings that were just changed as shown in the figure below.
Press the SELECT key to apply the control mode settings that were just changed by steps 1 to 4 and complete the control mode setting.

Press the Left key to go back to the Control mode menu without applying the settings that were just changed.

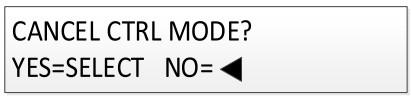


Table 5-11 Setting items of Control mode

NO.	Item	Description	Setting range	Unit
1	REMOTE/LOCAL	Remote / Local setting	R / L	-
2	INTERLOCK	Interlock unuse/use selection setting	UNUSE / USE	-
3	CB OPEN	CB open control operation block setting	UNBLK / BLK	-
4	CB CLOSE	CB close control operation block setting	UNBLK / BLK	-
5	ON TIMER	Control waiting time	0 - 60	s

5.3.4.2.2. CB Control (CB CONTROL) menu

[Operation path] SETTING MODE > CONTROL > CB CONTROL

The CB control (CB CONTROL) menu allows CB open control/CB close control.
This item can be selected for implementing CB control only in the SETTING mode.

For CB control, the control mode settings must be as shown in the table below.
For details about control mode operation, refer to 5.3.4.2.1.
For details about the CB control functions including other conditions required for CB control, refer to Chapter 9.

Table 5-12 Control mode settings when CB Control is executed

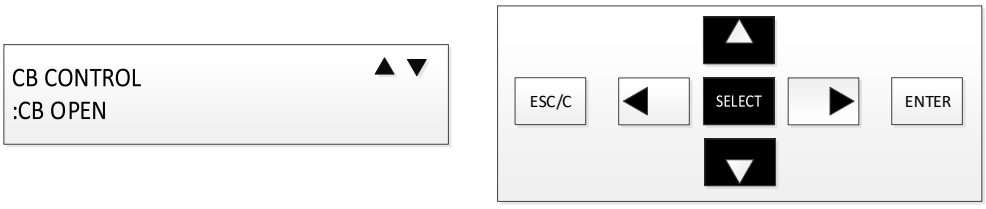
・CB open control

Item	Setting value	Description of the setting value
REMOTE/LOCAL	L	Set to the local state.
INTERLOCK	UNUSE	Set to the interlock unuse state.
CB OPEN	UNBLK	Set to the CB open control operation block resetting state. Set to UNBLK to enable CB open control.

・CB close control

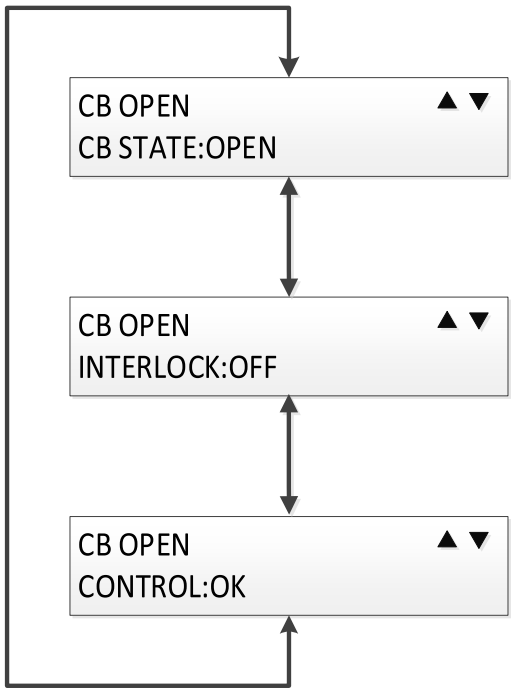
Item	Setting value	Description of the setting value
REMOTE/LOCAL	L	Set to the local state.
INTERLOCK	UNUSE	Set to the interlock unuse state.
CB CLOSE	UNBLK	Set to the CB close control operation block resetting state. Set to UNBLK to enable CB close control.

1. Use the Up and Down keys to show the CB control setting item to change and press the SELECT key.
   * Select CB OPEN for CB open control and CB CLOSE for CB close control.
   (The figure below shows an example of a screen that appears when CB OPEN is selected.)



Use ▲ and ▼ keys to switch between items and press the SELECT key to select an item.

2. The display switches to the CB status indication screen.
   Press the Up and Down keys to cycle through items of CB status indication.



3. After confirming the CB status, press the ENTER key while the CB status indication screen is shown.
   The following screen appears to confirm whether to execute CB control. Press the SELECT key to execute the control and press the Left key not to execute the control.

   If CB control has been successful, a control success message is displayed.

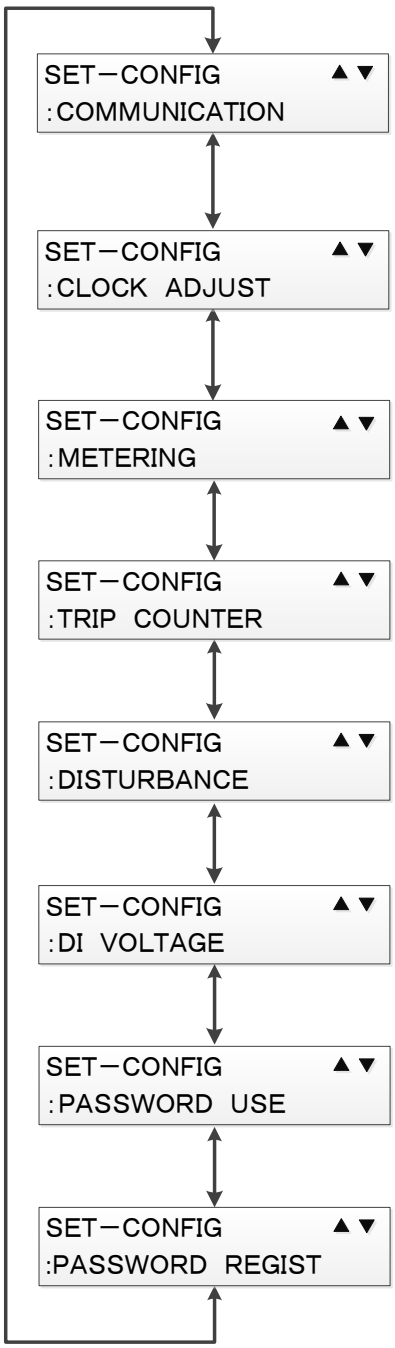
   If CB control has been unsuccessful, a control failure message is displayed.

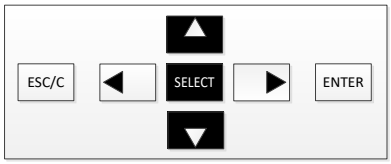
   If the control mode is not set as specified in Table 5-12 or if control condition is not satisfied, an error message as shown below is displayed.

   Pressing the SELECT key while the above control success message, control failure message, or error message is shown brings the display back to the CB control menu.

5.3.4.3. Configuration (CONFIG) menu

This subsection describes the operations for the Configuration (CONFIG) menu.
The Configuration menu can be selected in either DISPLAY or SETTING mode. Clock adjustment (CLOCK ADJUST), Password use/unuse (PASSWORD USE) and Password registration (PASSWORD REGIST) can be selected only in the SETTING mode.
The other settings can be changed in the SETTING mode only.
(The DISPLAY mode only allows viewing of the setting values)





Use ▲ and ▼ to switch between items and press SELECT to select an item.

5.3.4.3.1. Communication setting (COMMUNICATION) menu

[Operation path] SETTING MODE > CONFIG > COMMUNICATION

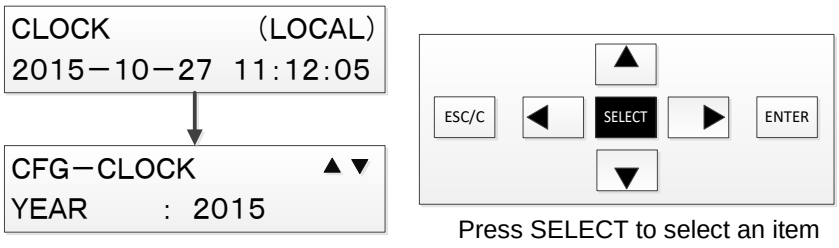
In regard to the standard products, there is no communication function.
In this menu, the message "NONE" appears on the display.

5.3.4.3.2. Clock adjustment (CLOCK ADJUST) menu

[Operation path] SETTING MODE > CONFIG > CLOCK ADJUST

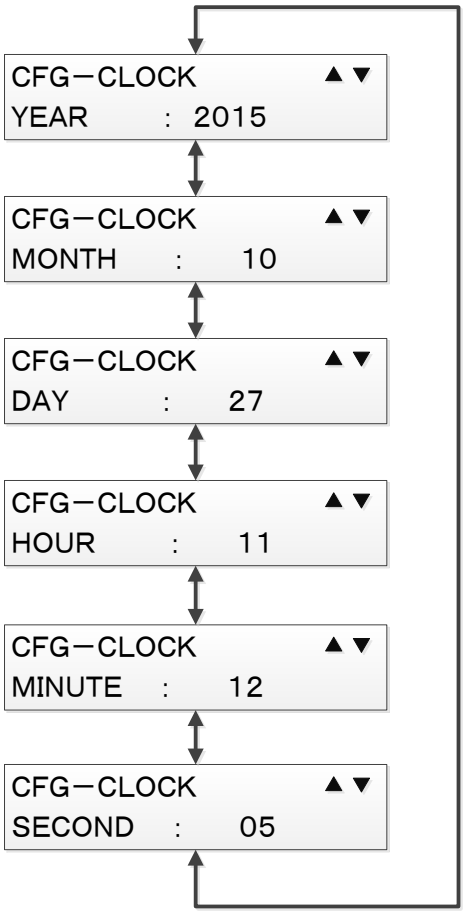
The Clock adjustment (CLOCK ADJUST) menu allows time setting.
This item can be selected only in the SETTING mode.

1. When the Clock adjustment menu is selected, the current time is indicated as shown below.
   Pressing SELECT while this screen is shown allows changing of the year, month, day, hour, minute and second settings.



Press SELECT to select an item

2. Pressing the Up and Down keys cycles through the year, month, day, hour, minute and second selection items. Select the item to change and press SELECT.



3. The cursor moves to the setting value. Use the Up and Down keys to select the value and the Left and Right keys to select the digit to make the change.

4. Press SELECT to change the setting value.

5. Complete setting of all other items to change by repeating steps 1. to 3..

6. Press ENTER and the confirmation message of the time setting appears.
   Press SELECT to apply the time setting changed by steps 1. to 4. and complete the Clock adjustment setting.
   Press the Left key to go back to the Clock adjustment menu without applying the setting changes.

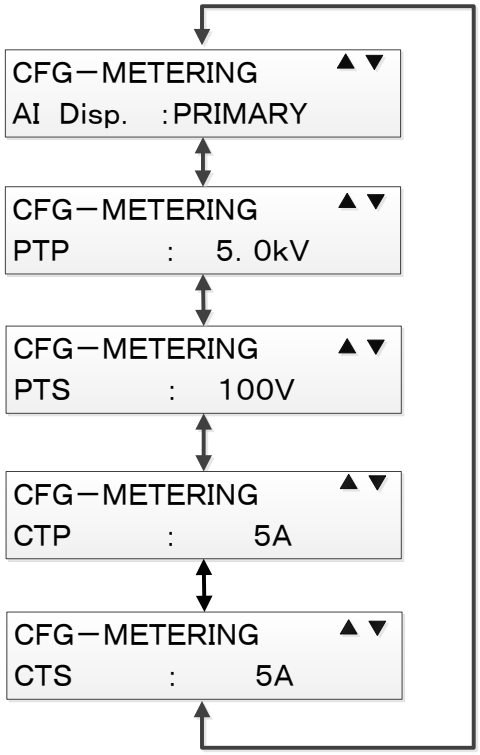
5.3.4.3.3. Analog value display switching (METERING) menu

[Operation path] SETTING MODE > CONFIG > METERING

The Analog value display switching (METERING) menu allows configuration of the following settings.

(1) Set the indication type from the primary or secondary side of CT/VT
(2) Set the rating of CT/VT.
(The DISPLAY mode only allows viewing of the setting values)

The following describes the operation procedure for viewing and changing the settings for the Measurement value display switching menu.



Note: This is an example.

1. Use the Up and Down keys to select the item to change and press SELECT for selection.

2. The cursor moves to the setting value. Use the Up and Down keys to select the value and the Left and Right keys to select the digit to make the change.

3. Press SELECT to change the setting value.

4. Complete setting of all other items to change by repeating steps 1. to 3..

5. Press ENTER and the confirmation message of the new measurement settings appears as shown in the figure below.
   Press SELECT to apply the measurement value settings changed by steps 1. to 4. and complete the setting.
   Press the Left key to go back to the Analog value display switching menu without applying the setting changes.

Table 5-13 Setting items of analog value display

- CGP2-A41D1

No.	Item	Setting description	Setting range	Unit
1	AI Disp	AI display primary value / secondary value selection	PRIMARY / SECONDARY	―
2	PTP	VT primary side rating	0.1 ~ 500.0	kV
3	PTS	VT secondary side rating	100 ~ 125	V
4	CTP	CT primary side rating	5 ~ 30000	A
5	CTS	CT secondary side rating	5 (fixed value)	A

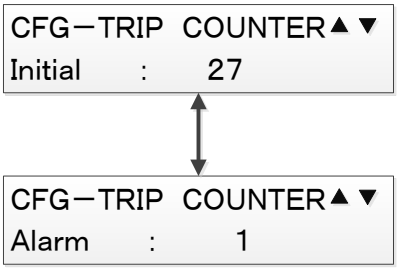
- CGP2-A42D1

No.	Item	Setting description	Setting range	Unit
1	AI Disp	AI display primary value / secondary value selection	PRIMARY / SECONDARY	―
2	CTP	CT primary side rating	5 ~ 30000	A
3	CTS	CT secondary side rating	5 (fixed value)	A

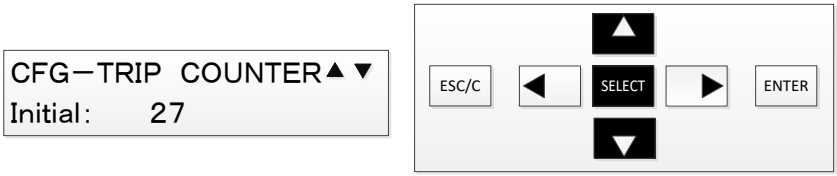
5.3.4.3.4. Trip counter (TRIP COUNTER) menu

[Operation path] SETTING MODE > CONFIG > TRIP COUNTER

The Trip counter (TRIP COUNTER) menu allows setting of the initial counter and alarm counter values. The trip counter will count the number of trip times.
(The DISPLAY mode only allows viewing of the setting values)

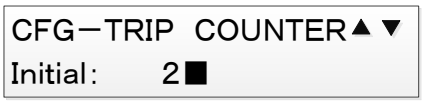


1. The trip counter setting menu appears. Use the Up and Down keys to select the item to change and press SELECT.



Use ▲ and ▼ to switch between items and press SELECT to select an item.

2. The cursor moves to the setting value. Use the Up and Down keys to select the value and the Left and Right keys to select the digit to make the change.



3. Press SELECT to change the setting value.

4. Complete setting of all other items to change by repeating steps 1. to 3..

5. Press ENTER and the confirmation message of the trip counter settings appears.
Press SELECT to apply the trip counter settings changed by steps 1. to 4. and complete the setting.
Press the Left key to go back to the setting menu in step 1. above without applying the setting changes.

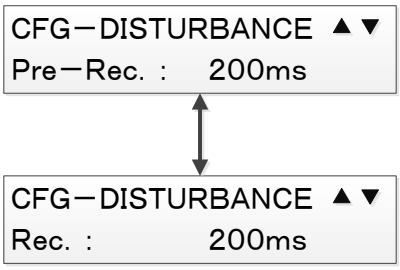
Table 5-14 Setting items of trip counter

No.	Item	Setting description	Setting range	Unit
1	Initial	Initial value of trip counter	0~10000	Times
2	Alarm	Alarm value of trip counter	1~10000	Times

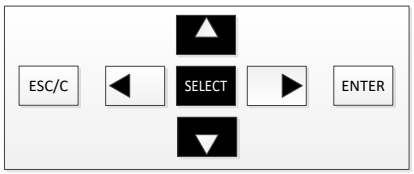
5.3.4.3.5. Disturbance record (DISTURBANCE) menu

[Operation path] SETTING MODE > CONFIG > DISTURBANCE

The Disturbance record (DISTURBANCE) menu allows setting of maximum recording time and pre-fault recording time of each disturbance (fault) record.
(The DISPLAY mode only allows viewing of the setting values)



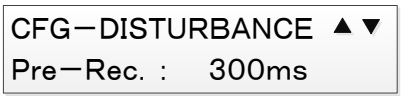
1. Use the Up and Down keys to select the item to change and press SELECT.



Use ▲ and ▼ to switch between items and press SELECT to select an item.

2. The cursor moves to the setting value. Use the Up and Down keys to select the value and the Left and Right keys to select the digit to make the change.

3. Press SELECT to change the setting value.



4. Complete setting of all other items to change by repeating steps 1. to 3..

5. Press ENTER and the message to confirm application of the disturbance record time settings appears. Press SELECT to apply the disturbance record time settings changed by steps 1. to 4. and complete the setting.
Press the Left key to go back to the setting menu in step 1. above without applying the setting changes.

Table 5-15 Setting items of disturbance record time

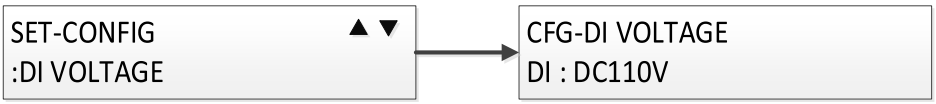
No.	Item	Setting description	Setting range	Unit
1	Pre-Rec.	Save time of pre-fault waveform data	100 ~ 4500	ms
2	Rec.	Save time of waveform data	200 ~ 5000	ms

Note: The save time of “Pre-Rec.” is included in that of “Rec.”.
In other words, the setting value of “Rec.” must be larger than that of “Pre-Rec.”.

