MITSUBISHI ELECTRIC

Numerical Protection Relay

MELPRO™-D Series

FEEDER PROTECTION RELAY

MODEL

CFP1-A02D1

INSTRUCTION MANUAL

Request

Ensure that this Instruction Manual is delivered to the end users and the maintenance manager.

- Introduction -

Thank for your purchasing MITSUBISHI ELECTRIC **MELPRO** TM – D Series Digital Protection Relay.

Please read this manual carefully to be familiar with the functions and performances enough to use the product properly.

It is necessary to forward end users this instruction manual.

For operation of the product, this manual should be used in conjunction with the following materials:

Title of document	Document No.
MELPRO – D Series Protection Relay General Operation Manual	JEP0-IL9416

When the protection relay is used together with a communication card, use the following documents too:

(For CC-Link)

Title of document	Document No.
MELPRO – D Series Protection Relay CC-COM Communication Card (CC-Link) Operation Manual (General information)	JEP0-IL9417
MELPRO – D Series Protection Relay CC-COM Communication Card (CC-Link) Operation Manual (Model-specific information)	JEP0-IL9418

– CONTENTS –

1 Features

1.1 General description

Mitsubishi Electric MELPRO-D Series is a digital protection relay product with a microprocessor for protecting high/extra-high-voltage electric power system.

With its improved functions, including operation support using the advanced communication networks, data saving at the power system faults and power system voltage/current measurement, this series of protection relay will allow stable and effective control and monitoring of electric power systems as well as provide high-reliable protection.

1.2 Features

(1) High-reliable protection

CFP1-A02D1 relay contains a two-phase overcurrent protection element and an earth fault directional protection element. It is used to protect high voltage feeder lines.

(2) Diverse operation and reset characteristics

The product is provided with diversified operation and reset characteristics that meet the requirements of IEC 60255-3, and can be used for protecting various types of electric systems.

(3) Communication Network

- With an open field bus system, the relays can be used to build a high-speed, high-performance network system. In addition, the relay's multi-drop serial wiring reduces the amount of labor required for communication wiring.
- Control of measurement values, operation status, as well as setting changes, etc., can be performed from a remote location.
- In consideration of future network system variations and compatibility with communication networks, communication features are mounted in the relay using a replaceable card.

(4) Measurement & Recording Functions

- Real time monitor of relay input data

  The relay can measure steady state relay input values, supporting energy management.
- Fault Data Monitor

  When a fault occurs, the relay saves the past 5 effective input values and waveform data to assist with fault analysis.

(5) Programmable Output Configuration

The operating output contacts (DO) can be set by combining the outputs of the protection relay element using 'OR' logic, thereby simplifying sequence design.

(6) High Accurate Digital Computation

The digital computation using high-speed sampling minimizes the effect of high harmonics, etc., and results in highly accurate protection.

(7) Self-diagnosis

The relay continuously monitors electronic circuits from input to output so that it can detect internal failure before that failure causes damage on the power system, thereby improving reliability.

(8) Easy Replacement

The dimensions of the panel cutout are the same as the prior MULTICAP series. Changing from an existing relay type to this new type is easy.

(9) Easy Maintenance

The relays are adopted as draw-out unit mechanisms with automatic CT shorting at drawing, thereby making maintenance easy.

(10) Easy wiring check

It is possible to carry out forced operation of the output contacts individually. This will allow an easy wiring check.

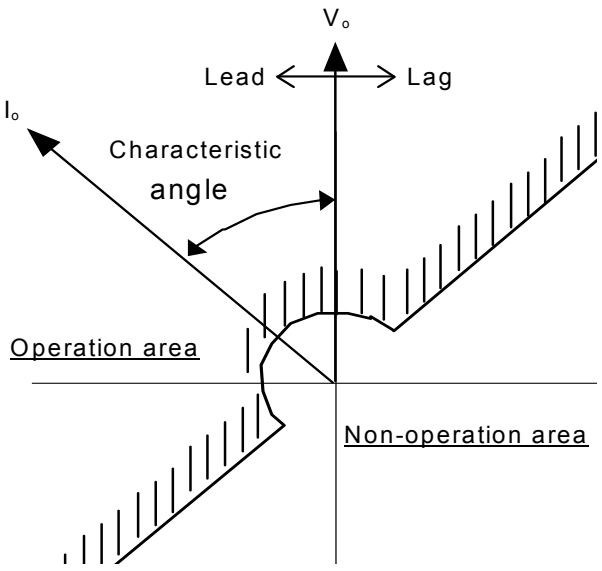
2 Ratings and specifications

2.1 General information

<table>
<tr><td colspan="3">Type name</td><td colspan="5">CFP1-A02D1</td></tr>
<tr><td rowspan="2">Style</td><td colspan="2">Relay without RS232C I/F</td><td>374PMB</td><td>375PMB</td><td>376PMB</td><td colspan="2">377PMB</td></tr>
<tr><td colspan="2">Relay with RS232C I/F</td><td>553PMB</td><td>554PMB</td><td>555PMB</td><td colspan="2">556PMB</td></tr>
<tr><td rowspan="2">Combined instrument transformer</td><td colspan="2">Zero-phase current</td><td colspan="5">Commercial ZCT with standard JEC-1201 (200/1.5mA)</td></tr>
<tr><td colspan="2">Zero-phase voltage</td><td colspan="5">Commercial EVT with standard JEC-1201</td></tr>
<tr><td rowspan="4">Elements</td><td colspan="2" rowspan="3">Protection</td><td colspan="5">Phase fault time-delayed element × 2</td></tr>
<tr><td colspan="5">Phase fault instantaneous element × 2</td></tr>
<tr><td colspan="5">Earth fault directional element × 1</td></tr>
<tr><td colspan="2">Measurement</td><td colspan="5">Phase current, zero-phase current, Zero-phase voltage,
Phase (zero-phase voltage base, lead°)</td></tr>
<tr><td rowspan="6">Ratings</td><td colspan="2">Frequency</td><td>50 Hz</td><td>60 Hz</td><td>50 Hz</td><td colspan="2">60 Hz</td></tr>
<tr><td colspan="2">Phase current</td><td colspan="2">5 A</td><td colspan="3">1 A</td></tr>
<tr><td colspan="2">Zero-phase current</td><td colspan="5">2 A</td></tr>
<tr><td colspan="2">Zero-phase voltage</td><td colspan="5">100~ 208V</td></tr>
<tr><td rowspan="2">Auxiliary Power supply *21</td><td>Voltage</td><td colspan="5">Common use for 100 ~ 220VDC / 100 ~ 220VAC</td></tr>
<tr><td>Operative range</td><td colspan="5">DC : 85 ~ 242 V (Range of 80 ~ 286VDC is allowable temporarily.)
AC : 85 ~ 242 V (Range of 80 ~ 253VAC is allowable temporarily.)</td></tr>
<tr><td rowspan="4">Display</td><td colspan="2">RUN</td><td colspan="5">Indicate the result of self-diagnosis. The lamp is lit for normal conditions and off for abnormal.</td></tr>
<tr><td colspan="2">Unit</td><td colspan="5">Indicate the unit symbol for measurements.</td></tr>
<tr><td colspan="2">Item No., Item data</td><td colspan="5">Display measurement, status, setting and option data selected with an item number.</td></tr>
<tr><td colspan="2">Communication</td><td colspan="5">With a communication card installed: the lamp is lit for normal conditions, blinking during communication and off for abnormal.
With a communication card not installed: the lamp is off.</td></tr>
<tr><td colspan="3">Self-diagnosis</td><td colspan="5">Monitor the electronic circuit and internal power supply to output signal to the RUN LED and self-diagnosis output (ALARM).</td></tr>
<tr><td rowspan="6">Output contacts</td><td rowspan="3">Configurations</td><td>For trip</td><td colspan="5">2 make contacts: X_4 and X_5 (programmable output)</td></tr>
<tr><td>For signaling</td><td colspan="5">4 make contacts: X_0 to X_3 (programmable output)</td></tr>
<tr><td>For self-diagnosis output</td><td colspan="5">1 break contact: Y (open for normal result of self-diagnosis with power on)</td></tr>
<tr><td rowspan="5">Capacity</td><td rowspan="3">For trip</td><td>Make</td><td colspan="4">110VDC, 15A, 0.5 s (L/R = 0 s)
220VDC, 10A, 0.5 s (L/R = 0 s)</td></tr>
<tr><td>Break</td><td colspan="4">110VDC, 0.3A (L/R≤40 ms)
220VDC, 0.15A (L/R≤40 ms)</td></tr>
<tr><td>Carry</td><td colspan="4">1.5 A, continuously</td></tr>
<tr><td rowspan="3">For signaling and self-diagnosis output</td><td>Make and Break</td><td colspan="4">500 VA (cosφ= 0.4),
60W (L/R = 0.007 s)</td></tr>
<tr><td>Max. current</td><td colspan="4">5 A</td></tr>
<tr><td>Max. voltage</td><td colspan="4">380VAC, 125VDC</td></tr>
<tr><td rowspan="4">Burden</td><td colspan="2">Phase current circuit</td><td colspan="5">0.5 VA or less (with rated current)</td></tr>
<tr><td colspan="2">Zero-phase current circuit</td><td colspan="5">10Ω or less</td></tr>
<tr><td colspan="2">Zero-phase voltage circuit</td><td colspan="5">0.15 VA or less (with rated voltage)</td></tr>
<tr><td colspan="2">Auxiliary power supply circuit</td><td colspan="5">For 100VDC: approx. 5 W (approx. 7W including communication card)
For 100VAC: approx. 7 VA (approx. 9VA including communication card)
For 220VDC: approx. 6 W (approx. 8W including communication card)
For 220VAC: approx. 12 VA(approx. 14VA including communication card)</td></tr>
<tr><td colspan="3">Mass</td><td colspan="5">Net weight of relay unit : approx. 2.3 kg
Including case : approx. 3.0 kg</td></tr>
<tr><td colspan="3">Case/cover</td><td colspan="5">Size : D1 type
Color : N1.5</td></tr>
</table>

*21 When an uninterruptible AC power source is not included in your system for the auxiliary supply voltage, use the type CPS1 AC/DC converter or commercially available uninterruptible power supply (UPS).
24VDC auxiliary power supply rating of relay is also available if ordered (non-standard product).
In addition, the power supply duration of the type CPS1 AC/DC converter is confirmed about 2 seconds in combination with one MELPRO-D series relay. Therefore, in the case that the required power supply duration after power source loss exceeds 2 seconds, please use a suitable commercial uninterruptible power supply.
When the power supply back up for the control power supply of a circuit breaker is required, it is necessary to prepare the backup power supply different from the type CPS1 AC/DC converter.

2.2 Protective elements

<table>
<tr><td rowspan="2">Style</td><td colspan="2">Relay without RS232C I/F</td><td>374PMB</td><td>375PMB</td><td>376PMB</td><td>377PMB</td></tr>
<tr><td colspan="2">Relay with RS232C I/F</td><td>553PMB</td><td>554PMB</td><td>555PMB</td><td>556PMB</td></tr>
<tr><td rowspan="11">Settings
*24</td><td rowspan="4">Phase fault time-delayed</td><td>Operation current</td><td colspan="2">LOCK - 1 ~ 12A (0.1A step)</td><td colspan="2">LOCK - 0.2 ~ 2.4A (0.02A step)</td></tr>
<tr><td>Operation time multiplier</td><td colspan="4">0.25 - 0.5 ~ 50 (0.5 step)</td></tr>
<tr><td>Operation time characteristics</td><td colspan="4">Normal inverse time-delayed×3, Very inverse time-delayed×2, Extremely inverse time-delayed×3, Long inverse time-delayed×3, Definite time-delayed</td></tr>
<tr><td>Reset time characteristics</td><td colspan="4">Inverse, definite time-delayed×2</td></tr>
<tr><td rowspan="2">Phase fault instantaneous</td><td>Operation current</td><td colspan="2">LOCK – 2 ~ 80A (1A step)</td><td colspan="2">LOCK - 0.4 ~ 16A (0.2A step)</td></tr>
<tr><td>Operation time</td><td colspan="4">INST - 0.1 ~ 0.5 s (0.1 s step)</td></tr>
<tr><td rowspan="5">Earth fault directional</td><td>I_0 Operation current</td><td colspan="4">10～100mA (5mA step)</td></tr>
<tr><td>V_0 Operation voltage</td><td colspan="4">LOCK-5~60V (1V step)</td></tr>
<tr><td>Operation time</td><td colspan="4">INST-0.1~10s (0.1s step)</td></tr>
<tr><td>Characteristic angle</td><td colspan="4">Lead angle 0°~90° (5°step)
 
</td></tr>
<tr><td>ZCT error correction</td><td colspan="4">When the actual measured transformation ratio is within range of 200/1.5~4.1mA, the error based on ZCT nominal transmission ratio 200/1.5mA can be corrected.</td></tr>
<tr><td colspan="3">Forced operation</td><td colspan="4">Forced operation is available for any trip or signaling contact individually.</td></tr>
<tr><td colspan="3">Operation indication</td><td colspan="4">Operation indicator LED (red) comes on when the relay operates.</td></tr>
</table>