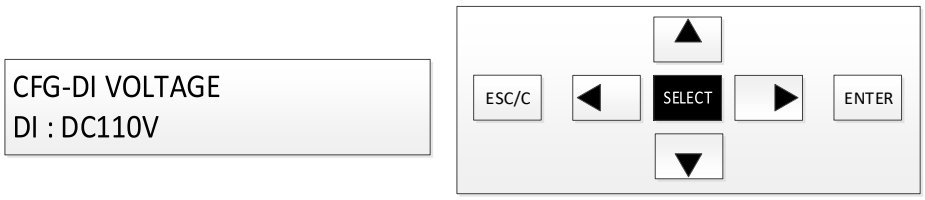
5.3.4.3.6. DI voltage (DI VOLTAGE) menu

[Operation path] SETTING MODE > CONFIG > DI VOLTAGE

The DI voltage (DI VOLTAGE) menu allows setting of the DI rated voltage.
(The DISPLAY mode only allows viewing of the setting values)



1. In the DI voltage setting menu, display the item “DI” and press the SELECT key.
   * The DI voltage setting menu has one item: “DI”



Press the SELECT key to select an item.

2. The cursor moves to the setting value. Use the Up and Down keys to select the setting to make the change.

3. Press the SELECT key to change the setting value.

4. Press the ENTER key, and a message appears to confirm application of the DI voltage setting value that was just changed.
   Press the SELECT key to apply the DI voltage setting value and complete the setting.

Press the Left key to go back to the DI voltage setting menu without applying the setting that was just changed.

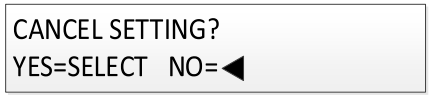


Table 5-16 Setting item of DI voltage

No.	Item	Setting description	Setting
1	DI	DI voltage setting	DC 110 / 220V

5.3.4.3.7. Password use/unuse (PASSWORD USE) menu

[Operation path] SETTING MODE > CONFIG > PASSWORD USE

The Password use/unuse (PASSWORD USE) menu specifies whether to use or not use a password input when the SETTING mode is selected.
(This item is not shown in the DISPLAY mode)

1. In the Password use/unuse menu, press SELECT.

Press SELECT to select an item

2. The cursor moves to the setting value. Use the Up and Down keys to select the setting to be changed.

3. Press SELECT to change the setting value.

4. Press ENTER and the confirmation message of the password use/unuse setting changed appears as shown in the figure below.
   Press SELECT to apply the password use/unuse setting and complete the setting.
   Press the Left key to go back to the setting menu in step 1. above without applying the setting changes.

Table 5-17 Setting item of Password use/unuse

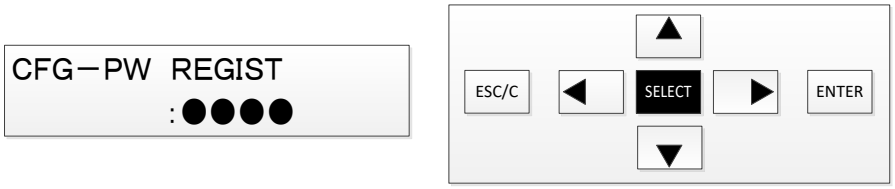
No.	Item	Setting description	Setting
1	PASSWORD	Password use/unuse setting	USE / UNUSE

5.3.4.3.8. Password registration (PASSWORD REGIST) menu

[Operation path] SETTING MODE > CONFIG > PASSWORD REGIST

The Password registration (PASSWORD REGIST) menu allows the setting of the password input when the SETTING mode is selected.
(This item is not shown in the DISPLAY mode)

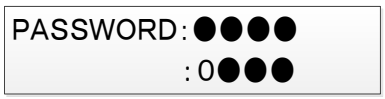
1. In the Password registration menu, press SELECT.



Press SELECT to select an item

2. The Password registration screen appears.
   For registering a password, press SELECT after each digit is entered.
   Pressing SELECT confirms the value for the digit entered and moves the cursor to the digit on the right.
   It is not possible to return to the previous digit by using the Left key.
   Use the Up and Down keys to select a value out of 0 to 9 for each digit.

3. When the four digits have been entered, password input is requested again.
   Enter the same password as that registered in step 2 above.

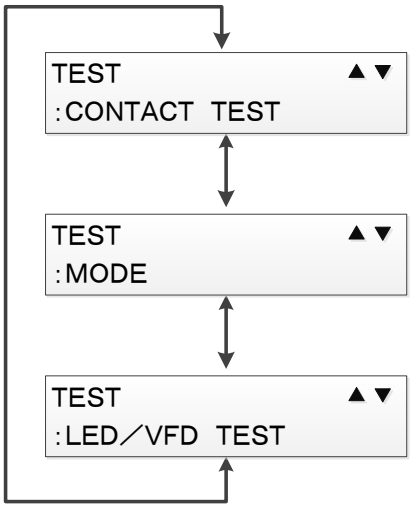


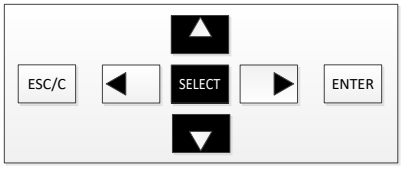
4. If the above two password-inputs in steps 2 and 3 are same, the screen shown in step 1 appears.
   Press ENTER and the confirmation message of the password registration appears.
   Press SELECT to apply the password registration and complete the setting.
   Press the Left key to go back to the setting menu in step 1. above without applying the setting changes.

If the two password-inputs in steps 2 and 3 are not same, an error message as shown below appears.

5.3.4.4. TEST menu

This subsection describes the operations for the Test menu.
The Test menu can be selected only in the SETTING mode.





Use ▲ and ▼ to switch between items
and press SELECT to select an item

5.3.4.4.1. DO contact test (CONTACT TEST) menu

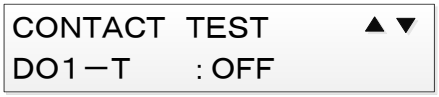
[Operation path] SETTING MODE > TEST > CONTACT TEST

The DO contact test (CONTACT TEST) menu allows contact testing of DO signals (DO1 to DO8).

1. When the DO contact test menu has been selected, the caution message appears.

When pressing SELECT, the next message appears. Then, press “SELECT” again.

2. The setting screen for the DO contact test appears.
Use the Up and Down keys to select the item to set and press SELECT.



3. The cursor moves to the setting of the selected item.
   Use the Up and Down keys to switch the setting.
   Select ON to conduct a contact test on the selected DO. If not, select OFF.

4. Press SELECT to change the setting and bring the cursor back to the item name.

5. Complete settings of all the items to change by repeating steps 2. to 4. above.

6. After the settings are completed, press ENTER while the setting item selection screen in step 4 is shown in order to operate DO contact test.
   *The selected DO contact(s) is(are) operated while ENTER is held down. The operation of the respective DO contact corresponds to the settings in steps (2) to (5) above.

   To exit the DO contact test setting screen, press the Left key.

Table 5-18 Setting items of DO contact test

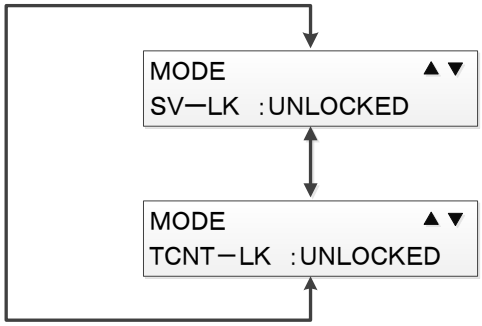
No.	Item
1	DO1-T
2	DO2-T
3	DO3-T
4	DO4-T
5	DO5-T
6	DO6-T
7	DO7-T
8	DO8-T

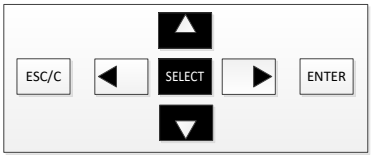
5.3.4.4.2. Test mode (MODE) menu

[Operation path] SETTING MODE > TEST > MODE

The Test mode (MODE) menu allows setting of the test mode.

1. Use the Up and Down keys to select the item to set and press SELECT.





Use ▲ and ▼ to switch between items and press SELECT to select an item.

2. The cursor moves to the setting of the selected item. Use the Up and Down keys to switch the setting.

3. Press SELECT to change the setting.

4. Complete setting of all other items to change by repeating steps 1. to 3. above.

5. Press ENTER to be enable the test mode as set in steps 1. to 4. above.
The RUN LED flashes during the test mode.

Caution

During the test mode, use of the Left or ESC key to exit the SETTING mode is disabled.
(Operations implemented in the SETTING mode are enabled)
When turning off the VFD screen or moving to the DISPLAY mode, it exits the test mode.

5.3.4.4.3. LED/VFD lighting test (LED/VFD TEST) menu

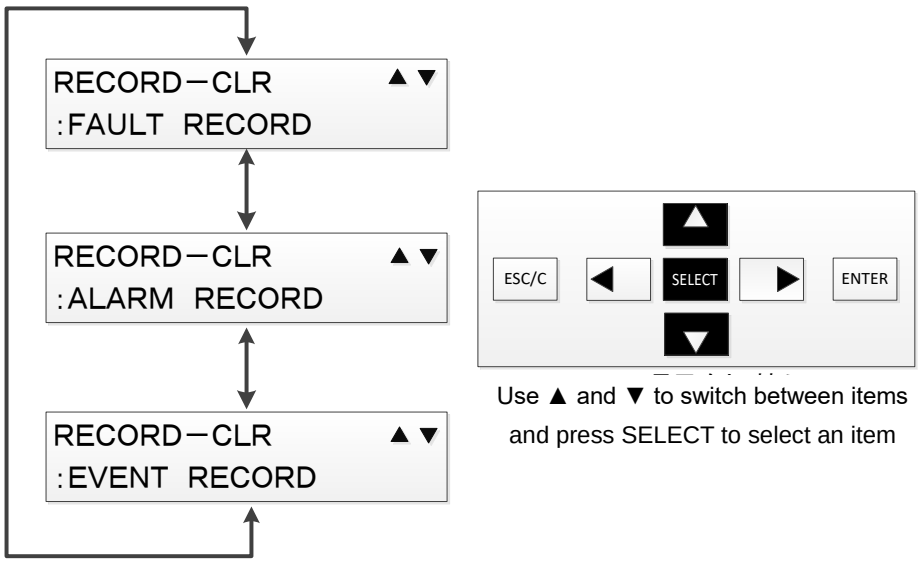
[Operation path] SETTING MODE > TEST > LED/VFD TEST

The LED/VFD lighting test (LED/VFD TEST) menu allows lighting of all LEDs/VFDs.

When LED/VFD TEST is selected in the Test menu, a screen as shown below appears.
Pressing ENTER and all LEDs and VFDs are lighting while the key is held down.
It can be checked the LED/VFD indication visually.

5.3.4.5. Clear record (RECORD-CLR) menu

The Clear record (RECORD-CLR) menu allows clearing three types of log data: fault, event and alarm records.
*Access record log data cannot be cleared.



5.3.4.5.1. Clear fault record (FAULT REC CLEAR) menu

[Operation path] SETTING MODE > RECORD-CLR > FAULT RECORD

The Clear fault record (FAULT REC CLEAR) menu allows clearing of fault records.
In the Clear record menu, select FAULT RECORD and press ENTER. Then, the next screen appears.
Press SELECT to clear the fault records.
When pressing the Left key, the display returns to the selection screen of Clear record menu without clearing the fault records.

When clearing of the fault records are completed, the display returns to the Clear record menu.
If the clearing is unsuccessful, a message screen as shown below appears.
Pressing SELECT while the message below is shown brings the display back to the Clear record menu selection screen.

5.3.4.5.2. Clear alarm record (ALARM REC CLEAR) menu

[Operation path] SETTING MODE > RECORD-CLR > ALARM RECORD

The Clear alarm record (ALARM REC CLEAR) menu allows clearing of alarm records.
In the Clear record menu, select ALARM RECORD and press ENTER. Then, the next screen appears.
Press SELECT to clear the alarm records.
When pressing the Left key, the display returns to the selection screen of Clear record menu without clearing the alarm records.

When clearing of the alarm records are completed, the display returns to the Clear record menu.
If the clearing is unsuccessful, a message screen as shown below appears.
Pressing SELECT while the message below is shown brings the display back to the Clear record menu selection screen.

5.3.4.5.3. Clear event record (EVENT REC CLEAR) menu

[Operation path] SETTING MODE > RECORD-CLR > EVENT RECORD

The Clear event record (EVENT REC CLEAR) menu allows clearing of event records.
In the Clear record menu, select EVENT RECORD and press ENTER. Then, the next screen appears.
Press SELECT to clear the event records.
When pressing the Left key, the display returns to the selection screen of Clear record menu without clearing the event records.

When clearing of the event records are completed, the display returns to the Clear record menu.
If the clearing is unsuccessful, a message screen as shown below appears.
Pressing SELECT while the message below is shown brings the display back to the Clear record menu selection screen.

6. PC-HMI

PC-HMI is a software for setting, configuration, and supervision of this relay.
The software can be downloaded on the web site of Mitsubishi Electric FA (Factory Automation).
The operation method is described in a separate volume. Please refer to the following document.

Title of document	Document No.
MELPRO-D Series Protection Relay PC-HMI Instruction Manual	JEP0-IL9504

In regard to PLC signals, refer to Table 6-1 and Table 6-2.

Table 6-1 PLC signals of CGP2-A41D1

Signal name	Description
DI1	Status of DI1
DI2	Status of DI2
DI3	Status of DI3
DI4	Status of DI4
DI5	Status of DI5
DI6	Status of DI6
DI7	Status of DI7
DI8	Status of DI8
TCNT_ALM	Alarm of trip counter
DIFSV-A	Definitive signal of supervision of differential current on A phase
DIFSV-B	Definitive signal of supervision of differential current on B phase
DIFSV-C	Definitive signal of supervision of differential current on C phase
MANU_CLS	Command of CB close
MANU_OPN	Command of CB open
DIFF-AD	Detection signal of current ratio differential (87G) element on A phase
DIFF-BD	Detection signal of current ratio differential (87G) element on B phase
DIFF-CD	Detection signal of current ratio differential (87G) element on C phase
LOF-D	Detection signal of loss of field (40) element
LOF_OC-D	Detection signal of overcurrent for loss of field (40) element
DIFSV-AD	Detection signal of supervision of differential current on A phase
DIFSV-BD	Detection signal of supervision of differential current on B phase
DIFSV-CD	Detection signal of supervision of differential current on C phase
ALARM	Abnormal condition of constant supervision (serious failure)
ALARM-L	Abnormal condition of constant supervision (minor failure)
RY-LOCK	Locking of relay
RESET	Reset signal (activated by pushing ESC/C button for more than 3 seconds)
INTER1	1st intermediate output signal of PLC
INTER2	2nd intermediate output signal of PLC
INTER3	3rd intermediate output signal of PLC
INTER4	4th intermediate output signal of PLC
INTER5	5th intermediate output signal of PLC
INTER6	6th intermediate output signal of PLC
INTER7	7th intermediate output signal of PLC
INTER8	8th intermediate output signal of PLC
DIFF-3D_O	Detection signal of any DIFF of A, B, and C phase
DFSV-3D_O	Detection signal of any DIFFSV of A, B, and C phase
ALLEL-D_O	Detection signal of any of all elements (OR of all detection signals)
DIFF-3T_O	“DIFF_A-T” OR “DIFF_B-T” OR “DIFF_C-T”
DFSV-3_O	Definitive signal of any DIFFSV of A, B, and C phase
ALLEL-O	OR of all “Definitive signal AND Operation lock signal”
DIFF-A	“DIFF_A-T” or forced operation from PC-HMI
DIFF-B	“DIFF_B-T” or forced operation from PC-HMI
DIFF-C	“DIFF_C-T” or forced operation from PC-HMI
LOF	“LOF-T” or forced operation from PC-HMI
OPLK-DIFA	Operation lock on DIFF element of A phase
OPLK-DIFB	Operation lock on DIFF element of B phase

OPLK-DIFC	Operation lock on DIFF element of C phase
OPLK-LOF	Operation lock on LOF element
DIFF_A-T	“Definitive signal of DIFF on A phase” AND “Operation lock signal”
DIFF_B-T	“Definitive signal of DIFF on B phase” AND “Operation lock signal”
DIFF_C-T	“Definitive signal of DIFF on C phase” AND “Operation lock signal”
LOF-T	“Definitive signal of LOF” AND “Operation lock signal”
DIFF_A-TL	Latch signal of DIFF_A-T (*)
DIFF_B-TL	Latch signal of DIFF_B-T (*)
DIFF_C-TL	Latch signal of DIFF_C-T (*)
LOF-TL	Latch signal of LOF-T (*)

(*) Note: The latch signal can be reset by pushing ESC/C button for more than 3 seconds.