2.3 Measurement elements

<table>
<tr><td colspan="3" rowspan="2">Style</td><td colspan="2">Relay without RS232C I/F</td><td>374PMB</td><td>375PMB</td><td>376PMB</td><td>377PMB</td></tr>
<tr><td colspan="2">Relay with RS232C I/F</td><td>553PMB</td><td>554PMB</td><td>555PMB</td><td>556PMB</td></tr>
<tr><td rowspan="3">Option *24</td><td rowspan="2">CT primary</td><td colspan="2">Phase current</td><td colspan="2">5-10-12-12.5-15-20-25-30-40-
50-60-75-80-100-120-125-150-
200-250-300-400-500-600-750-
800-1000-1200-1250-1500-2000-
2500-3000-4000-5000-6000-7500-
8000[A]</td><td colspan="2">1-5-10-12-12.5-15-20-25-30-40-
50-60-75-80-100-120-125-150-
200-250-300-400-500-600-750-
800-1000-1200-1250-1500-2000-
2500-3000-4000-5000-6000-7500-
8000[A]</td></tr>
<tr><td colspan="2">EVT primary voltage</td><td colspan="4">100~ 999[V] (1V step)
1000~ 9990[V] (10V step)
10.0~ 99.9[KV] (0.1KV step)
100~ 300[KV] (1KV step)</td></tr>
<tr><td colspan="2">EVT tertiary voltage</td><td colspan="4">100-110-115-120-100√3-110√3-115√3-120√3 [V]
(173) (190) (200) (208)</td></tr>
<tr><td rowspan="19">Display</td><td rowspan="5">Phase current</td><td rowspan="3">Real time</td><td>Conversion</td><td colspan="2">Indication value = Relay input value
×CT primary setting / 5</td><td colspan="2">Indication value = Relay input value
×CT primary setting</td></tr>
<tr><td>Range *22</td><td colspan="4">0.00 ~ CT primary setting ×2 [A]</td></tr>
<tr><td>Update</td><td colspan="4">Approx. 200 ms</td></tr>
<tr><td>Max. records</td><td>Conversion</td><td colspan="2">Indication value = Relay input value
×CT primary setting / 5</td><td colspan="2">Indication value = Relay input value
×CT primary setting</td></tr>
<tr><td>Range *22</td><td colspan="4">0.00 ~ CT primary setting ×2 [A]</td></tr>
<tr><td rowspan="2">Fault records
*23</td><td>Conversion</td><td colspan="2">Indication value = Relay input value
×CT primary setting / 5</td><td colspan="2">Indication value = Relay input value
×CT primary setting</td></tr>
<tr><td>Range *22</td><td colspan="4">0.00 ~ CT primary setting ×40 [A]</td></tr>
<tr><td rowspan="5">Zero-phase current</td><td rowspan="3">Real time</td><td>Conversion</td><td colspan="4">Indication value = Relay input value×0.2/0.0015</td></tr>
<tr><td>Range *22</td><td colspan="4">When ZCT error correction status off : 0.00~20[A]
When ZCT error correction status on : 0.00~6[A]</td></tr>
<tr><td>Update</td><td colspan="4">Approx. 200 ms</td></tr>
<tr><td rowspan="2">Max. records</td><td>Conversion</td><td colspan="4">Indication value = Relay input value×0.2/0.0015</td></tr>
<tr><td>Range *22</td><td colspan="4">When ZCT error correction status off : 0.00~20[A]
When ZCT error correction status on : 0.00~6[A]</td></tr>
<tr><td rowspan="2">Fault records
*23</td><td>Conversion</td><td colspan="4">Indication value = Relay input value×0.2/0.0015</td></tr>
<tr><td>Range *22</td><td colspan="4">When ZCT error correction status off : 0.00~20[A]
When ZCT error correction status on : 0.00~6[A]</td></tr>
<tr><td rowspan="5">Zero-phase voltage</td><td rowspan="3">Real time</td><td>Conversion</td><td colspan="4">Indication value = Relay input value
×(EVT primary setting / EVT tertiary setting) ×(1/ √3)</td></tr>
<tr><td>Range *22</td><td colspan="4">0.00 ~ (EVT primary setting / EVT tertiary setting)×(1/ √3) ×210 [V]</td></tr>
<tr><td>Update</td><td colspan="4">Approx. 200 ms</td></tr>
<tr><td rowspan="2">Max. records</td><td>Conversion</td><td colspan="4">Indication value = Relay input value
×(EVT primary setting / EVT tertiary setting) ×(1/ √3)</td></tr>
<tr><td>Range *22</td><td colspan="4">0.00 ~ (EVT primary setting / EVT tertiary setting)×(1/ √3) ×210 [V]</td></tr>
<tr><td rowspan="2">Fault records
*23</td><td>Conversion</td><td colspan="4">Indication value = Relay input value
×(EVT primary setting / EVT tertiary setting) ×(1/ √3)</td></tr>
<tr><td>Range *22</td><td colspan="4">0.00 ~ (EVT primary setting / EVT tertiary setting)×(1/ √3) ×210 [V]</td></tr>
<tr><td rowspan="3">Phase</td><td rowspan="2">Real time</td><td>Range *22</td><td colspan="4">-179~0~180[°]</td></tr>
<tr><td>Update</td><td colspan="4">Approx. 200 ms</td></tr>
<tr><td>Fault records
*23</td><td>Range *22</td><td colspan="4">-179~0~180[°]</td></tr>
</table>

*22 The form of display depends on value range as shown in the tables below:

CT primary setting value and EVT primary setting value determine the minimum number of digits to be displayed on each measurement display.

When a value to be displayed exceeds the max. value of the display range, the max. value will blink.

(1) Display of current

CT primary setting		1[A]	5 ~ 40[A]	50 ~ 400[A]	500 ~ 4000[A]	5000 ~ 8000[A]
Form of display	0.00 ~ 9.99[A]	□.□□[A]	□.□[A]	□[A]	-	-
	10.0 ~ 99.9[A]	□□.□[A]	□□.□[A]	□□[A]	□.□□[kA]	-
	100 ~ 999[A]	□□□[A]	□□□[A]	□□□[A]	□.□□[kA]	□.□[kA]
	1.00 ~ 9.99[kA]	□.□□[kA]	□.□□[kA]	□.□□[kA]	□.□□[kA]	□.□[kA]
	10.0 ~ 99.9[kA]	□□.□[kA]	□□.□[kA]	□□.□[kA]	□□.□[kA]	□□.□[kA]
	100 ~ 999[kA]	□□□[kA]	□□□[kA]	□□□[kA]	□□□[kA]	□□□[kA]

(2) Display of voltage

EVT primary setting		100 ~ 500[V]	501 ~ 10000[V]	11 ~ 300[KV]
Form of display	0.00 ~ 999[V]	□□□[V]	□.□□[KV]	□.□[kV]
	1.00 ~ 9.99[kV]	□.□□[kV]	□.□□[kV]	□.□[kV]
	10.0 ~ 99.9[kV]	□□.□[kV]	□□.□[kV]	□□.□[kV]
	100 ~ 999[kV]	□□□[kV]	□□□[kV]	□□□[kV]

(3) Display of phase

Range of display	Form of display
-179 ~ -1[°]	-□□□[°]
0 ~ 180[°]	□□□[°]

*23 When a communication card is connected, waveform data in the event of system fault can be read.

(See the section 4 “Function”).

*24 When the product is shipped from the factory, each setting value is “Lock” (With lock setting element) or “minimum setting value“ (Without lock setting element).

3 Characteristics

Common conditions	(1) Rated frequency: ±1% (2) Ambient temperature: 20°C±10°C (3) Aux. supply voltage: Rated voltage±2%	The conditions shown on the left should be applied unless otherwise specified.

3.1 Protective elements

Items			Conditions	Guaranteed performance
Operation value	Phase fault time-delayed element		(Common conditions)	- For setting of 1.0 ~ 2.0A (5A rating product) For setting of 0.2 ~ 0.4A (1A rating product) Setting value ±10% - For setting of other range Setting value ±5%
	Phase fault instantaneous element			Setting value ±10%
	Earth fault directional elements	Zero-phase current	Setting : Zero-phase voltage = Minimum Input : Zero-phase voltage = Rating voltage×30% Phase = Characteristic angle	- For setting of 10mA Setting value ±10% - For setting of other values Setting value ±5%
		Zero-phase voltage	Setting : Zero-phase current = Minimum Input : Zero-phase current = Setting value×1000% Phase = Characteristic angle	Setting value ±5%
Reset value	Phase fault time-delayed element		(Common conditions)	- For setting of 1.0 ~ 2.0A (5A rating product) For setting of 0.2 ~ 0.4A (1A rating product) Operation value×90% or more - For setting of other range Operation value×95% or more
	Phase fault instantaneous element			Operation value×95% or more
	Earth fault directional elements	Zero-phase current	Setting : Zero-phase voltage = Minimum Input : Zero-phase voltage = Rating voltage×30% Phase = Characteristic angle	Operation value×90% or more
		Zero-phase voltage	Setting : Zero-phase current = Minimum Input : Zero-phase current = Setting value×1000% Phase = Characteristic angle	

Items		Conditions	Guaranteed performance
Operation time	Phase fault time-delayed element	Operation setting: Minimum, Operation time multiplier: 10 Input: 0→Operation setting×300, 500, 1000 %	See Figures 3.1 to 2. See Tables 3.1 to 3.12
	Phase fault instantaneous element	Operation setting: Minimum Input: 0→200% of setting	Setting value ± 25ms INST = 40 ms or less
	Earth fault directional element	Setting : Zero-phase current = Minimum Zero-phase voltage = Minimum Input : Zero-phase current = 0→Setting value × 1000% Zero-phase voltage = 0→Rating value×30% Phase = Characteristic angle	- For INST setting 80ms or less - For setting of 0.1 ~ 0.4s setting value ± 25ms - For setting of 0.5 ~ 1s operation value ± 5%
Reset time	Phase fault time-delayed element	300% of setting→0 [A]	See Figure 3.3 See Table 3.13
	Phase fault instantaneous element	300% of setting→0 [A]	200 ms ± 25ms
	Earth fault directional element	Setting : Zero-phase current = Minimum Zero-phase voltage = Minimum Input : Zero-phase current = Setting value × 1000%→0 Zero-phase voltage = Rating value×30%→0 Phase = Characteristic angle	200 ms ± 25ms
Overshoot characteristics	Phase fault time-delayed element	Operation setting: Minimum Operation time multiplier : 10 Operation characteristics : All Input current : 0A→Setting value×1000%	No-operation limit time / operation time = 90% or more
Phase characteristics	Earth fault directional element	Setting : Zero-phase current = Minimum Zero-phase voltage = Minimum Input : Zero-phase current = Setting value×1000% Zero-phase voltage = Rating value×30%	Setting value: ±5°

3.2 Measurement elements

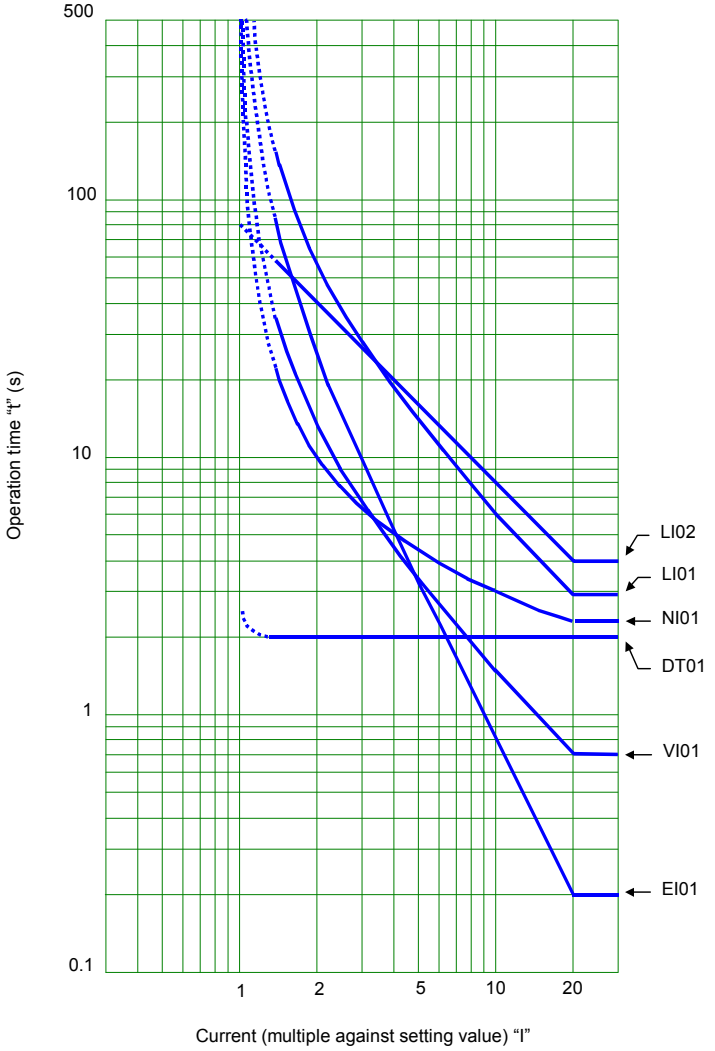
Items		Condition	Guaranteed performance
Real time and max. records	Phase current	CT primary setting×2	±1%
	Zero-phase current	2A	±2%
	Zero-phase voltage	(EVT primary setting / EVT tertiary setting)×(1/ √3) ×210	±5%
	Phase	0°	±5°

3.3 Common technical data

ITEM		DESCRIPTION	CONDITION	STANDARD
Environment	Ambient operating temperature	-10°C to +55°C		IEC60255-6
	Ambient storage and transport temperature	-25°C to +70°C		IEC60255-6
	Damp heat	+40°C, 95%RH, 4 days		IEC60068-2-3
Thermal withstand	VT	1.15Vn, 3h		
	CT	40In, 1s		
Dielectric test	Circuit of 60V or below	500VAC, 1min.	1) Between each circuit and the exposed conductive parts, the terminals of each independent circuit being connected together 2) Between independent circuits, the terminals of each independent circuit being connected together	IEC60255-5
	Circuit of more than 60V and 500v or below	2000VAC 1min.		
	Open contact	1000VAC, 1min.	Between open contact poles	
Impulse voltage test		5kV, 1.2μs/50μs	1) Between each circuit and the exposed conductive parts, the terminals of each independent circuit being connected together 2) Between independent circuits, the terminals of each independent circuit being connected together	IEC60255-5
High-frequency disturbance test	Common mode	2.5kV peak, 1MHz with 200Ω source impedance for 2s	Between independent circuits, and between independent circuit and earth	IEC60255-22-1 class 3
	Differential mode	1.0kV peak, 1MHz with 200Ω source impedance for 2s	Across terminals of the same circuit	
Electrostatic discharge test		8kV	Contact discharge	IEC60255-22-2 Class 4
		15kV	Air discharge	
Radiated electromagnetic field disturbance test		68 to 87Mhz 146 to 174MHz 420 to 470MHz		IEC60255-22-3 class 3
Fast transient disturbance test		2.0kV, 5ns/50ns, 1min		IEC60255-22-4
Vibration test		Refer to class 1		IEC60255-21-1 Class 1
Shock response		Refer to class 2		IEC60255-21-2 Class 2
Shock withstand		Refer to class 1		IEC60255-21-2 Class 1
Bump		Refer to class 1		IEC60255-21-2 Class 1
Enclosure protection		IP51		IEC60529

Vn: Rated voltage, In: Rated current

12 types of operation time characteristics and 3 types of reset time characteristics as shown in Figures 3.1 to 3.3 are integrated the Phase fault time-delayed elements.