Table 6-2 PLC signals of CGP2-A42D1

Signal name	Description
DI1	Status of DI1
DI2	Status of DI2
DI3	Status of DI3
DI4	Status of DI4
DI5	Status of DI5
DI6	Status of DI6
DI7	Status of DI7
DI8	Status of DI8
TCNT_ALM	Alarm of trip counter
DIFSV-A	Definitive signal of supervision of differential current on A phase
DIFSV-B	Definitive signal of supervision of differential current on B phase
DIFSV-C	Definitive signal of supervision of differential current on C phase
MANU_CLS	Command of CB close
MANU_OPN	Command of CB open
DIFF-AD	Detection signal of current ratio differential (87G) element on A phase
DIFF-BD	Detection signal of current ratio differential (87G) element on B phase
DIFF-CD	Detection signal of current ratio differential (87G) element on C phase
DIFSV-AD	Detection signal of supervision of differential current on A phase
DIFSV-BD	Detection signal of supervision of differential current on B phase
DIFSV-CD	Detection signal of supervision of differential current on C phase
ALARM	Abnormal condition of constant supervision (serious failure)
ALARM-L	Abnormal condition of constant supervision (minor failure)
RY-LOCK	Locking of relay
RESET	Reset signal (activated by pushing ESC/C button for more than 3 seconds)
INTER1	1st intermediate output signal of PLC
INTER2	2nd intermediate output signal of PLC
INTER3	3rd intermediate output signal of PLC
INTER4	4th intermediate output signal of PLC
INTER5	5th intermediate output signal of PLC
INTER6	6th intermediate output signal of PLC
INTER7	7th intermediate output signal of PLC
INTER8	8th intermediate output signal of PLC
DIFF-3D_O	Detection signal of any DIFF of A, B, and C phase
DFSV-3D_O	Detection signal of any DIFFSV of A, B, and C phase
ALLEL-D_O	Detection signal of any of all elements (OR of all detection signals)
DIFF-3T_O	“DIFF_A-T” OR “DIFF_B-T” OR “DIFF_C-T”
DFSV-3_O	Definitive signal of any DIFFSV of A, B, and C phase
ALLEL-O	OR of all “Definitive signal AND Operation lock signal”
DIFF-A	“DIFF_A-T” or forced operation from PC-HMI
DIFF-B	“DIFF_B-T” or forced operation from PC-HMI
DIFF-C	“DIFF_C-T” or forced operation from PC-HMI
OPLK-DIFA	Operation lock on DIFF element of A phase
OPLK-DIFB	Operation lock on DIFF element of B phase
OPLK-DIFC	Operation lock on DIFF element of C phase
DIFF_A-T	“Definitive signal of DIFF on A phase” AND “Operation lock signal”
DIFF_B-T	“Definitive signal of DIFF on B phase” AND “Operation lock signal”

DIFF_C-T	“Definitive signal of DIFF on C phase” AND “Operation lock signal”
DIFF_A-TL	Latch signal of DIFF_A-T (*)
DIFF_B-TL	Latch signal of DIFF_B-T (*)
DIFF_C-TL	Latch signal of DIFF_C-T (*)

(*) Note: The latch signal can be reset by pushing ESC/C button for 3 seconds or longer.

7. Rating, Specification

7.1. Features

(1) Multi-function

- The relay incorporates a variety of protection functions which are required for generator protection.
- The relay has two Group settings sets. Therefore, it can be used for different purposes, such as operation/test, or quickly adapted to meet load conditions.
- Control of a circuit breaker is possible via the font panel, PC-HMI, or DI terminal.

(2) High-precision measuring functions

- Measurement functions are enhanced.
  Measurement values (e.g. current and voltage) can be viewed via the front panel display on the relay or using interface software on a PC.
  In addition, you can expand the character size of the measured values on the front panel display, which enables to check values easily.
- Fault / Disturbance Recording
  The relay stores up to 5 fault / disturbance records which can be used for fault investigations. Fault record function is the record of analog input values (as RMS) at the time when relay elements are operated. Disturbance record function is the record of waveform data for the prescribed period before and after occurrence of fault at sampling rate of 24 samples/cycle.

(3) Programmable Output Contacts provide flexibility

The configuration of output contact is possible by PLC (Programmable Logic Controller), which enables to apply the relay to various systems.

(4) Advanced constant monitoring function improves reliability

The relay continuously monitors the electronic circuits and can detect internal component failure, which enables to improve reliability.

The relay's behavior is as follows:

- In normal conditions: RUN LED lights.
- In abnormal conditions: ALARM LED lights.
  During serious abnormal conditions, the protection elements are locked to prevent an unnecessary output, and the relay fail alarm is issued.

(5) The draw-out Subunit improves maintainability

The provision of an automatic CT shorting mechanism at the time of drawing out the unit makes it very easy to maintain the relay.

Remarks: This mechanism is installed only in relay devices with current protection element.

7.2. Standard Ratings

Item			Contents
Rating	Current		5 A
	Line voltage		57 ~ 120 V
	Frequency		50 Hz / 60 Hz
	DI input voltage		DC 110 V (Variation range: 88 ~ 150 V) DC 220 V (Variation range: 176 ~ 300 V)
	Power Supply	Voltage	DC: 100 ~ 220 V AC: 100 ~ 220 V
		Variation range	DC: 85 ~ 242 V (Range of 80 ~ 286 V is allowable temporarily.) AC: 85 ~ 242 V (Range of 85 ~ 253 V is allowable temporarily.)
Communication function	CC-LINK		Option

7.3. Protection elements

Protection element		Operating value	Operating time	Other setting
87G	Current ratio differential (DIFF)	Minimum operating current: 0.4 ~ 1.0 A (0.1 A step) Ratio: 5 ~ 50 % (1 % step)	0.00 ~ 10.00 s (0.01 s step) In setting 0.00 s, instantaneous operating time is less than 50 ms.	
40 (*)	Loss of field (LOF)	Impedance ZF: 5.0 ~ 50.0 Ω (0.1 Ω step) Impedance ZB: 0.40 ~ 4.00 Ω (0.01 Ω step)	0.20 ~ 10.00 s (0.01 s step)	
OP LOCK	Operation lock function (OPLOCK)	—	0.0 ~ 10.0 s (0.1 s step) In setting 0.0 s, instantaneous operating time is less than 50 ms.	

* In CGP2-A42D1, there are no 40 (Loss of field) element.
* Factory settings are set to a default of “OFF (Non-use)” for the items with setting of Use/Non-use. In regard to other default settings, refer to Chapter 13.
* For details about protective function, refer to Chapter 8.

7.4. Measuring element

・CGP2-A41D1

Contents displayed		Range	Measured value		Accident record	Waveform record
Name of signal	Item	(Secondary value / Primary value)	Primary	Secondary	Primary only	Common
I1a	A-phase current on output side	0.00 ~ 10.00 A (0.01 A step) / 0 ~ 60000 A (1 A step)	○	○	○	○
I1b	B-phase current on output side		○	○	○	○
I1c	C-phase current on output side		○	○	○	○
I2a	A-phase current on neutral side		○	○	○	○
I2b	B-phase current on neutral side		○	○	○	○
I2c	C-phase current on neutral side		○	○	○	○
Vab	AB-phase voltage	0.0 ~ 260.0 V (0.1 V step) / 0.0 ~ 750.0 kV (0.1 kV step)	○	○	○	○
Ida	A-phase differential current	0.00 ~ 10.00 A (0.01 A step) / 0 ~ 60000 A (1 A step)	○	○	○	×
Idb	B-phase differential current		○	○	○	×
Idc	C-phase differential current		○	○	○	×
I1a-phase	Phase angle of Ia on output side	0.0 ~ 359.9 ° (0.1 ° step) On the basis of Vab (Lag angle)	○	○	○	×
I1b-phase	Phase angle of Ib on output side		○	○	○	×
I1c-phase	Phase angle of Ic on output side		○	○	○	×
I2a-phase	Phase angle of Ia on neutral side		○	○	○	×
I2b-phase	Phase angle of Ib on neutral side		○	○	○	×
I2c-phase	Phase angle of Ic on neutral side		○	○	○	×
Vab-phase	Phase angle of Vab		○	○	○	×

・CGP2-A42D1

Contents displayed		Range	Measured value		Accident record	Waveform record
Name of signal	Item	(Secondary value / Primary value)	Primary	Secondary	Primary only	Common
I1a	A-phase current on output side	0.00 ~ 10.00 A (0.01 A step) / 0 ~ 60000 A (1 A step)	○	○	○	○
I1b	B-phase current on output side		○	○	○	○
I1c	C-phase current on output side		○	○	○	○
I2a	A-phase current on neutral side		○	○	○	○
I2b	B-phase current on neutral side		○	○	○	○
I2c	C-phase current on neutral side		○	○	○	○
Ida	A-phase differential current	0.00 ~ 10.00 A (0.01 A step) / 0 ~ 60000 A (1 A step)	○	○	○	×
Idb	B-phase differential current		○	○	○	×
Idc	C-phase differential current		○	○	○	×
I1a-phase	Phase angle of Ia on output side	0.0 ~ 359.9 ° (0.1 ° step) On the basis of Vab (Lag angle)	○	○	○	×
I1b-phase	Phase angle of Ib on output side		○	○	○	×
I1c-phase	Phase angle of Ic on output side		○	○	○	×
I2a-phase	Phase angle of Ia on neutral side		○	○	○	×
I2b-phase	Phase angle of Ib on neutral side		○	○	○	×
I2c-phase	Phase angle of Ic on neutral side		○	○	○	×

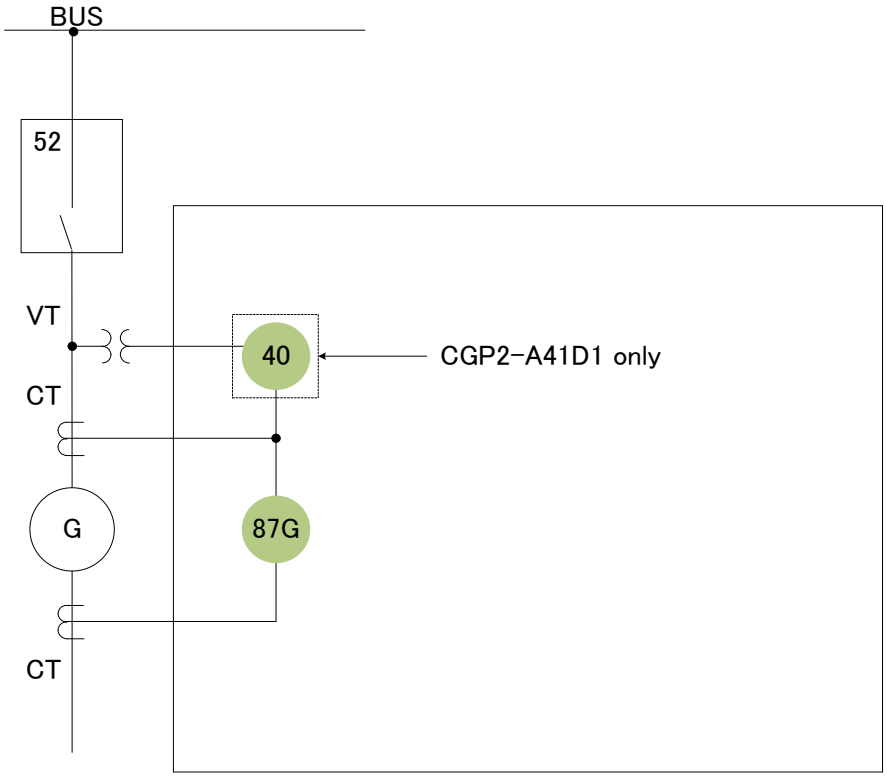
7.5. List of functions

Menu	Item	Operation system	
		PC-HMI	Front panel
Status (STATUS)	Clock (CLOCK)	○	○
	Measured analog value (METERING)	○	○
	DI/DO status (DIGITAL I/O)	○	○
	Trip counter (TRIP COUNTER)	○	○
	Device name (DEVICE NAME)	○	○
	Monitoring	○	×
	LED reset	○	×
Record (RECORD)	Waveform analysis	○	×
	Disturbance record	○	×
	Fault record (FAULT RECORD)	○ (*)	○
	Event record (EVENT RECORD)	○	○
	Access record (ACCESS RECORD)	○	○
	Alarm record (ALARM RECORD)	○	○
Setting (SETTING)	Active group (ACTIVE WG)	○	○
	Group 1 setting (G1)	○	○
	Group 2 setting (G2)	○	○
	PLC	○	×
Control (CONTROL)	Control mode (CTRL MODE)	○	○
	CB control (CB CONTROL)	○	○
Configuration (CONFIG)	Communication setting (COMMUNICATION)	×	○
	Clock adjustment (CLOCK ADJUST)	○	○
	Analog value display switching (METERING)	○	○
	Trip counter (TRIP COUNTER)	○	○
	Disturbance record (DISTURBANCE)	○	○
	DI voltage (DI VOLTAGE)	○	○
	Password use/unuse (PASSWORD USE)	×	○
	Password registration (PASSWORD REGIST)	×	○
	Device name setting	○	×
	Time management setting	○	×
	DO contact test setting	○	×
Test (TEST)	DO contact test (CONTACT TEST)	○	○
	Test mode (MODE)	○	○
	LED/VFD lighting test (LED/VFD TEST)	×	○
	Forced operation of relay	○	×
Clear record (RECORD-CLR)	Clear fault record (FAULT REC CLEAR)	○	○
	Clear alarm record (ALARM REC CLEAR)	○	○
	Clear event record (EVENT REC CLEAR)	○	○

(*) In PC-HMI, the item of Fault record is included in Disturbance record.

8. Protective function

In the relay, following protection elements are provided for the purposes of generator protection.
In this chapter, the protection elements incorporated in the relay are described.



Model	Protection elements	Input	Purpose
CGP2-A41D1	87G, 40	I1a, I1b, I1c, I2a, I2b, I2c (6 phase) Vab (1 phase)	
CGP2-A42D1	87G	I1a, I1b, I1c, I2a, I2b, I2c (6 phase)	

8.1. Current ratio differential element

A current ratio differential element is incorporated in CGP2-A41D1 and CGP2-A42D1, and this enables rapid detection of faults in a generator.

Apparatus No.	Display name	Protective function
87G	DIFF	Current ratio differential element

8.1.1. DIFF element

Fig. 8-1 shows the internal function blocks of DIFF element.

The DIFF element takes in the inflow current (generator's neutral side) and the outflow current (generator's output side) and calculates the differential current and the restraint current (*) inside the relay.
The DIFF element outputs a definitive signal after the preset time of the operation timer (Ope. Time) has passed, when the ratio of the differential current to the restraint current is within the operating range as shown in Fig. 8-2.
An off-delay timer of 200 ms is added in order to prevent chattering of the output contacts.
(*) The restraint current is calculated according to the setting of the calculation method of restraint current (Ires Meth.).

Furthermore, this element is enabled only when the setting of Use/Non-use of DIFF element (DIFF EN) is set to ON. Therefore, when this element is not used, unnecessary operation can be prevented by setting to OFF. It is not necessary to set other setting items with regard to DIFF element.
This element is provided with two DI circuits for interlocking the operation (OPLOCK element).
For the operations of the OPLOCK element, refer to 8.3.1.

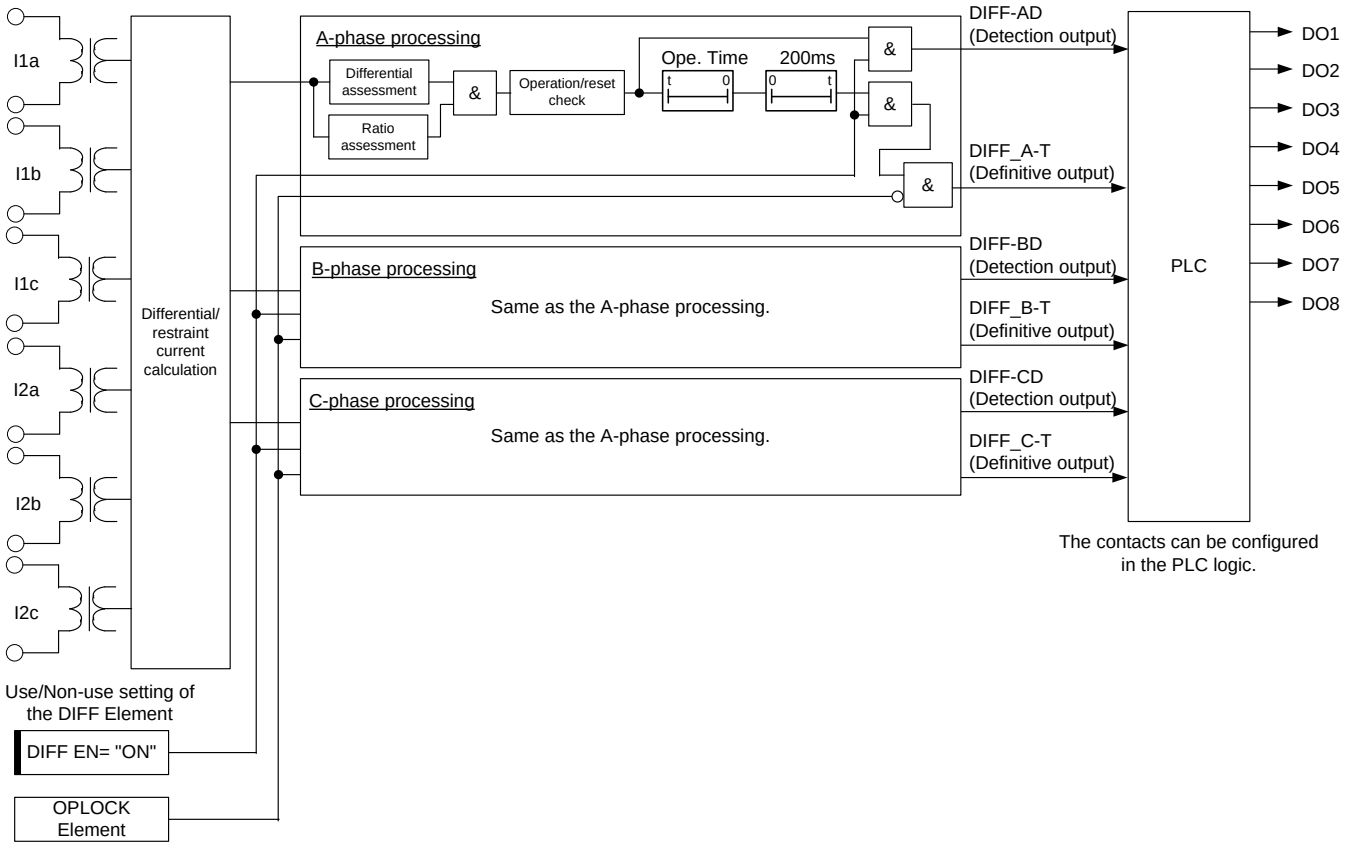


Fig. 8-1 Internal function block diagram of DIFF element

* [ ] shows setting values.