NI01: Normal inverse time-delayed characteristic

$$t = \frac{0.14}{I^{0.02} - 1} \times \frac{M}{10}(s)$$

VI01: Very inverse time-delayed characteristic

$$t = \frac{13.5}{I - 1} \times \frac{M}{10}(s)$$

EI01: Extremely inverse time-delayed characteristic

$$t = \frac{80}{I^{2} - 1} \times \frac{M}{10}(s)$$

LI01: Long inverse time-delayed characteristic

$$t = \frac{54}{I - 1} \times \frac{M}{10}(s)$$

LI02: Long inverse time-delayed characteristic

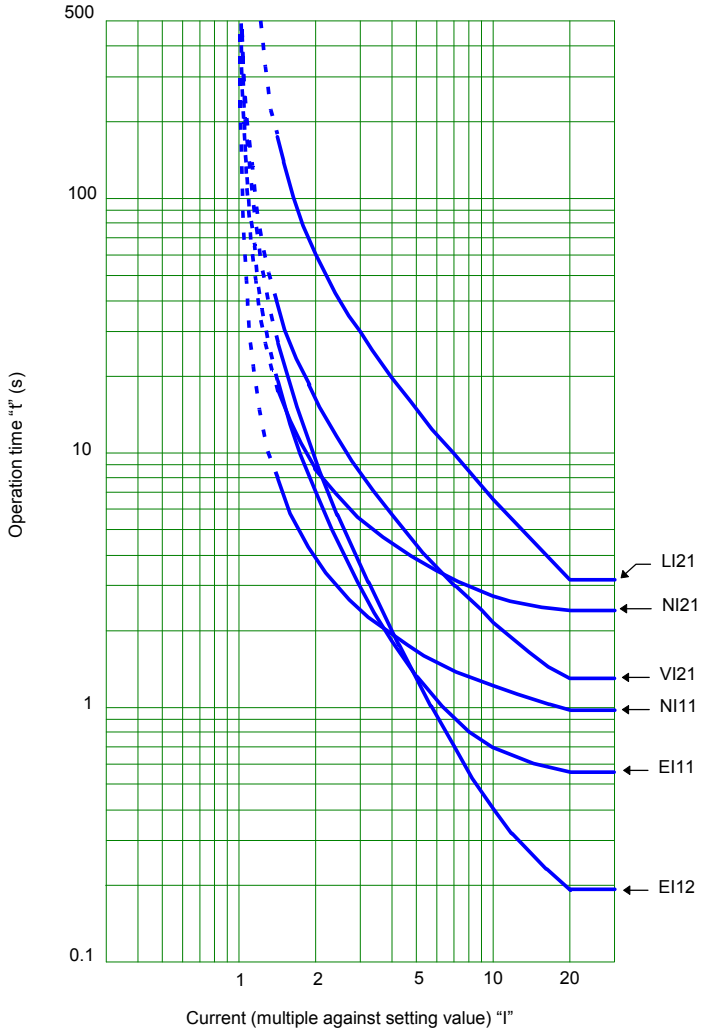
$$t = \frac{80}{I} \times \frac{M}{10}(s)$$

DT01: Definite time-delayed characteristic

$$t = 2 \times \frac{M}{10}(s)$$

t : Operation time (s)
I : Multiple of input current against setting value (times)
M : Operation time multiplier (times)

Figure 3.1 Operation time characteristic (1)



NI11: Normal inverse time-delayed characteristic

$$t = \left(\frac{0.0515}{I^{0.02} - 1} + 0.114 \right) \times \frac{M}{10} (s)$$

EI11: Extremely inverse time-delayed characteristic

$$t = \left(\frac{19.61}{I^{2} - 1} + 0.491 \right) \times \frac{M}{10} (s)$$

EI12: Extremely inverse time-delayed characteristic

$$t = \left(\frac{28.2}{I^{2} - 1} + 0.1217 \right) \times \frac{M}{10} (s)$$

NI21: Normal inverse time-delayed characteristic

$$t = \left(\frac{2.4}{I^{0.4} - 1} + 1.2 \right) \times \frac{M}{10} (s)$$

VI21: Very inverse time-delayed characteristic

$$t = \left(\frac{16}{I - 1} + 0.4 \right) \times \frac{M}{10} (s)$$

LI21: Long inverse time-delayed characteristic

$$t = \frac{60}{I - 1} \times \frac{M}{10} (s)$$

t : Operation time (s)
I : Multiple of input current against setting value (times)
M : Operation time multiplier (times)

Figure 3.2 Operation time characteristic (2)