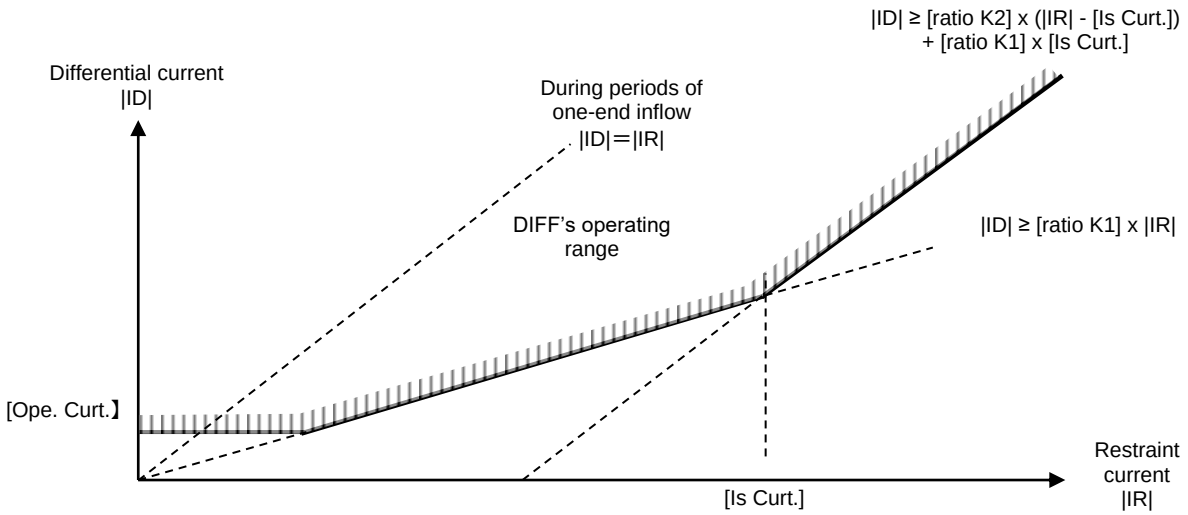


Fig. 8-2 Operating characteristics of DIFF element

Table 8-1 Setting items of DIFF element

Display name	Setting parameter	Setting		Description
		Range of setting	step	
DIFF	DIFF EN	OFF, ON	-	OFF: Non-use, ON: Use When this element is used, set to ON.
	Ires Meth.	Max, MIN, SUM	-	Calculation method of restraint current: MAX: I1 or I2, whichever is greater MIN: I1 or I2, whichever is smaller SUM: vectorial sum ($\lvert \dot{I}1+\dot{I}2 \rvert$)
	Ope. Curt.	0.4 ~ 1.0 A	0.1 A	Minimum operating current
	ratio K1	5 ~ 50 %	1 %	Ratio K1 for small current region Ratio K2 for large current region K1≦K2
	ratio K2	5 ~ 50 %	1 %	
	Is Curt.	0.4 ~ 10.0 A	0.1 A	Ratio switching point
	Ope. Time	0.00 ~ 10.00 s	0.01 s	Operating time INST: ≤ 50 ms

*1 Setting the ratio K1 and ratio K2

Normally, as shown in Fig. 8-3, increase the ratio setting in the large current area (ratio K1 < ratio K2) to expand the non-operating area. Or, as shown in Fig. 8-4, set the non-operating area to the same setting (ratio K1 = ratio K2) even when the current is large.

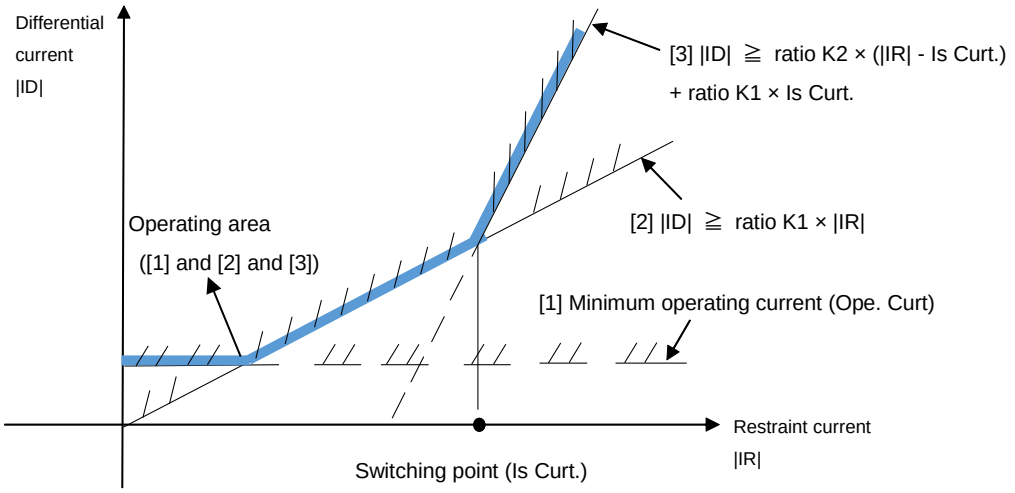


Fig. 8-3 DIFF element characteristic (ratio K1 < ratio K2)

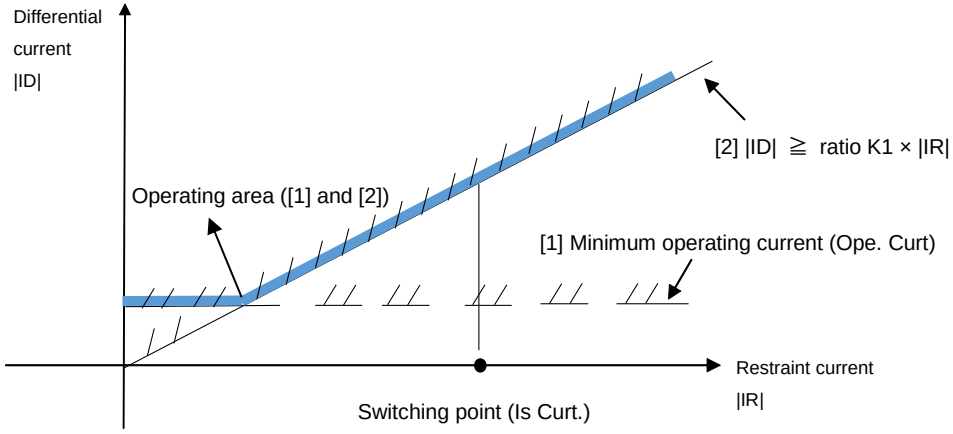


Fig. 8-4 DIFF element characteristic (ratio K1 = ratio K2)

If the setting is incorrect (ratio K1 > ratio K2), the DIFF Element operates in the area indicated by the expression [3] as shown in Fig. 8-5.

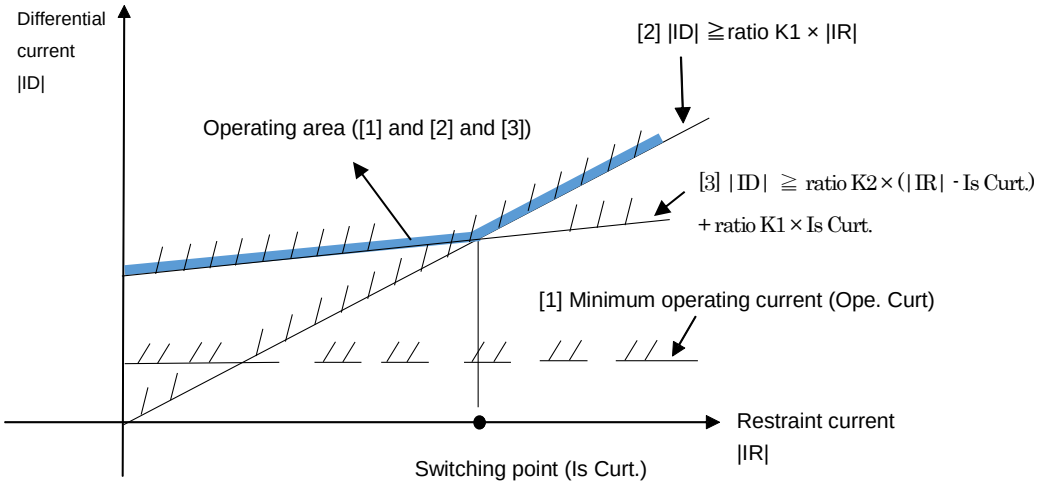


Fig. 8-5 DIFF element characteristic (ratio K1 > ratio K2)

8.1.1.1.Operating principles

Assuming that the current on the neutral side of the generator (inflow current) is I1 and the current on the output side of the generator (outflow current) is I2 as shown in Fig. 8-6, the differential current is calculated inside the Relay according to the following equation.

Differential current: ID = $|\dot{I1} - \dot{I2}|$

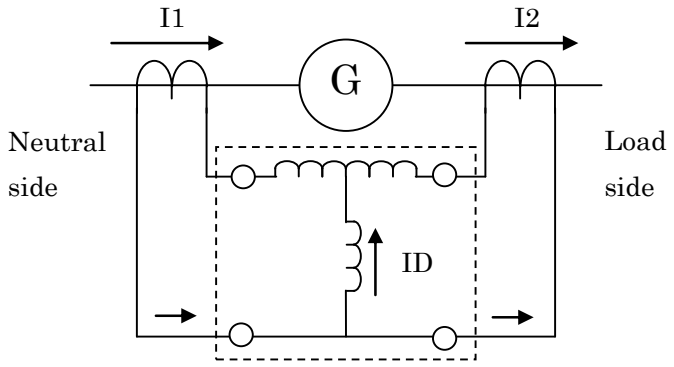


Fig. 8-6 Input current of the DIFF element

The ratio is expressed as the ratio of the differential current to I1 and I2. The DIFF element operates when the ratio is equal to or greater than the setting value (ratio K1 or ratio K2) and the ID is equal to or greater than the minimum operating current setting value (Ope. Curt.).

Operation determination formula

[1] Ratio: $\frac{\text{Differential current}}{\text{Restraint current}} \times 100(\%)$

(1) When the restraint method selection setting (Ires Meth.) is set to “MAX”

・ Ratio K1 determination

$$\frac{ID}{MAX(I1, I2)} = \frac{|\dot{I1} - \dot{I2}|}{\text{Larger of } |I1| \text{ and } |I2|} \times 100\ (\%) \geq \text{ratio K1}$$

・ Ratio K2 determination

$$\frac{|\dot{I1} - \dot{I2}|}{\text{Larger of } |I1| \text{ and } |I2| - \text{Ratio switching point (Is Curt.)}} + (\text{ratio K1}) \times (\text{Is Curt.}) \times 100\ (\%) \geq \text{ratio K2}$$

(2) When the restraint method selection setting (Ires Meth.) is “MIN”

・ Ratio K1 determination

$$\frac{ID}{MIN(I1, I2)} = \frac{|\dot{I}1 - \dot{I}2|}{\text{Smaller of } |I1| \text{ and } |I2|} \times 100\ (\%) \geq \text{ratio K1}$$

・ Ratio K2 determination

$$\frac{|\dot{I}1 - \dot{I}2|}{\text{Smaller of } |I1| \text{ and } |I2| - \text{Ratio switching point (Is Curt.)}}$$

+ (ratio K1) × (Is Curt.) × 100 (%) ≥ ratio K2

(3) When the restraint method selection setting (Ires Meth.) is “SUM”

・ Ratio K1 determination

$$\frac{ID}{\text{Vector sum}(I1+I2)} = \frac{|\dot{I}1 - \dot{I}2|}{|\dot{I}1 + \dot{I}2|} \times 100\ (\%) \geq \text{ratio K1}$$

・ Ratio K2 determination

$$\frac{|\dot{I}1 - \dot{I}2|}{|\dot{I}1 + \dot{I}2| - \text{Ratio switching point (Is Curt.)}}$$

+ (ratio K1) × (Is Curt.) × 100 (%) ≥ ratio K2

[2] Minimum operating value: ID = $|\dot{I}1-\dot{I}2|$ ≥ Minimum operating current setting value (Ope. Curt.)

If a large current passes through due to an external accident, an unbalanced differential current will flow due to the difference in the characteristic of the CT itself, the length of the secondary wiring, or the unbalance of loads. Therefore, when the current is large, increase the ratio to prevent the protection element from malfunctioning due to unbalanced differential current.
Fig. 8-7 shows the inflow current versus outflow current characteristic and Fig. 8-8 shows the outflow current versus differential current characteristic.
Note: The setting values shown in the figure are examples.

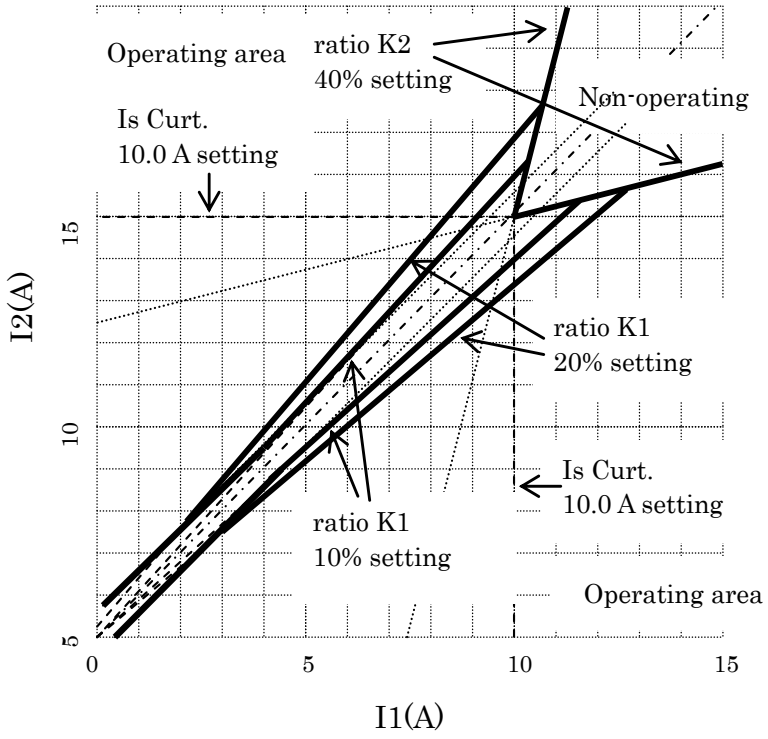


Fig. 8-7 Inflow current versus Outflow current characteristic of DIFF element

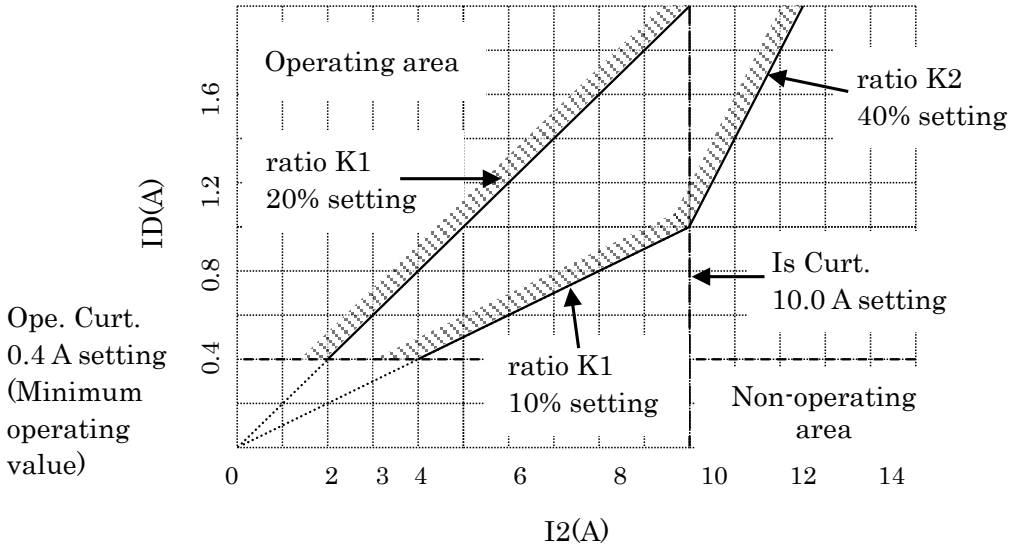


Fig. 8-8 Outflow current versus Differential current characteristic of DIFF element

8.2. Loss of field element

A loss of field element is incorporated in CGP2-A41D1 to detect decline or loss of field due to the open or short of the field circuit of the generator.

Apparatus No.	Display name	Protective function
40	LOF	Loss of field element

8.2.1. LOF element

Fig. 8-9 shows the internal function blocks of LOF element.

LOF element calculates the impedance from the line voltage (Vab) and the phase current (I1a, I1b) and compares it with the setting value (LOF ZF, LOF ZB).
LOF element outputs a definitive signal after the preset time of the operation timer (Ope. Time) has passed, when the calculated impedance is within the operating range.
An off-delay timer of 200 ms is added in order to prevent chattering of the output contacts.

Furthermore, this element is enabled only when the setting of Use/Non-use of LOF element (LOF EN) is set to ON. Therefore, when this element is not used, unnecessary operation can be prevented by setting to OFF. It is not necessary to set other setting items with regard to LOF element.
This element is provided with two DI circuits for interlocking the operation (OPLOCK element).
For the operations of the OPLOCK element, refer to 8.3.1.

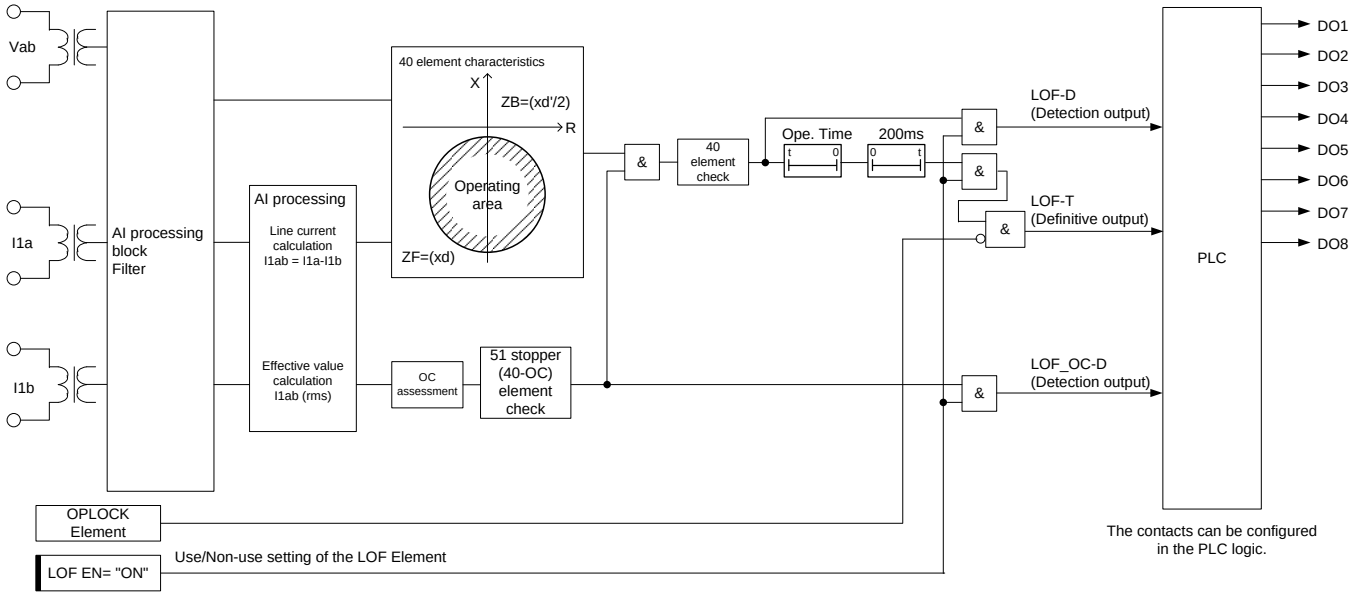


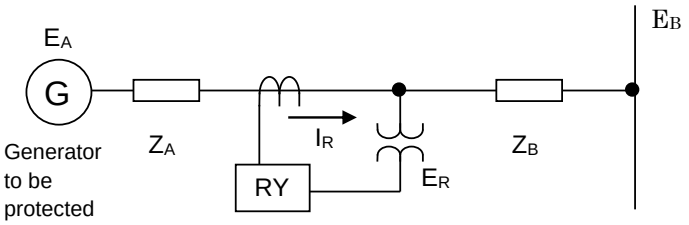
Fig. 8-9 Internal function block diagram of LOF element

Table 8-2 Setting items of LOF element

Display name	Setting parameter	Setting		Description
		Range of setting	step	
LOF	LOF EN	OFF, ON	-	OFF: Non-use, ON: Use When this element is used, set to ON.
	LOF ZF	5.0 ~ 50.0 Ω	0.1 Ω	Impedance of ZF
	LOF ZB	0.40 ~ 4.00 Ω	0.01 Ω	Impedance of ZB
	Ope. Time	0.20 ~ 10.00 s	0.01 s	Operating time

8.2.1.1.Impedance during operation

This section describes the impedance detected by the loss of field element at the time when the loss of field or the step-out occurs.



$\dot{E}_A$: Generator voltage induced
$\dot{E}_B$: Infinite bus bar voltage
$\dot{Z}_A$: Internal impedance of the generator
$\dot{Z}_B$: Impedance from the relay installation point to the infinite bus bar
$\dot{I}_R$: Current flowing through the relay installation point
$\dot{E}_R$: Voltage at the relay installation point

Fig. 8-10 Impedance of the Loss of field element

In a system as seen in Fig. 8-10, the system voltage and the current are respectively expressed as follows.

$$\dot{I}_R = \frac{\dot{E}_A - \dot{E}_B}{\dot{Z}_A + \dot{Z}_B} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (1)$$

$$\dot{E}_R = \dot{E}_A - \dot{I}_R \cdot \dot{Z}_A \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (2)$$

Substitute Equation (1) into Equation (2) to get the following equation.

$$\dot{E}_R = \frac{\dot{E}_A \dot{Z}_B + \dot{E}_B \dot{Z}_A}{\dot{Z}_A + \dot{Z}_B} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (3)$$

The impedance seen by the relay Z_R is as follows,

$$\dot{Z}_R = \frac{\dot{E}_R}{\dot{I}_R} = \frac{\dot{E}_A \dot{Z}_B + \dot{E}_B \dot{Z}_A}{\dot{E}_A - \dot{E}_B} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (4)$$

This Equation (4) is the basic equation for the impedance seen by the relay.

(a)When the loss-of-field occurs

When the field is completely lost, the internal induced voltage (E_A) of the generator finally becomes 0, and the impedance seen by the relay becomes

$$\dot{Z}_R = -\dot{Z}_A \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (5)$$

from Equation (4).

If $\dot{Z}_A$ is the direct-axis transient reactance of the generator jxd′, the equation becomes,

$$\dot{Z}_R = -jxd' \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (6)$$

and the impedance locus heads toward -jxd′.

Furthermore, the (synchronous) relationship with the unprotected generators connected in the system shows that the end of the impedance locus eventually heads toward the direct-axis synchronous reactance -jxd.

On the R-X diagram, it looks like the figure shown in Fig. 8-11.

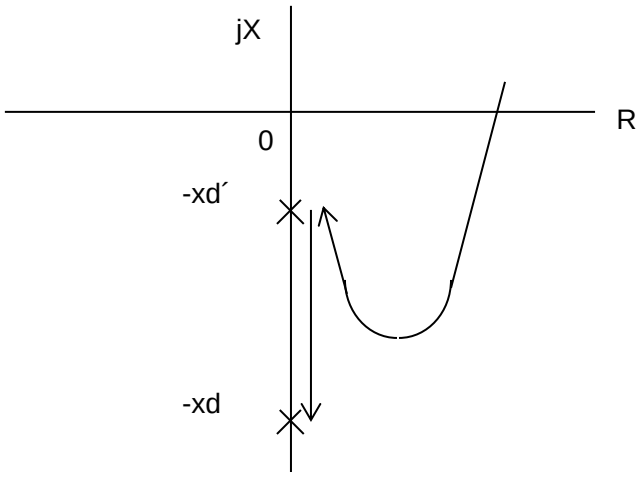


Fig. 8-11

(b)When the step-out occurs

When the magnitude of the generator's internal induced voltage and the infinite bus bar voltage are equal and the phase is different by 180°, the equation can be expressed as,

$$\dot{E}_A = -\dot{E}_B \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (7)$$

which is further expressed as.

$$\dot{Z}_R = -\frac{1}{2}(\dot{Z}_A - \dot{Z}_B) \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (8)$$

Assuming that Z_A is the generator's transient reactance jxd′ and Z_B is the transformer reactance jxt, the equation (8) is expressed as follows.

$$Z_R = -j\frac{1}{2}xd' + j\frac{1}{2}xt \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (9)$$

Therefore, it can be seen that the impedance locus at the time of step-out passes through a value less than -xd′/2 on the -X axis or on the +X axis as shown in Fig. 8-12.

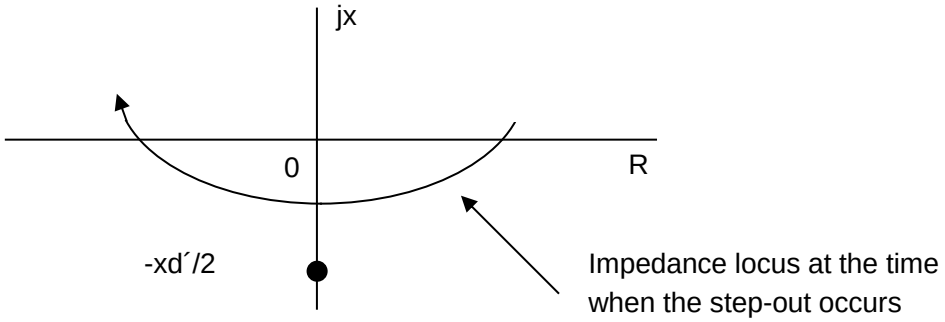


Fig. 8-12

It should be noted that the internal induced voltage $\dot{E_A}$ of the generator does not immediately become $\dot{E_A} = -\dot{E_B}$ or zero when the loss-of-field or the step-out actually occurs. The process depends on the time constant of the field circuit, system conditions, and the AVR response.
Taking into account the impedance locus for the step-out, it is possible to detect the loss-of-field by installing this relay that has an operating area within the circle which has its center on the X-axis and whose diameter extends from the point of -xd′/2 (transient impedance: -xd') to the point of synchronous impedance -xd as shown in Fig. 8-13.

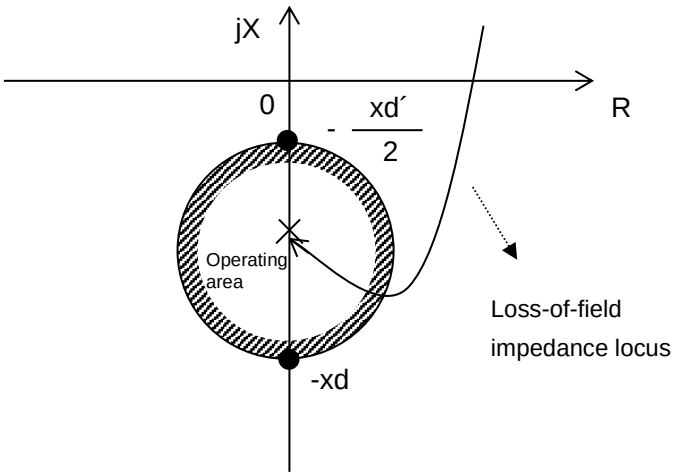


Fig. 8-13 Loss-of-field impedance locus

8.2.1.2.Operating principles

The impedance must be calculated with the current and voltage in the same phase relationship. Since the line voltage Vab is used as the voltage for this element, the currents I1a and I1b are taken in to match the phase and they are calculated (I1a-I1b) internally to be used for impedance calculation.
The operation principle of this element is to obtain a certain voltage component proportional to the system voltage and current from the voltage transformer and the current transformer, to derive the vector V_1 and the vector V_2, and to determine the operation based on the relationship between the vectors.

$V_1 = E_{(n)} - Z_F(I1a-I1b)$
$V_2 = -E_{(n)} + Z_B(I1a-I1b)$

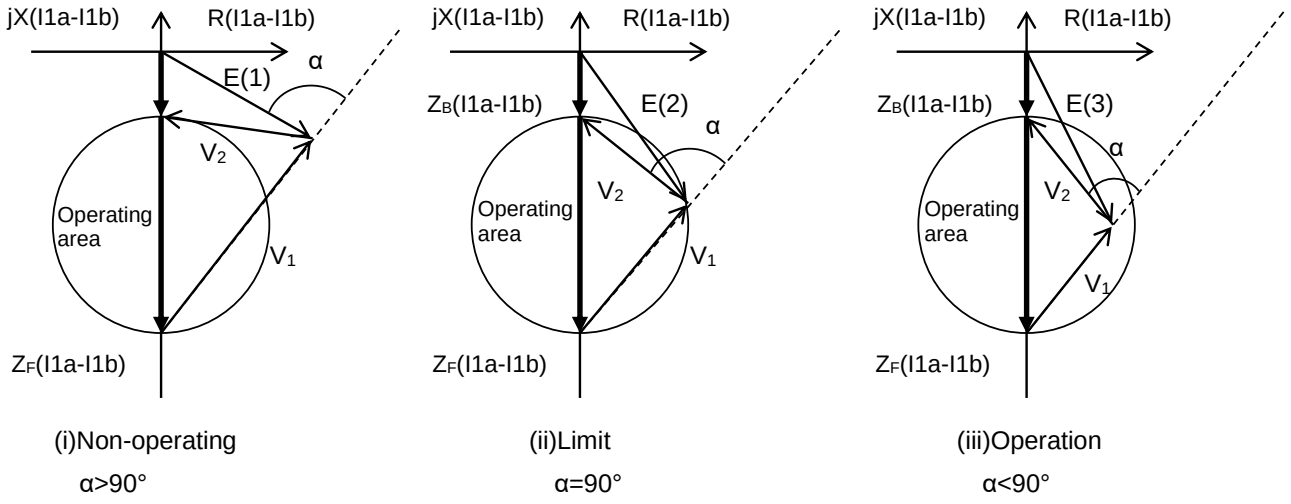


Fig. 8-14 Operating principle (Phase discrimination principle)

If the phase difference α between the vectors V_1 and V_2 is larger than 90° as shown in Fig. 8-14 (i), the operation is disabled. If α is smaller than 90° as shown in (iii), the operation is performed.
As shown in (ii), the operating limit occurs when α is 90°, which results in a circular characteristic where the operating area is limited within the circle.
This indicates that operation is performed when V_2 is within a phase difference of 90° with respect to V_1, as shown in Fig. 8-15.
This element is provided with a 51 stopper element, which does not operate at (I1a - I1b)/2 = 0.8 A or less, in order to prevent malfunction of the phase discrimination in the small current area.

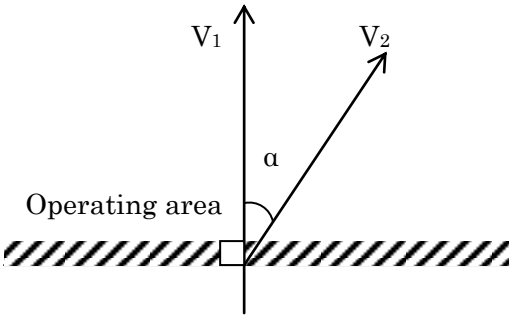


Fig. 8-15 Phase discrimination characteristic

8.2.1.3.Examples of setting calculation

This element is set as follows.

Setting data:

Generator’s rated capacity	kVA
Rated voltage.....	kV
Synchronous impedance (p.u. value).....	xd p.u.
Transient impedance (p.u. value).....	xd´p.u.
CT ratio and VT ratio	

From the above, the following are obtained:

The generator's reference impedance: $GZ=\frac{(\text{Rated voltage})^2}{\text{Generator's rated capacity}}\times 1000$

Relay conversion value of GZ: $RZ=GZ\times\frac{\text{CT ratio}}{\text{PT ratio}}$

Relay conversion value of the synchronous impedance xd: Rxd = RZ × xd p.u. (Ω)
Relay conversion value of the transient impedance xd′: Rxd´ = RZ × xd´ p.u. (Ω)

Therefore, the setting impedance on the relay side is as shown in Fig. 8-16.

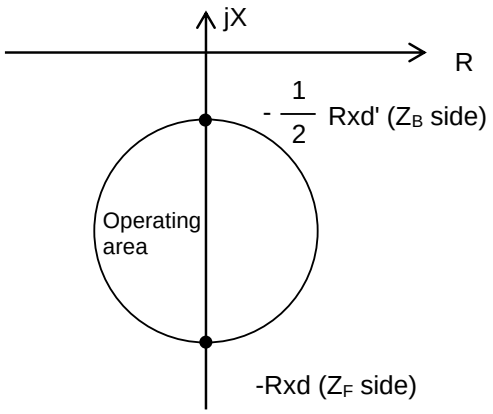


Fig. 8-16

Setting example

Generator's rated capacity ..... kVA	112500 kVA
Rated voltage ..... kV	11 kV
Synchronous impedance (p.u. value) ..... xd p.u.	2.66 p.u.
Transient impedance (p.u. value) ..... xd′p.u.	0.24 p.u.
CT ratio	8000/5 A
VT ratio	11000/110 V

Generator's reference impedance

$$GZ=\frac{(\text{Rated voltage})^2}{\text{Generator's rated capacity}}\times 1000$$

$$=\frac{11^2}{112500}\times 1000$$

$$=1.08(\Omega)$$

Relay conversion value of GZ

$$RZ=GZ\times\frac{\text{CT ratio}}{\text{PT ratio}}$$

$$=1.08\times\frac{8000/5}{11000/110}$$

$$=17.28(\Omega)$$

Relay side conversion value of the synchronous impedance xd

$$Rxd=RZ\times xd\ p.u.$$

$$=17.28\times 2.66$$

$$=45.96(\Omega)$$

Relay side conversion value of the transient impedance xd′

$$Rxd'=RZ\times xd'p.u.$$

$$=17.28\times 0.24$$

$$=4.15(\Omega)$$

Therefore, the setting value can be obtained as follows.

$$Z_B=\frac{1}{2}Rxd' =\frac{1}{2}\times 4.15$$

$$=2.075 \fallingdotseq 2.1(\Omega)$$

$$Z_F=Rxd$$

$$=45.96(\Omega) \fallingdotseq 46.0(\Omega)$$

8.3. Operation lock function

An operation lock function is incorporated in CGP2-A41D1 and CGP2-A42D1.

Apparatus No.	Display name	Protective function
OPLOCK	OPLOCK	Operation lock function

8.3.1. OPLOCK element

OPLOCK element is provided with two DI circuits for interlocking the operation of protection elements. This element remains in the operation lock state while voltage is applied to DI6 or DI7, and the lock is reset without the voltage after a preset time of the resetting timer (Rst. Time) has passed.
The protection elements subject to operation lock can be switched to one of the four patterns (OFF: Not used, DI6: Locked by DI6 input, DI7: Locked by DI7 input, DI67: Locked by either DI6 or DI7 input) depending on the lock element setting (○○ Lock EN*) for each element.
*○○ represents each element name.

Furthermore, this element is enabled only when the setting of Use/Non-use of OPLOCK element (OPLOCK EN) is set to ON. Therefore, when this element is not used, unnecessary operation can be prevented by setting to OFF. It is not necessary to set other setting items with regard to OPLOCK element.

Table 8-3 Setting items of OPLOCK element

Display name	Setting parameter	Setting		Description
		Range of setting	step	
OPLOCK	OPLOCK EN	OFF, ON	-	OFF: Non-use, ON: Use When this element is used, set to ON.
	Rst. Time	0.0 ~ 10.0 s	0.1 s	Resetting time for unlocking INST: ≤ 50 ms
	DIFFA Lock	OFF, DI6, DI7, DI67	-	DIFF-A Lock
	DIFFB Lock	OFF, DI6, DI7, DI67	-	DIFF-B Lock
	DIFFC Lock	OFF, DI6, DI7, DI67	-	DIFF-C Lock
	LOF Lock	OFF, DI6, DI7, DI67	-	LOF Lock (CGP2-A41D1 only)

OFF: Non-use
DI6: DI6 is activated.
DI7: DI7 is activated.
DI67: Both DI6 and DI7 are activated.

9. CB control function

In the relay, following CB control function is provided.
In this chapter, the CB control function incorporated in the relay are described.

CB control can be performed in the following three ways.
(1) Operation from the front panel (Refer to 5.3.4.2.)
(2) Operation from a locally attached PC (PC-HMI)
(3) Operation from the DI control instructions

9.1. CB open control

Fig. 9-1 shows the internal function blocks of CB open control.
Table 9-1 shows the control conditions.