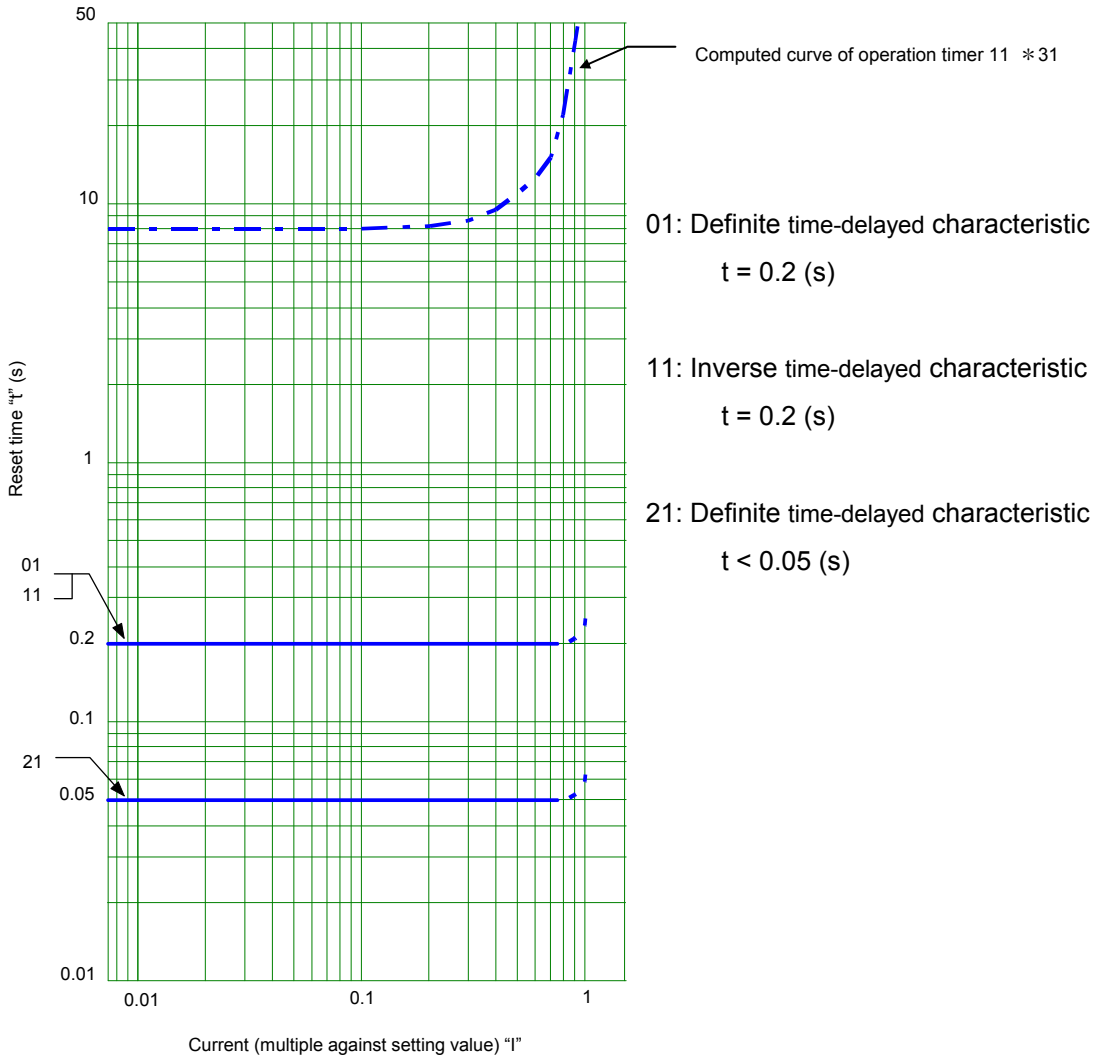


Figure 3.3 Reset time characteristic

*31 Inverse time-delayed characteristic for resetting

Following the principle of resetting an electromagnetic mechanical type induction disc, the inverse time-delayed characteristic given by the equation below is used for computing the reset time of the internal operation timer, although the output contact will be reset after a definite period of time (0.2 s). The inverse time-delayed characteristic may be useful for detecting recurrent overload, which typically occurs in starting a motor. For further information, see the section 4 "Functions".

$$t_r = \frac{8}{1-I^2} \times \frac{M}{10} (s)$$

Table 3.1 Operation time range for Normal inverse time-delayed characteristic (NI01)

Unit: s

Operation time multiplier (M)	Input		
	300%	500%	1000%
0.25	0.158 ± 5.50%	0.107 ± 3.75%	0.074 ± 3.75%
	* 0.040 ~ 0.504	* 0.040 ~ 0.267	* 0.040 ~ 0.186
0.5	0.315 ± 5.67%	0.214 ± 3.83%	0.149 ± 3.83%
	* 0.040 ~ 0.672	* 0.040 ~ 0.378	* 0.040 ~ 0.262
1	0.630 ± 6.00%	0.428 ± 4.00%	0.297 ± 4.00%
	0.252 ~ 1.008	0.257 ~ 0.599	0.178 ~ 0.416
1.5	0.945 ± 6.33%	0.642 ± 4.17%	0.446 ± 4.17%
	0.546 ~ 1.344	0.464 ~ 0.820	0.322 ~ 0.569
2	1.260 ± 6.67%	0.856 ± 4.33%	0.594 ± 4.33%
	0.840 ~ 1.681	0.670 ~ 1.041	0.465 ~ 0.723
2.5	1.575 ± 7.00%	1.070 ± 4.50%	0.743 ± 4.50%
	1.134 ~ 2.017	0.877 ~ 1.263	0.609 ~ 0.876
3	1.891 ± 7.33%	1.284 ± 4.67%	0.891 ± 4.67%
	1.428 ~ 2.353	1.084 ~ 1.484	0.753 ~ 1.030
3.5	2.206 ± 7.67%	1.498 ± 4.83%	1.040 ± 4.83%
	1.723 ~ 2.689	1.291 ~ 1.705	0.896 ~ 1.183
4	2.521 ± 8.00%	1.712 ± 5.00%	1.188 ± 5.00%
	2.017 ~ 3.025	1.498 ~ 1.926	1.040 ~ 1.337
4.5	2.836 ± 8.33%	1.926 ± 5.17%	1.337 ± 5.17%
	2.311 ~ 3.361	1.705 ~ 2.147	1.183 ~ 1.490
5	3.151 ± 8.67%	2.140 ± 5.33%	1.485 ± 5.33%
	2.605 ~ 3.697	1.912 ~ 2.368	1.327 ~ 1.644
6	3.781 ± 9.33%	2.568 ± 5.67%	1.782 ± 5.67%
	3.193 ~ 4.369	2.325 ~ 2.810	1.614 ~ 1.951
7	4.411 ± 10.00%	2.996 ± 6.00%	2.079 ± 6.00%
	3.781 ~ 5.042	2.739 ~ 3.253	1.901 ~ 2.258
8	5.042 ± 10.67%	3.424 ± 6.33%	2.376 ± 6.33%
	4.369 ~ 5.714	3.153 ~ 3.695	2.188 ~ 2.565
9	5.672 ± 11.33%	3.852 ± 6.67%	2.674 ± 6.67%
	4.958 ~ 6.386	3.566 ~ 4.137	2.475 ~ 2.872
10	6.302 ± 12.00%	4.280 ± 7.00%	2.971 ± 7.00%
	5.546 ~ 7.058	3.980 ~ 4.579	2.763 ~ 3.179
15	9.453 ± 12.00%	6.420 ± 7.00%	4.456 ± 7.00%
	8.319 ~ 10.587	5.970 ~ 6.869	4.144 ~ 4.768
20	12.604 ± 12.00%	8.559 ± 7.00%	5.941 ± 7.00%
	11.091 ~ 14.116	7.960 ~ 9.159	5.525 ~ 6.357
30	18.906 ± 12.00%	12.839 ± 7.00%	8.912 ± 7.00%
	16.637 ~ 21.174	11.940 ~ 13.738	8.288 ~ 9.536
40	25.208 ± 12.00%	17.119 ± 7.00%	11.882 ± 7.00%
	22.183 ~ 28.233	15.921 ~ 18.317	11.051 ~ 12.714
50	31.510 ± 12.00%	21.399 ± 7.00%	14.853 ± 7.00%
	27.728 ~ 35.291	19.901 ~ 22.897	13.813 ~ 15.893

Note: The values shown in the upper column of each box represent the theoretical operation tome and error limit, and those in the lower column represent the permissible range
Refer to the *32 to *35.

Table 3.2 Operation time range for Very inverse time-delayed characteristic (VI01)