The CB open control provides control output by receiving control instructions.
To output the control signal, check the presence or absence of interlock condition and the presence or absence of operation block setting (CB OPEN), and then output the control instruction.

When the Remote/Local setting (REMOTE/LOCAL) is set to REMOTE, the control output is performed after a preset time set on the operation timer (ON TIMER). When the Remote/Local setting (REMOTE/LOCAL) is set to LOCAL, the control output is performed instantaneously after the operation. At this time, the control state is held by the flip-flop, but it is reset when the control result becomes clear. When the Remote/Local setting (REMOTE/LOCAL) is set to REMOTE, the DI control signal must be continuously input so as to exceed the set time of the operation timer (ON TIMER). If you want to stop the control for some reason, it is possible to stop the control by stopping the DI input during the timer count.

An one-shot timer of 200 ms is added to the control output for performing open control to maintain the output until the CB is fully opened. This is because, if the breaking current that flows when the CB is opened is released by relay's own contact, the contact will be welded.

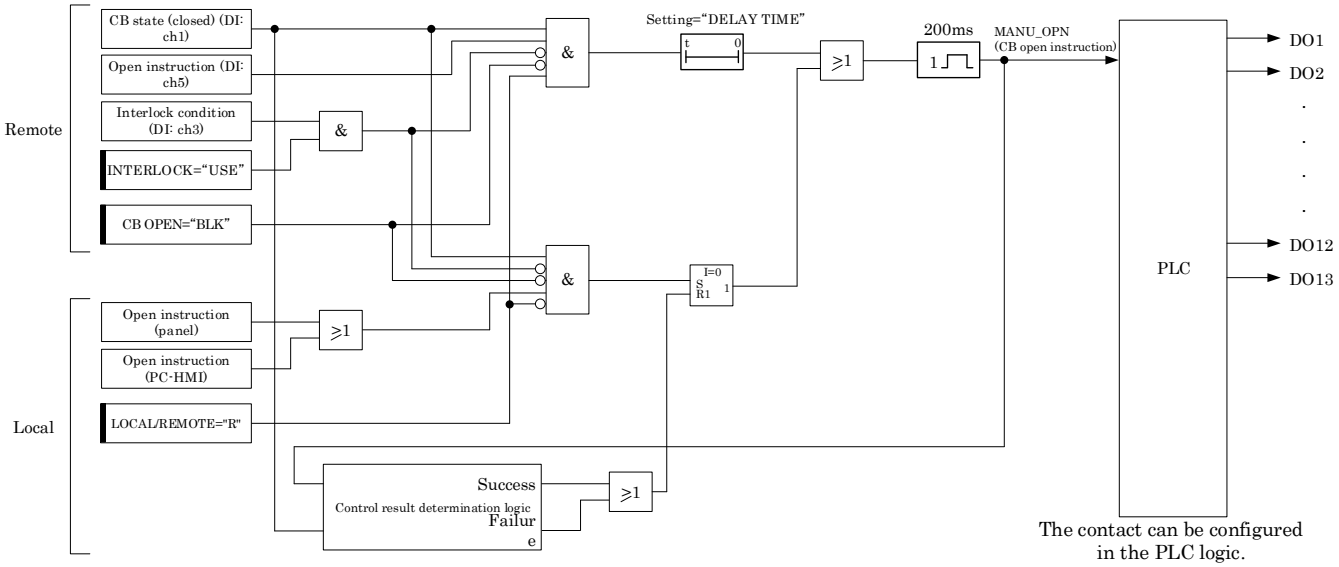


Fig. 9-1 Internal function block diagram of CB open control

As shown in Table 9-1, when "CB control: DI input" and "CB control: Setting" are both established, it is possible to execute the CB open instruction.
Note that the open instruction method that can be used in Local mode is different from that used in Remote mode.

Local: Open instruction is executed by panel operation or PC-HMI operation.
Remote: Open instruction is executed by the input to DI (ch5).

Table 9-1 Control conditions of CB open

	CB control: DI input		CB control: Setting (Refer to 5.3.4.2)			CB open instruction	
	CB State (Closed) (DI:ch1)	Interlock condition (DI:ch3)	Interlock	CB OPEN	LOCAL/ REMOTE	Open instruction (Panel or PC-HMI)	Open instruction (DI:ch5)
Local	○		UNUSE	UNBLK	L	Possible	
	○	○	UNUSE	UNBLK	L	Possible	
	○		USE	UNBLK	L	Possible	
Remote	○		UNUSE	UNBLK	R		Possible
	○	○	UNUSE	UNBLK	R		Possible
	○		USE	UNBLK	R		Possible

* The cell with a circle "○" under the "DI:ch*" column means that "the DI input is on".

9.2. CB close control

Fig. 9-2 shows the internal function blocks of CB close control.
Table 9-2 shows the control conditions.

The CB close control provides control output by receiving control instructions.
To output the control signal, check the presence or absence of interlock condition and the presence or absence of operation block setting (CB CLOSE), and then output the control instruction.

When the Remote/Local setting (REMOTE/LOCAL) is set to REMOTE, the control output is performed after a preset time set on the operation timer (ON TIMER). When the Remote/Local setting (REMOTE/LOCAL) is set to LOCAL, the control output is performed instantaneously after the operation. At this time, the control state is held by the flip-flop, but it is reset when the control result becomes clear. When the Remote/Local setting (REMOTE/LOCAL) is set to REMOTE, the DI control signal must be continuously input so as to exceed the set time of the operation timer (ON TIMER). If you want to stop the control for some reason, it is possible to stop the control by stopping the DI input during the timer count.

An one-shot timer of 200 ms is added to the control output for performing close control to maintain the output until the CB is fully closed. This is because, if the making current that flows when the CB is closed is released by relay's own contact, the contact will be welded.

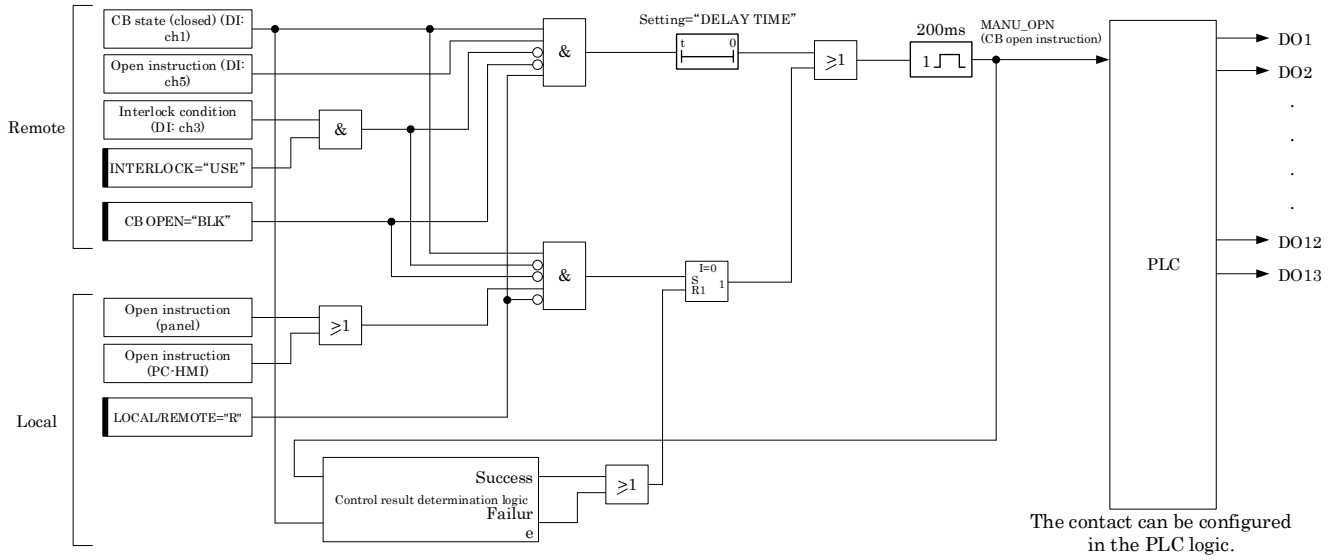


Fig. 9-2 Internal function block diagram of CB close control

As shown in Table 9-2, when "CB control: DI input" and "CB control: Setting" are both established, it is possible to execute the CB close instruction.
Note that the close instruction method that can be used in Local mode is different from that used in Remote mode.

Local: Close instruction is executed by panel operation or PC-HMI operation.
Remote: Close instruction is executed by the input to DI (ch5).

Table 9-2 Control conditions of CB close

	CB control: DI input		CB control: Setting (Refer to 5.3.4.2)			CB close instruction	
	CB State (Closed) (DI:ch1)	Interlock condition (DI:ch2)	Interlock	CB CLOSE	LOCAL/ REMOTE	Close instruction (Panel or PC-HMI)	Close instruction (DI:ch4)
Local			UNUSE	UNBLK	L	Possible	
		○	UNUSE	UNBLK	L	Possible	
			USE	UNBLK	L	Possible	
Remote			UNUSE	UNBLK	R		Possible
		○	UNUSE	UNBLK	R		Possible
			USE	UNBLK	R		Possible

* The cell with a circle “○” under the “DI:ch*” column means that “the DI input is on”.

10. Standard (Technical data)

Compliance standards: Standard of the Japanese Electrotechnical Committee (JEC)

JEC2500 (2010) Protection relays for electric power systems

JEC2501 (2010) Electromagnetic compatibility tests for protection relays

JEC2515 (2005) Percentage differential relays for electric power apparatus protection

Guaranteed performance

Common conditions	Frequency: Rated frequency Control power supply voltage: Rated voltage Ambient temperature: 20°C Relative humidity: 30 to 80 % on daily average	Unless otherwise indicated, the common conditions shall be as described in the left column.

10.1. Relay characteristic data

Item	Test condition			Standard
Operating value	Current ratio differential element (87G)	Minimum operating current	Setting: Minimum operating current = 0.4 A Operating time = Minimum Restraint current method: All methods Input: Input to one terminal on the neutral side or output side	Setting ± 5%
	Loss of field element (40)	ZF operating value	Setting: ZF = 5.0, 27.5, 50.0Ω ZB = 0.40, 2.2, 4.00Ω Operating time = Minimum Input: Current = Rated current × 2 (10 A) (As follows: I1a = 5A, I1b = 5A, I1a-I1b = 10 A) Current lags by 270° to voltage * When the voltage becomes 110 V or more for the constant current of the rated current × 2, keep the voltage constant at 110 V and decrease the current for measurement.	Setting ± 5%
		ZB operating value		
Resetting value	Current ratio differential element (87G)	Minimum operating current	Setting: Minimum operating current = 0.4 A Operating time = Minimum Restraint current method: All methods Input: Input to one terminal on the neutral side or output side	Operating value × 90% or more
	Loss of field element (40)	ZF operating value	Setting: ZF = 5.0, 27.5, 50.0Ω ZB = 0.40, 2.2, 4.00Ω Operating time = Minimum Input: Current = Rated current × 2 (10 A) (As follows: I1a = 5A, I1b = 5A, I1a-I1b = 10 A) Lags by 270° to voltage * When the voltage becomes 110 V or more for the constant current of the rated current × 2, keep the voltage constant at 110 V and decrease the current for measurement.	Operating value × 105% or less
		ZB operating value		Operating value × 95% or more

Operating time	Current ratio differential element (87G)	Setting: Minimum operating current = 0.4 A Ratio switching point = Minimum Restraint current method: All methods Input: Input to one terminal Current = 0 → Setting value × 300% (a) Ope.Time : 0.00 s (b) Ope.Time : 0.01s ≤ Ope.Time < 1.00s (c) Ope.Time : 1.00s ≤ Ope.Time ≤ 10.00s	(a) Within 50 ms (b) Ope.time setting ± 50 ms (c) Ope.time setting ± 5%
	Loss of field element (40)	Setting: ZF, ZB = Minimum Input: Current = 0 → Rated current × 2 (10 A) Voltage = 110 V → Voltage corresponding to 80% of the impedance setting value Current lags behind voltage by 270° (a) Ope.Time : 0.20s ≤ Ope.Time < 1.00s (b) Ope.Time : 1.00s ≤ Ope.Time ≤ 10.00s	(a) Ope.time setting ± 50 ms (b) Ope.time setting ± 5%
Resetting time for unlocking	Operation lock function (OPLOCK)	DI input voltage: Rated voltage → 0 (a) Ope.Time : 0.0 s (b) Ope.Time : 0.1s ≤ Ope.Time < 1.0s (c) Ope.Time : 1.0s ≤ Ope.Time ≤ 10.0s	Operation time of relay element (a) Within 50 ms (b) Ope.time setting ± 50 ms (c) Ope.time setting ± 5%
Resetting time	Current ratio differential element (87G)	Setting: Minimum operating current = 0.4 A Ratio switching point = Minimum Restraint current method: All methods Input: Input to one terminal Current = Setting value × 300% → 0	200ms ± 50ms
	Loss of field element (40)	Setting: ZF, ZB = Minimum Input: Current = Rated current × 2 (10 A) → 0 Voltage = Voltage corresponding to 80% of the impedance setting value → 110V Current lags behind voltage by 270°	
Ratio characteristic	Current ratio differential element (87G)	Setting: Minimum operating current = Minimum Operating time = Minimum Restraint current method: MIN ratio K1 = 5, 28, 50% ratio K2 = 5, 28, 50% Ratio switching point = 0.4, 5.2, 10.0 A Input: Fix the inflow current I1 and vary the outflow current I2. Input the inflow current I1 to so that the outflow current I2 becomes 100%, 200%, or 500% of I1.	Setting ± 5%
Phase characteristics	Current ratio differential element (87G)	Setting: Minimum operating current = Minimum Operating time = Minimum Restraint current method: All methods ratio (K1, K2) = 5, 50% Ratio switching point = 0.4 A Input: Fix both the inflow current I1 and the outflow current I2 at N(*), change the phase of the outflow current I2 relative to the inflow current I1, and measure the operating phase angle. (*) N…100%(=5A), 200%(=10A)	Within ±5° of the nominal value

Phase characteristics	Loss of field element (40)		Setting: ZF, ZB = Minimum Operating time = Minimum Input: Current = Rated current × 2 (10 A) (As follows: I1a = 5A, I1b = 5A, I1a-I1b = 10 A) Characteristic control point: Points where the current lags behind the voltage by 250° and 290° (*) Refer to 11.2.2 for the calculation of theoretical values of operation.	Within ±5% of the theoretical value of operation at the characteristic control point
Current-impedance characteristic	Loss of field element (40)	ZF V-I characteristic	Setting: ZF = 5.0, 27.5, 50.0Ω ZB = 0.40Ω Operating time = Minimum Input: Current = 0.9 ~ 20 A Lags by 270° to voltage	(a) Input: 0.9A ≤ I < 1.0A Within -10 to +5% of the nominal value (b) Input: I ≥ 1.0A Within ±5% of the nominal value
		ZB V-I characteristic	Setting: ZF = 5.0Ω ZB = 0.40, 2.2, 4.00Ω Operating time = Minimum Input: Current = 0.9 ~ 20 A Lags by 270° to voltage	
Temperature characteristics	All elements		Variation range: 20°C ± 20°C	Operating value: Ope.value at 20°C ± 5%
				Resetting value (40 only) Ope.value at 20°C ± 5%
				Ratio characteristic (87G only) Ope.value at 20°C ± 5%
	All elements		Variation range: 20°C ± 30°C	Operating value: Ope.value at 20°C ± 10%
				Resetting value (40 only) Ope.value at 20°C ± 10%
				Ratio characteristic (87G only) Ope.value at 20°C ± 10%
Frequency characteristics	All elements		Variation range: Rated frequency ± 5%	Operating value: Ope.value at rated frequency ± 5%
				Resetting value (40 only) Ope.value at rated frequency ± 5%
				Ratio characteristic (87G only) Ope.value at rated frequency ± 5%
Power supply voltage characteristics	All elements		Variation range of control power supply =DC 88V, DC 300V, AC 85V, AC 264V	Operating value: Ope.value at rated voltage ± 5%
				Resetting value (40 only) Ope.value at rated voltage ± 5%
				Ratio characteristic (87G only) Ope.value at rated voltage ± 5%
Distorted wave characteristics	All elements		3rd harmonic content: 30% of distortion factor 5th harmonic content: 30% of distortion factor 7th harmonic content: 30% of distortion factor	Operating value: Ope.value at 1f ± 5%
				Resetting value (40 only) Ope.value at 1f ± 5%
				Ratio characteristic (87G only) Ope.value at 1f ± 5%

Maximum current in guaranteed operating range (Internal fault)	Current ratio differential element (87G)	Input current : 100A, for 300 ms, twice, at intervals of 1 min	The relay shall operate.
Maximum current in guaranteed operating range (External fault)	Current ratio differential element (87G)	Input: Through current = 25A (300ms, 10th)	The relay shall not operate.
Minimum current in guaranteed operating range	Loss of field element (40)	Setting: ZF = Maximum ZB, Operating time = Minimum Input: Voltage = 40 V Current lags behind the voltage by 270°	0.8A ± 5%

10.2. General specification data

<table>
<tr><th>Item</th><th colspan="4">Test condition</th><th>Standard</th></tr>
<tr><td rowspan="3">Contact capacity</td><td colspan="3" rowspan="2">Contact for tripping</td><td>Closed circuit capacity</td><td>DC 110 V : 15 A
DC 220 V : 10 A
0.5s L/R = 0</td></tr>
<tr><td>Open-circuit capacity</td><td>DC 110 V : 0.3 A
DC 220 V : 0.15 A
L/R = 40 ms</td></tr>
<tr><td colspan="4">Contact for annunciator</td><td>Open- / Closed circuit capacity :
500VA (cosφ = 0.4),
60W (L/R = 7ms)

Max. current : 5 A
Max. voltage : AC 380 V
DC 125 V</td></tr>
<tr><td rowspan="3">Overload capacity</td><td>Current circuit</td><td colspan="3">Rated current × 40 times,
for 2 s, twice, at intervals of 1 min</td><td rowspan="3">No malfunction,
no unnecessary operation,
no abnormal indication,
and etc.</td></tr>
<tr><td rowspan="2">Voltage circuit</td><td colspan="3">Rated voltage × 1.15 times, 3 hr</td></tr>
<tr><td colspan="3">Positive-phase-sequence voltage :
Rated voltage × 2.17 times, for 10 s, once

Zero-phase-sequence voltage :
Rated voltage × 1.5 times, for 5 s, once</td></tr>
<tr><td>Insulation resistance</td><td colspan="4">DC500 V meg-ohm-meter is used.
(1) Between collective electric circuit and ground
(However, the serial communication circuit is excluded.)
(2) Between mutual circuits, between contact poles
(However, the serial communication circuit is excluded.)</td><td>(1) 10 MΩ or more

(2) 5 MΩ or more</td></tr>
<tr><td>Withstand voltage at commercial frequency</td><td colspan="4">(1) Between collective electric circuit and ground :
AC2000 V, 1 min
(2) Between mutual circuits, between contact poles :
AC2000 V, 1 min
(However, the serial communication circuit is excluded.)
(3) Between contact terminals (between poles) :
AC1000 V, 1 min</td><td>No malfunction,
no unnecessary operation,
no abnormal indication,
and etc.</td></tr>
<tr><td rowspan="2">Withstand voltage against lightning impulse</td><td rowspan="2">Standard shock voltage waveform (1.2/50 μs)

Application to each of positive and negative pole for 3 times</td><td>4.5 kV</td><td colspan="2">▪ Between collective electric circuit and ground
▪ Between mutual transformer circuits for measuring instruments
▪ Between the transformer circuit for measuring instrument and the control circuit
(However, the serial communication circuit is excluded.)</td><td rowspan="2">No malfunction,
no unnecessary operation,
no abnormal indication,
and etc.</td></tr>
<tr><td>3 kV</td><td colspan="2">▪ Between mutual control circuits
▪ Between terminals of transformer circuit for measuring instrument
▪ Between contact circuit terminals (between poles)
▪ Between terminals of control power supply circuit
(However, the serial communication circuit is excluded.)</td></tr>
</table>

Item	Test condition	Standard
Trouble of control power supply	・ Turning on/off control power supply ・ Instantaneous interruption of control power supply ・ Slow variation of control power supply	No malfunction, no unnecessary operation, no abnormal indication, and etc.
Immunity against electrostatic discharge	8 kV: Contact discharge 15 kV: Aerial discharge 10 times of each of positive and negative pole at intervals of more than 1s	No malfunction, no unnecessary operation, no abnormal indication, and etc.
Immunity against commercial frequency	Applied point: Between line and ground Test voltage: 300 V, Test time: 10 s Applied point: Between lines Test voltage: 150 V, Test time: 10 s	No malfunction, no unnecessary operation, no abnormal indication, and etc.
Immunity against damped oscillatory wave	・ Peak value of 1st wave: 2.5 kV ・ Vibration frequency: 1 MHz ± 10% ・ Damping time to 1/2: 3 ~ 6 cycles ・ Frequency of repetition: 6 ~ 10 times/ 1 cycle of commercial frequency (asynchronous) ・ Output impedance of test circuit: 200 Ω ± 10% Applied point: ・ Between collective transformer circuit and ground ・ Between collective control power supply circuit and ground ・ Between terminals of control power supply circuit	No malfunction, no unnecessary operation, no abnormal indication, and etc.
Electric fast transient/Burst immunity	Applied voltage: ±2.0 kV Repetition frequency: 5.0 kHz Port for applied: Between collective control power supply circuit and ground Applied voltage: ±1.0 kV Repetition frequency: 5.0 kHz Port for applied: ・ Between collective transformer circuit for measuring instruments and ground ・ Between collective binary input/output (DI/DO) circuit and ground	No malfunction, no unnecessary operation, no abnormal indication, and etc.
Immunity to square wave impulse	Applied voltage: 1.0 kV ±10% Test time : 2s Each of positive and negative pole Output impedance : 50 Ω Pulse duration : 100 ns ±30% Pulse rise time : 1 ns or less Port for applied: ・ Between collective transformer circuit and ground ・ Between collective control power supply circuit and ground ・ Between collective binary input/output (DI/DO) circuit and ground ・ Between terminals of control power supply circuit	No malfunction, no unnecessary operation, no abnormal indication, and etc.

Item	Test condition	Standard
Surge immunity	Applied time : 1.2/50 μs at open circuit condition 8/20 μs at short circuit condition Effective output impedance : 2 Ω 5 times of each of positive and negative pole at intervals 1min Port for applied and applied voltage: ・ Between control power supply terminals: Applied voltage : 0.5, 1 kV (0 Ω, 18 μF, 1.5 mH) ・ Between collective control power supply and ground: Applied voltage : 0.5, 1, 2 kV (10 Ω, 9 μF, 1.5 mH) ・ Between binary input/output circuit terminals: Applied voltage : 0.5, 1 kV (40 Ω, 0.5 μF, 20 mH) ・ Between collective binary input/output circuit and ground: Applied voltage : 0.5, 1, 2 kV (40 Ω, 0.5 μF, 20 mH) ・ Between transformer circuits for measuring instruments: Applied voltage : 0.5, 1 kV (40 Ω, 0.5 μF, 20 mH) ・ Between collective transformer circuit for measuring instruments and ground: Applied voltage : 0.5, 1, 2 kV (40 Ω, 0.5 μF, 20mH)	No malfunction, no unnecessary operation, no abnormal indication, and etc.
Commercial frequency magnetic field immunity	Magnetic field intensity : 30 A/m, for 60 s (continuous), at once 300 A/m, for 2s, three times at intervals of 1 min * Setting value of the I0 circuit for ZCT input shall be 5 mA or more.	No malfunction, no unnecessary operation, no abnormal indication, and etc.
Immunity to conducted disturbances, induced by radio- frequency fields	Voltage level : 10 V Amplitude modulation : 1 kHz, ±80% Frequency range : (a) Sweep test : 150 kHz ~ 80 MHz (b) Spot test : 27, 68 MHz Test time : (a) Sweep test : 0.5 s or more at each step of frequency (b) Spot test : 10 s or more at each frequency Port for applied : ・Between collective control power supply and ground ・Between collective binary input/output circuit and ground ・Between collective transformer circuit for measuring instruments and ground	No malfunction, no unnecessary operation, no abnormal indication, and etc.
Radiated, radio-frequency, electromagnetic field immunity	Voltage level : 10 V/m Amplitude modulation : 1 kHz, ±80% Frequency range : (a) Sweep test : 80 MHz ~ 1.0 GHz, 1.4 GHz ~ 2.7 GHz (b) Spot test : 80, 160, 380, 450, 900, 1850, 2150 MHz Test time : (a) Sweep test : 0.5 s or more at each step of frequency (b) Spot test : 10 s or more at each frequency Number of test time : Twice at each frequency for each direction of back and forth, right and left (4 directions) ; In total, 8 times at each frequency	No malfunction, no unnecessary operation, no abnormal indication, and etc.

<table>
<tr><th>Item</th><th colspan="8">Test condition</th><th>Standard</th></tr>
<tr><td rowspan="4">Vibration</td><td rowspan="2">Frequency
(Hz)</td><td colspan="3">Amplitude
(mm)</td><td rowspan="2">Time
(s)</td><td colspan="3">Acceleration
(m/s^2)</td><td rowspan="4">No malfunction,
no unnecessary operation,
no abnormal indication,
and etc.</td></tr>
<tr><td>Back and forth</td><td>Right and left</td><td>Up and down</td><td>Back and forth</td><td>Right and left</td><td>Up and down</td></tr>
<tr><td>10</td><td colspan="2">5</td><td>2.5</td><td>30</td><td colspan="2">10</td><td>5</td></tr>
<tr><td>16.7</td><td colspan="3">0.4</td><td>600</td><td colspan="3">2</td></tr>
<tr><td>Shock</td><td colspan="8">・Shock acceleration : 300 m/s^2
・Duration of pulse : 11 ms
・Direction of pulses : Respective 3 directions in back and forth, right and left, up and down (6 directions)
・ Number of pulses : 3 times for 6 directions (In total : 18 times)</td><td>No malfunction,
no unnecessary operation,
no abnormal indication,
and etc.</td></tr>
<tr><td>Load</td><td colspan="8">(1) Current circuit
(2) Voltage circuit
(3) Control power supply</td><td>(1) At the rating of 5 A: 0.6 VA or less
At the rating of 1 A: 0.1 VA or less
(2) 0.1 VA or less
(3) 10 W or less</td></tr>
<tr><td>Mass</td><td colspan="8">(1) Subunit
(2) Subunit and outer case</td><td>(1) About 2.3 kg
(2) About 3.7 kg</td></tr>
</table>

11. Test

Although all necessary functional tests are implemented for this relay before shipment from the factory, it is recommendable to perform the tests with reference to the following items, before use.

11.1. Visual inspection

Perform the visual inspection check with reference to the following items.

Inspection item	Contents of inspection
Unit (working part)	(1) No deformation (2) Operational check of the operation key switches (3) Neither discoloration nor deformation of the front name plate (4) No damage at the terminal connectors
Case	No damage including the terminal connectors
Others	No foreign substances, such as dust, iron pieces, etc.

11.2. Characteristic test

11.2.1. Notes related to the tests

(1) Recommended test condition

Regarding the ambient conditions, following conditions shall be complied with, as far as possible. If the test is performed at the condition which is significantly different from the next condition, the correct test results may not be obtained.

- Ambient temperature: 20°C ± 10°C
- Rated frequency: ±1%
- Waveform (AC): Distortion factor 2% or less
- Control voltage: Rated voltage ±2%

(2) Functional control points

Refer to Chapter 10.

The functional control point (standard point) of each relay's element shall be checked by the relay alone. Therefore, when the combined test with external devices such as CT, ZCT, etc. is performed, it shall be considered the error factor of external devices.

Furthermore, if user-defined control point is specified (e.g. accracy of relay characteristic is controlled at service conditions), execute the test at the manufacturer-defined control point (mentioned in Section 10.1) before in-service operation and then check accuracy of the relay. After that, execute the test at the user-defined control point, and set this data to the subsequent standards.

(3) Setting change

Refer to 5.3.4.1 for the setting change.

(4) Judgment of operation

Basically, the measurement of the operating value, operating time, etc. shall be done by open/close of the output relay contact of each element.

11.2.2. Characteristic test

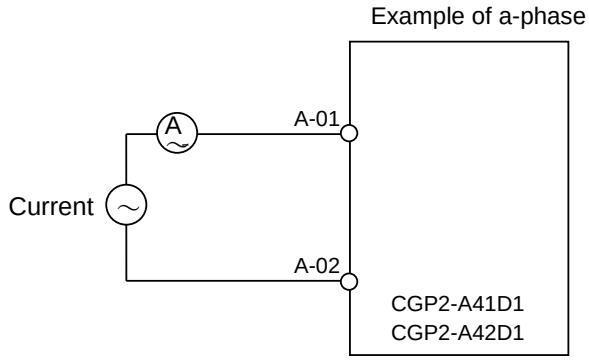
(1) Test circuit

The external connection of AC input circuit is as shown below as a reference.
Refer to Fig. 2-3 for the terminal arrangement.

[1] Current ratio differential element

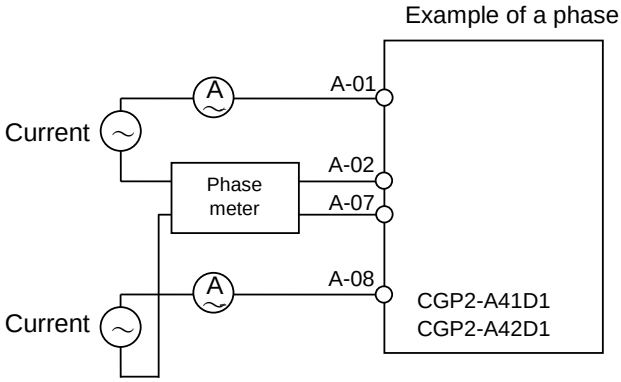
■ Minimum operating current test

■ Operating/Resetting time test



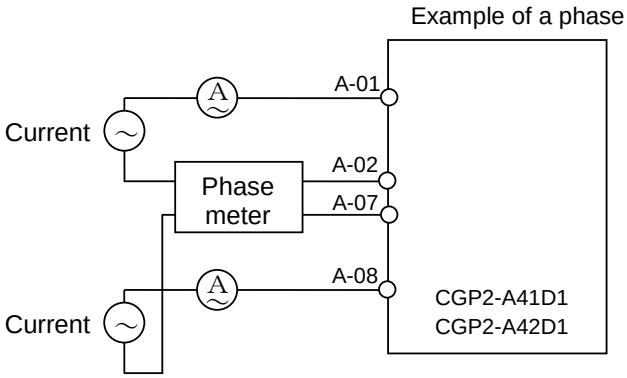
Test phase	Terminal number of output side	Terminal number of neutral side
a phase	A-01 - A-02	A-07 - A-08
b phase	A-03 - A-04	A-09 - A-10
c phase	A-05 - A-06	A-11 - A-12

■ Ratio characteristic test



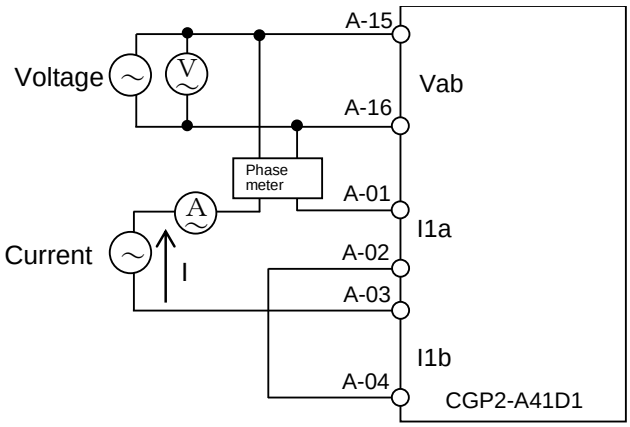
Test phase	Terminal number of output side	Terminal number of neutral side
a phase	A-01 - A-02	A-07 - A-08
b phase	A-03 - A-04	A-09 - A-10
c phase	A-05 - A-06	A-11 - A-12

■ Phase characteristic test



Test phase	Terminal number of output side	Terminal number of neutral side
a phase	A-01 - A-02	A-07 - A-08
b phase	A-03 - A-04	A-09 - A-10
c phase	A-05 - A-06	A-11 - A-12

[2] Loss of field element



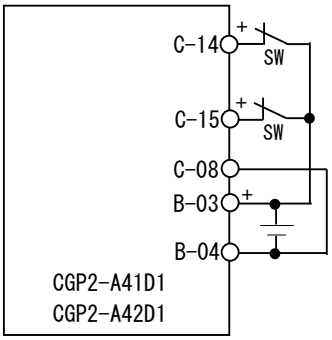
Current value measured by this test circuit is represented by I.

$$Z=\frac{Vab}{2\times I}$$

Calculate Z (Ω) using the above equation.

Note: 2×I = (I1a-I1b)
I = Input current

[3] Operation lock function



When the above switch (SW) is changed from closed to open on the conditions of operation of protection elements, the relay is locked up until the setting value of the unlocking time, and then the relay operates.
(When the SW is closed, "OP-LOCK" on the front panel lights up and the relay is locked.)

(2) Test items

[1] Test setting

Before staring test, it is recommended to to use ‘Test setting’ function in order to lock the operation of un-tested phases and elements.

As for the method of test setting, refer to 5.3.4.4.2 in Chapter 5.
As for the list of test setting items, refer to the table shown below.

List of test setting items

No.	Name of items	Contents of setting	Setting
1	SV-LK	Locking of alarm function	UNLOCKED / LOCKED
2	TCNT-LK	Locking of trip counter	UNLOCKED / LOCKED

[2] Forced operation test (DO contact test)

Refer to 5.3.4.4.1 in Chapter 5.

[3] Operating value test

Refer to the “Operating value” and “Resetting value” in Chapter 10.

[4] Operating time test

Refer to the “Operating time” in Chapter 10.

[5] Reset time test

Refer to the “Reset time” in Chapter 10.

[6] Phase characteristics test

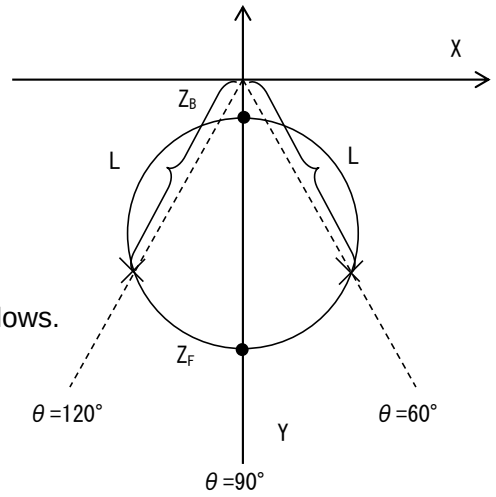
Refer to the “Phase characteristics” in Chapter 10.

[7] LED/VFD full lighting test

Refer to 5.3.4.4.3 in Chapter 5.

(Supplement) How to find the characteristic control point for the Loss of field element

Z_F: Operating measured value at θ = 90° (ohm)
Z_B: Operating measured value at θ = 90° (ohm)
L: Theoretical value of operation at θ = 60° and 120°
for the above Z_F and Z_B values
(Ohm value: x dot in the figure on the right)



(Note) Maximum sensitivity angle: θ = 90°
The characteristic circle in the right figure is expressed as follows.

$$X^2+\left(y-\frac{Z_F+Z_B}{2}\right)^2=\left(\frac{Z_F-Z_B}{2}\right)^2 \quad \cdots\cdots\cdots\cdots\cdots\cdots(1)$$

Substituting the relationship X = Lsin 30° and y = Lcos 30° into (1) yields the following quadratic equation.

$$L^2 - L0.866(Z_F + Z_B)+Z_FZ_B=0 \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots(2)$$

By determining the root of the Equation (2), the theoretical values of θ = 60° and 120° are given as follows.

$$L =0.433(Z_F+Z_B)+\sqrt{}(0.187(Z_F+Z_B)^2 - Z_FZ_B)= 0 \quad \cdots\cdots\cdots\cdots(3)$$

$$L_F=0.433(Z_F+Z_B)+\sqrt{}(0.187(Z_F+Z_B)^2 - Z_FZ_B) \quad \cdots\cdots\cdots\cdots\cdots(3)$$

$$L_B=0.433(Z_F+Z_B)-\sqrt{}(0.187(Z_F+Z_B)^2 - Z_FZ_B) \quad \cdots\cdots\cdots\cdots\cdots(4)$$

The setting values of the phase characteristic control point are Z_F = 5Ω and Z_B = 0.4Ω. When these are substituted into Equations (3) and (4) to obtain L_F and L_B, the following results are obtained: L_F = 4.2 Ω and L_B = 0.476 Ω.