Unit: s

Operation time multiplier (M)	Input		
	300%	500%	1000%
0.25	0.169 ± 5.50%	0.084 ± 3.75%	0.038 ± 3.75%
	* 0.040 ~ 0.540	* 0.040 ~ 0.211	* 0.040 ~ 0.094
0.5	0.338 ± 5.67%	0.169 ± 3.83%	0.075 ± 3.83%
	* 0.040 ~ 0.720	* 0.040 ~ 0.298	* 0.040 ~ 0.133
1	0.675 ± 6.00%	0.338 ± 4.00%	0.150 ± 4.00%
	0.270 ~ 1.080	0.203 ~ 0.473	0.090 ~ 0.210
1.5	1.013 ± 6.33%	0.506 ± 4.17%	0.225 ± 4.17%
	0.585 ~ 1.440	0.366 ~ 0.647	0.163 ~ 0.288
2	1.350 ± 6.67%	0.675 ± 4.33%	0.300 ± 4.33%
	0.900 ~ 1.800	0.529 ~ 0.821	0.235 ~ 0.365
2.5	1.688 ± 7.00%	0.844 ± 4.50%	0.375 ± 4.50%
	1.215 ~ 2.160	0.692 ~ 0.996	0.308 ~ 0.443
3	2.025 ± 7.33%	1.013 ± 4.67%	0.450 ± 4.67%
	1.530 ~ 2.520	0.855 ~ 1.170	0.380 ~ 0.520
3.5	2.363 ± 7.67%	1.181 ± 4.83%	0.525 ± 4.83%
	1.845 ~ 2.880	1.018 ~ 1.344	0.453 ~ 0.598
4	2.700 ± 8.00%	1.350 ± 5.00%	0.600 ± 5.00%
	2.160 ~ 3.240	1.181 ~ 1.519	0.525 ~ 0.675
4.5	3.038 ± 8.33%	1.519 ± 5.17%	0.675 ± 5.17%
	2.475 ~ 3.600	1.344 ~ 1.693	0.598 ~ 0.753
5	3.375 ± 8.67%	1.688 ± 5.33%	0.750 ± 5.33%
	2.790 ~ 3.960	1.508 ~ 1.868	0.670 ~ 0.830
6	4.050 ± 9.33%	2.025 ± 5.67%	0.900 ± 5.67%
	3.420 ~ 4.680	1.834 ~ 2.216	0.815 ~ 0.985
7	4.725 ± 10.00%	2.363 ± 6.00%	1.050 ± 6.00%
	4.050 ~ 5.400	2.160 ~ 2.565	0.960 ~ 1.140
8	5.400 ± 10.67%	2.700 ± 6.33%	1.200 ± 6.33%
	4.680 ~ 6.120	2.486 ~ 2.914	1.105 ~ 1.295
9	6.075 ± 11.33	3.038 ± 6.67%	1.350 ± 6.67%
	5.310 ~ 6.840	2.813 ~ 3.263	1.250 ~ 1.450
10	6.750 ± 12.00%	3.375 ± 7.00%	1.500 ± 7.00%
	5.940 ~ 7.560	3.139 ~ 3.611	1.395 ~ 1.605
15	10.125 ± 12.00%	5.063 ± 7.00%	2.250 ± 7.00%
	8.910 ~ 11.340	4.708 ~ 5.417	2.093 ~ 2.408
20	13.500 ± 12.00%	6.750 ± 7.00%	3.000 ± 7.00%
	11.880 ~ 15.120	6.278 ~ 7.223	2.790 ~ 6.357
30	20.250 ± 12.00%	10.125 ± 7.00%	4.500 ± 7.00%
	17.820 ~ 22.680	9.416 ~ 10.834	4.185 ~ 4.815
40	27.000 ± 12.00%	13.500 ± 7.00%	6.000 ± 7.00%
	23.760 ~ 30.240	12.555 ~ 14.445	5.580 ~ 6.420
50	33.750 ± 12.00%	16.875 ± 7.00%	7.500 ± 7.00%
	29.700 ~ 37.800	15.694 ~ 18.056	6.975 ~ 8.025

Note: The values shown in the upper column of each box represent the theoretical operation tome and error limit, and those in the lower column represent the permissible range
Refer to the *32 to *35.

Table 3.3 Operation time range for Extremely inverse time-delayed characteristic (EI01)

Unit: s

Operation time multiplier (M)	Input		
	300%	500%	1000%
0.25	0.250 ± 5.50%	0.083 ± 3.75%	0.020 ± 0.05
	* 0.040 ~ 0.800	* 0.040 ~ 0.208	* 0.040 ~ 0.070
0.5	0.500 ± 5.67%	0.167 ± 3.83%	0.040 ± 0.05
	* 0.040 ~ 1.067	* 0.040 ~ 0.294	* 0.040 ~ 0.090
1	1.000 ± 6.00%	0.333 ± 4.00%	0.081 ± 0.05
	0.400 ~ 1.600	0.200 ~ 0.467	* 0.040 ~ 0.131
1.5	1.500 ± 6.33%	0.500 ± 4.17%	0.121 ± 0.05
	0.867 ~ 2.133	0.361 ~ 0.639	0.071 ~ 0.171
2	2.000 ± 6.67%	0.667 ± 4.33%	0.162 ± 0.05
	1.333 ~ 2.667	0.522 ~ 0.811	0.112 ~ 0.212
2.5	2.500 ± 7.00%	0.833 ± 4.50%	0.202 ± 0.05
	1.800 ~ 3.200	0.683 ~ 0.983	0.152 ~ 0.252
3	3.000 ± 7.33%	1.000 ± 4.67%	0.242 ± 0.05
	2.267 ~ 3.733	0.844 ~ 1.156	0.192 ~ 0.292
3.5	3.500 ± 7.67%	1.167 ± 4.83%	0.283 ± 0.05
	2.733 ~ 4.267	1.006 ~ 1.328	0.233 ~ 0.333
4	4.000 ± 8.00%	1.333 ± 5.00%	0.323 ± 0.05
	3.200 ~ 4.800	1.167 ~ 1.500	0.273 ~ 0.373
4.5	4.500 ± 8.33%	1.500 ± 5.17%	0.364 ± 0.05
	3.667 ~ 5.333	1.328 ~ 1.672	0.314 ~ 0.414
5	5.000 ± 8.67%	1.667 ± 5.33%	0.404 ± 0.05
	4.133 ~ 5.867	1.489 ~ 1.844	0.354 ~ 0.454
6	6.000 ± 9.33%	2.000 ± 5.67%	0.485 ± 0.05
	5.067 ~ 6.933	1.811 ~ 2.189	0.435 ~ 0.535
7	7.000 ± 10.00%	2.333 ± 6.00%	0.566 ± 0.05
	6.000 ~ 8.000	2.133 ~ 2.533	0.516 ~ 0.616
8	8.000 ± 10.67%	2.667 ± 6.33%	0.646 ± 6.33%
	6.933 ~ 9.067	2.456 ~ 2.878	0.595 ~ 0.698
9	9.000 ± 11.33%	3.000 ± 6.67%	0.727 ± 6.67%
	7.867 ~ 10.133	2.778 ~ 3.222	0.673 ~ 0.781
10	10.000 ± 12.00%	3.333 ± 7.00%	0.808 ± 7.00%
	8.800 ~ 11.200	3.100 ~ 3.567	0.752 ~ 0.865
15	15.000 ± 12.00%	5.000 ± 7.00%	1.212 ± 7.00%
	13.200 ~ 16.800	4.650 ~ 5.350	1.127 ~ 1.297
20	20.000 ± 12.00%	6.667 ± 7.00%	1.616 ± 7.00%
	17.600 ~ 22.400	6.200 ~ 7.133	1.503 ~ 1.729
30	30.000 ± 12.00%	10.000 ± 7.00%	2.424 ± 7.00%
	26.400 ~ 33.600	9.300 ~ 10.700	2.255 ~ 2.594
40	40.000 ± 12.00%	13.333 ± 7.00%	3.232 ± 7.00%
	35.200 ~ 44.800	12.400 ~ 14.267	3.006 ~ 3.459
50	50.000 ± 12.00%	16.667 ± 7.00%	4.040 ± 7.00%
	44.000 ~ 56.000	15.500 ~ 17.833	3.758 ~ 4.323

Note: The values shown in the upper column of each box represent the theoretical operation tome and error limit, and those in the lower column represent the permissible range
Refer to the *32 to *35.