As the theoretical value ±5% at the characteristic control point falls within the range of the impedance value at the characteristic control point ±5°, the warranty conditions are for the theoretical value ±5% at the characteristic control point.
Therefore, the warranty conditions are as follows.

Name	$Z_F(L_F)$		$Z_B(L_B)$	
Phase θ (°)	60	120	60	120
Operating theoretical value (Ω)	4.20	4.20	0.476	0.476
Allowable error: Operating theoretical value ±5%	4.20Ω ± 5% : 3.99 to 4.41 Ω		0.476Ω ± 5% : 0.452 to 0.499 Ω	

12. Maintenance and self diagnosis

12.1. Maintenance

12.1.1. Daily inspection

It is recommended to check the following items daily;

- No dust (such as iron powder, etc) is in/on the relay case
- No abnormal noise is generated
- ‘RUN’ LED is lighting

12.1.2. Periodic inspection

It is recommended to test the following items periodically.

- Visual inspection, referring to Section 11.1.
- Characteristic test, referring to Section 11.2.

12.2. Self diagnosis

Monitoring of the electronic circuit as well as the incorporated power supply is performed. If any trouble is generated, fault display by LED and output by alarm DO (b contact) are executed.

1. Alarm indication

The relay alarm, which would be appeared at relay failure, is divided two types, minor failure and serious failure.

Minor failure ------ This alarm may appear by detecting the abnormal current or voltage input, or abnormality of the circuits which would not affect the relay's trip operation directly.

Serious failure --- This alarm may appear by detecting abnormality of the important circuits which would affect the relay's trip operation directly.

The operation of LED display and alarm DO output are shown in next table.

Table 12-1 LED display, Alarm DO

Status of the relay	Alarm DO	RUN LED	ALARM LED
Minor failure	OFF	ON	ON
Serious failure	ON	OFF	ON

Since the indication of 'ALARM LED' at fault detection is latched, it is necessary to press 'ESC/C' key for 3 sec or more after removing the cause of trouble.

2. Handling of Alarm indication

When any trouble is generated, please collect the necessary information as shown below which would be useful for finding the cause of trouble.

[1] Confirm the state of LED display and the contact of alarm DO.
Refer to Fig. 12-1, Fig. 12-2 for LED display and alarm DO.

[2] Confirm the error code in monitoring
Refer to 5.3.2.2.4 in Chapter 5 for the confirmation method of the error code,

[3] Please contact your service provider.

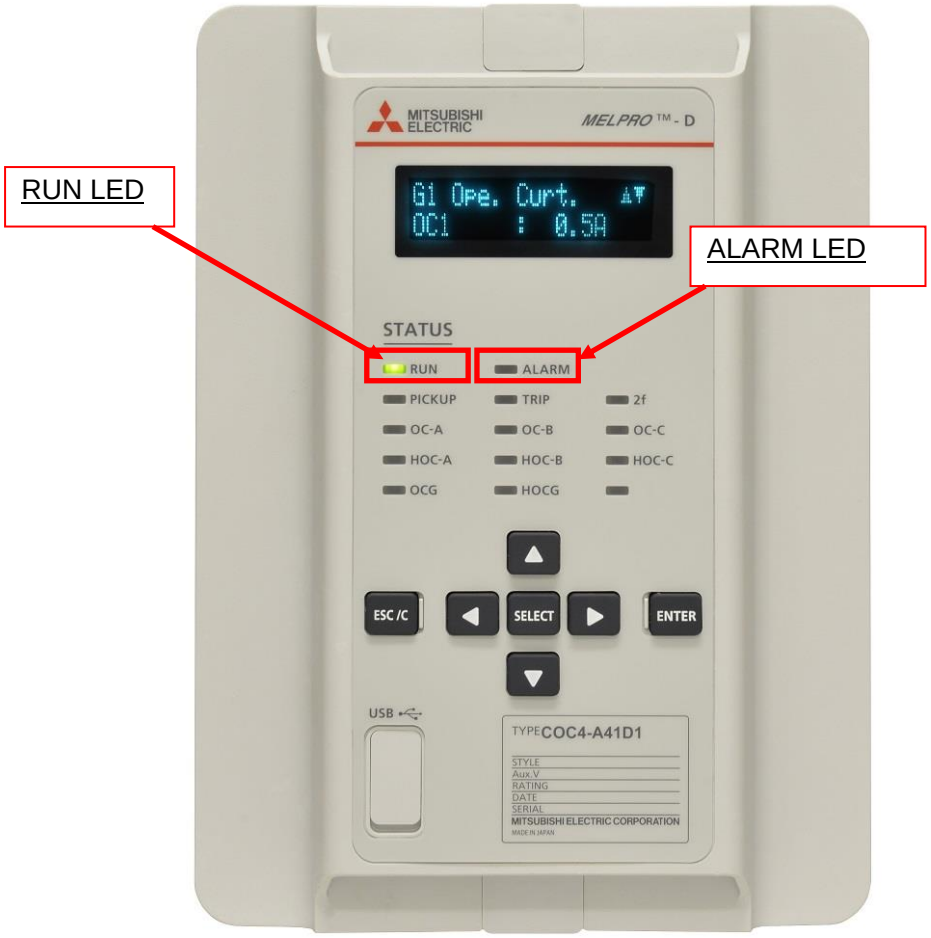


Fig. 12-1 Position of RUN LED, ALARM LED

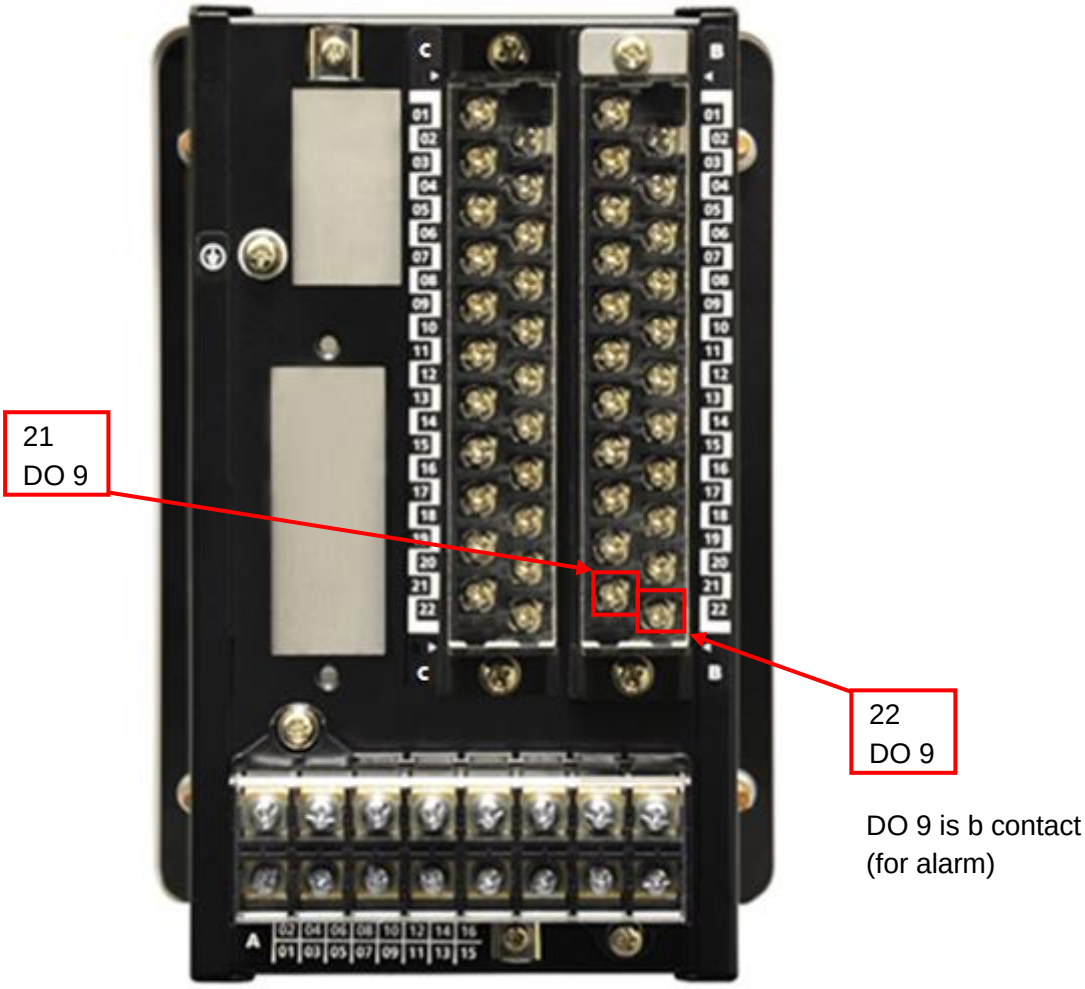


Fig. 12-2 Position of alarm DO

13. Default setting or configuration value

13.1. Setting

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Category	Element	Setting								
		Item name or Setting parameter		Range		Step	Default value		Please make a note about setting.	
		VFD	PC-HMI	VFD	PC-HMI		VFD	PC-HMI	Group 1 (G1)	Group 2 (G2)
DIFF	DIFF	DIFF EN	DIFF EN	OFF ON	Off On	–	OFF	Off		
		Ires Meth.	DIFF Ires Meth.	MAX MIN SUM		–	MAX	MAX		
		Ope. Curt.	DIFF Ope. Curt.	0.4 ~ 1.0A		0.1A	0.4A	0.4A		
		ratio K1	DIFF ratio K1	5 ~ 50%		1%	5%	5%		
		ratio K2	DIFF ratio K2	5 ~ 50%		1%	5%	5%		
		Is Curt.	DIFF Is Curt.	0.4 ~ 10.0A		0.1A	0.4A	0.4A		
		Ope. Time	DIFF Ope. Time	0.00 ~ 10.00s		0.01s	0.00s	0.00s		
LOF	LOF	LOF EN	LOF EN	OFF ON	Off On	–	OFF	Off		
		LOF ZF	LOF ZF	5.0~50.0Ω		0.1Ω	5.0Ω	5.0Ω		
		LOF ZB	LOF ZB	0.40 ~ 4.00Ω		0.01Ω	0.40Ω	0.40Ω		
		Ope. Time	LOF Ope. Time	0.20 ~ 10.00s		0.01s	0.20s	0.20s		
OPLOCK	OPLOCK	OPLOCK EN	OPLOCK EN	OFF ON	Off On	–	OFF	Off		
		Rst. Time	OPLOCK Rst. Time	0.0 ~ 10.0s		0.1s	0.0s	0.0s		
		DIFFA Lock	OPLOCK DIFFA Lock	OFF DI6 DI7 DI67	Off DI6 DI7 DI67	–	OFF	Off		
		DIFFB Lock	OPLOCK DIFFB Lock	OFF DI6 DI7 DI67	Off DI6 DI7 DI67	–	OFF	Off		
		DIFFC Lock	OPLOCK DIFFC Lock	OFF DI6 DI7 DI67	Off DI6 DI7 DI67	–	OFF	Off		
		LOF Lock	OPLOCK LOF Lock	OFF DI6 DI7 DI67	Off DI6 DI7 DI67	–	OFF	Off		
System setting	–	DI VOLTAGE	DI Voltage Level	DC110V DC220V		–	DC110V	DC110V		
	–	Pre-Rec.	Pre-Rec. Time	100 ~ 4500ms		10ms	100ms	100ms		
	–	Rec.	Max. Rec. Time	200 ~ 5000ms		10ms	200ms	200ms		
	–	PASSWORD	–	UNUSE USE	–	–	UNUSE	–		
	–	PASS	–	0000 ~ 9999		1	0000	–		
Trip counter	–	Initial	Initial Value	0 ~ 10000		1	0	0		
	–	Alarm	Alarm Value	1 ~ 10000		1	1	1		
Analog value display	–	AI Disp.	AI Display Style	PRIMARY SECONDARY	Primary Secondary	–	PRIMARY	Primary		
	–	PTP	PTP	0.1 ~ 500.0kV		0.1kV	5.0kV	5.0kV		
	–	PTS	PTS	100 ~ 125V		1V	100V	100V		
	–	CTP	CTP	5 ~ 30000A		1A	5A	5A		
	–	CTS	CTS	5A		–	5A	5A		
CB control	–	REMOTE/LOCAL	Remote/Local	R L	Remote Local	–	R	Remote		
	–	INTERLOCK	Interlock Use	UNUSE USE	Non-Use Use	–	USE	Use		
	–	CB OPEN	CB Open Block	UNBLK BLK	Unblocked Blocked	–	UNBLK	Unblocked		
	–	CB CLOSE	CB Close Block	UNBLK BLK	Unblocked Blocked	–	UNBLK	Unblocked		
	–	ON TIMER	CB On-Delay Timer	0 ~ 60s		1s	0s	0s		
DO contact test setting	–	–	One-Shot Time	–	1 ~ 20s	1s	–	1s		

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Category	Element	Setting								
		Item name or Setting parameter		Range		Step	Default value		Please make a note about setting.	
		VFD	PC-HMI	VFD	PC-HMI		VFD	PC-HMI	Group 1 (G1)	Group 2 (G2)
DIFF	DIFF	DIFF EN	DIFF EN	OFF ON	Off On	—	OFF	Off		
		Ires Meth.	DIFF Ires Meth.	MAX MIN SUM		—	MAX	MAX		
		Ope. Curt.	DIFF Ope. Curt.	0.4 ~ 1.0A		0.1A	0.4A	0.4A		
		ratio K1	DIFF ratio K1	5 ~ 50%		1%	5%	5%		
		ratio K2	DIFF ratio K2	5 ~ 50%		1%	5%	5%		
		Is Curt.	DIFF Is Curt.	0.4 ~ 10.0A		0.1A	0.4A	0.4A		
		Ope. Time	DIFF Ope. Time	0.00 ~ 10.00s		0.01s	0.00s	0.00s		
OPLOCK	OPLOCK	OPLOCK EN	OPLOCK EN	OFF ON	Off On	—	OFF	Off		
		Rst. Time	OPLOCK Rst. Time	0.0 ~ 10.0s		0.1s	0.0s	0.0s		
		DIFFA Lock	OPLOCK DIFFA Lock	OFF DI6 DI7 DI67	Off DI6 DI7 DI67	—	OFF	Off		
		DIFFB Lock	OPLOCK DIFFB Lock	OFF DI6 DI7 DI67	Off DI6 DI7 DI67	—	OFF	Off		
		DIFFC Lock	OPLOCK DIFFC Lock	OFF DI6 DI7 DI67	Off DI6 DI7 DI67	—	OFF	Off		
System setting	—	DI VOLTAGE	DI Voltage Level	DC110V DC220V		—	DC110V	DC110V		
	—	Pre-Rec.	Pre-Rec. Time	100 ~ 4500ms		10ms	100ms	100ms		
	—	Rec.	Max. Rec. Time	200 ~ 5000ms		10ms	200ms	200ms		
	—	PASSWORD	—	UNUSE USE	—	—	UNUSE	—		
	—	PASS	—	0000 ~ 9999		1	0000	—		
Trip counter	—	Initial	Initial Value	0 ~ 10000		1	0	0		
	—	Alarm	Alarm Value	1 ~ 10000		1	1	1		
Analog value display	—	AI Disp.	AI Display Style	PRIMARY SECONDARY	Primary Secondary	—	PRIMARY	Primary		
	—	CTP	CTP	5 ~ 30000A		1A	5A	5A		
	—	CTS	CTS	5A		—	5A	5A		
CB control	—	REMOTE/LOCAL	Remote/Local	R L	Remote Local	v	R	Remote		
	—	INTERLOCK	Interlock Use	UNUSE USE	Non-Use Use	—	USE	Use		
	—	CB OPEN	CB Open Block	UNBLK BLK	Unblocked Blocked	—	UNBLK	Unblocked		
	—	CB CLOSE	CB Close Block	UNBLK BLK	Unblocked Blocked	—	UNBLK	Unblocked		
	—	ON TIMER	CB On-Delay Timer	0 ~ 60s		1s	0s	0s		
DO contact test setting	—	—	One-Shot Time	—	1 ~ 20s	1s	—	1s		

13.2. Output contacts

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	Item name (PC-HMI)	Default value (PLC signal)	Please make a note about setting.
CB control Condition (DI)	CB status	DI1	
	Interlock of CB close	DI2	
	Interlock of CB open	DI3	
	CB close	DI4	
	CB open	DI5	
Operation lock (DI)	-	DI6	
	-	DI7	
Contacts for tripping (DO)	DO1	ALLEL-O	
	DO2	ALLEL-O	
	DO3	ALLEL-O	
	DO4	ALLEL-O	
Contacts for annunciator (DO)	DO5	DIFF_A-T	
	DO6	DIFF_B-T	
	DO7	DIFF_C-T	
	DO8	LOF-T	

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	Item name (PC-HMI)	Default value (PLC signal)	Please make a note about setting.
CB control Condition (DI)	CB status	DI1	
	Interlock of CB close	DI2	
	Interlock of CB open	DI3	
	CB close	DI4	
	CB open	DI5	
Operation lock (DI)	-	DI6	
	-	DI7	
Contacts for tripping (DO)	DO1	ALLEL-O	
	DO2	ALLEL-O	
	DO3	ALLEL-O	
	DO4	ALLEL-O	
Contacts for annunciator (DO)	DO5	DIFF_A-T	
	DO6	DIFF_B-T	
	DO7	DIFF_C-T	
	DO8	ALLEL-O	

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