Table 3.4 Operation time range for Long inverse time-delayed characteristic (LI01)

Unit: s

Operation time multiplier (M)	Input		
	300%	500%	1000%
0.25	0.675 ± 5.50%	0.338 ± 3.75%	0.150 ± 3.75%
	* 0.040 ~ 2.160	* 0.040 ~ 0.844	* 0.040 ~ 0.375
0.5	1.350 ± 5.67%	0.675 ± 3.83%	0.300 ± 3.83%
	* 0.040 ~ 2.880	0.158 ~ 1.193	0.070 ~ 0.530
1	2.700 ± 6.00%	1.350 ± 4.00%	0.600 ± 4.00%
	1.080 ~ 4.320	0.158 ~ 1.890	0.360 ~ 0.840
1.5	4.050 ± 6.33%	2.025 ± 4.17%	0.900 ± 4.17%
	2.340 ~ 5.760	1.463 ~ 2.588	0.650 ~ 1.150
2	5.400 ± 6.67%	2.700 ± 4.33%	1.200 ± 4.33%
	3.600 ~ 7.200	2.115 ~ 3.285	0.940 ~ 1.460
2.5	6.750 ± 7.00%	3.375 ± 4.50%	1.500 ± 4.50%
	4.860 ~ 8.640	2.768 ~ 3.983	1.230 ~ 1.770
3	8.100 ± 7.33%	4.050 ± 4.67%	1.800 ± 4.67%
	6.120 ~ 10.080	3.420 ~ 4.680	1.520 ~ 2.080
3.5	9.450 ± 7.67%	4.725 ± 4.83%	2.100 ± 4.83%
	7.380 ~ 11.520	4.073 ~ 5.378	1.810 ~ 2.390
4	10.800 ± 8.00%	5.400 ± 5.00%	2.400 ± 5.00%
	8.640 ~ 12.960	4.725 ~ 6.075	2.100 ~ 2.700
4.5	12.150 ± 8.33%	6.075 ± 5.17%	2.700 ± 5.17%
	9.900 ~ 14.400	5.378 ~ 6.773	2.390 ~ 3.010
5	13.500 ± 8.67%	6.750 ± 5.33%	3.000 ± 5.33%
	11.160 ~ 15.840	6.030 ~ 7.470	2.680 ~ 3.320
6	16.200 ± 9.33%	8.100 ± 5.67%	3.600 ± 5.67%
	13.680 ~ 18.720	7.335 ~ 8.865	3.260 ~ 3.940
7	18.900 ± 10.00%	9.450 ± 6.00%	4.200 ± 6.00%
	16.200 ~ 21.600	8.640 ~ 10.260	3.840 ~ 4.560
8	21.600 ± 10.67%	10.800 ± 6.33%	4.800 ± 6.33%
	18.720 ~ 24.480	9.945 ~ 11.655	4.420 ~ 5.180
9	24.300 ± 11.33%	12.150 ± 6.67%	5.400 ± 6.67%
	24.300 ± 11.33%	12.150 ± 6.67%	5.400 ± 6.67%
10	27.000 ± 12.00%	13.500 ± 7.00%	6.000 ± 7.00%
	23.760 ~ 30.240	12.555 ~ 14.445	5.580 ~ 6.420
15	40.500 ± 12.00%	20.250 ± 7.00%	9.000 ± 7.00%
	35.640~ 45.360	18.833 ~ 21.668	8.370 ~ 9.630
20	54.000 ± 12.00%	27.000 ± 7.00%	12.000 ± 7.00%
	47.520 ~ 60.480	25.110 ~ 28.890	11.160 ~ 12.840
30	81.000 ± 12.00%	40.500 ± 7.00%	18.000 ± 7.00%
	71.280 ~ 90.720	37.665 ~ 43.335	16.740 ~ 19.260
40	108.00 ± 12.00%	54.000 ± 7.00%	24.000 ± 7.00%
	95.040 ~ 120.96	50.220 ~ 57.780	22.320 ~ 25.680
50	135.00 ± 12.00%	67.500 ± 7.00%	30.000 ± 7.00%
	118.80 ~ 151.20	62.775 ~ 72.225	27.900 ~ 32.100

Note: The values shown in the upper column of each box represent the theoretical operation tome and error limit, and those in the lower column represent the permissible range
Refer to the *32 to *35.

Table 3.5 Operation time range for Long inverse time-delayed characteristic (LI02)

Unit: s

Operation time multiplier (M)	Input		
	300%	500%	1000%
0.25	0.667 ± 5.50%	0.400 ± 3.75%	0.200 ± 3.75%
	* 0.040 ~ 2.133	* 0.040 ~ 1.000	* 0.040 ~ 0.500
0.5	1.333 ± 5.67%	0.800 ± 3.83%	0.400 ± 3.83%
	* 0.040 ~ 2.844	0.187~ 1.413	0.093 ~ 0.707
1	2.667 ± 6.00%	1.600 ± 4.00%	0.800 ± 4.00%
	1.067~ 4.267	0.960 ~ 2.240	0.480 ~ 1.120
1.5	4.000 ± 6.33%	2.400 ± 4.17%	1.200 ± 4.17%
	2.311 ~ 5.689	1.733 ~ 3.067	0.867 ~ 1.533
2	5.333 ± 6.67%	3.200 ± .33%	1.600 ± 4.33%
	3.556 ~ 7.111	2.507 ~ 3.893	1.253 ~ 1.947
2.5	6.667 ± 7.00%	4.000 ± 4.50%	2.000 ± 4.50%
	4.800 ~ 8.533	3.280 ~ 4.720	1.640 ~ 2.360
3	8.000 ± 7.33%	4.800 ± 4.67%	2.400 ± 4.67%
	6.044 ~ 9.956	4.053 ~ 5.547	2.027 ~ 2.773
3.5	9.333 ± 7.67%	5.600 ± 4.83%	2.800 ± 4.83%
	7.289 ~ 1.378	4.827 ~ 6.373	2.413 ~ 3.187
4	10.667 ± 8.00%	6.400 ± 5.00%	3.200 ± 5.00%
	8.533 ~ 12.800	5.600 ~ 7.200	2.800 ~ 3.600
4.5	12.000 ± 8.33%	7.200 ± 5.17%	3.600 ± 5.17%
	9.778 ~ 14.222	6.373 ~ 8.027	3.187 ~ 4.013
5	13.333 ± 8.67%	8.000 ± 5.33%	4.000 ± 5.33%
	11.022 ~ 15.644	7.147 ~ 8.853	3.573 ~ 4.427
6	16.000 ± 9.33%	9.600 ± 5.67%	4.800 ± 5.67%
	13.511 ~ 18.489	8.693 ~ 10.507	4.347 ~ 5.253
7	18.667 ± 10.00%	11.200 ± 6.00%	5.600 ± 6.00%
	16.000 ~ 21.333	10.240 ~ 12.160	5.120 ~ 6.080
8	21.333 ± 10.67%	12.800 ± 6.33%	6.400 ± 6.33%
	18.489 ~ 24.178	11.787 ~ 13.813	5.893 ~ 6.907
9	24.000 ± 11.33%	14.400 ± 6.67%	7.200 ± 6.67%
	20.978 ~ 27.022	13.333 ~ 15.467	6.667 ~ 7.733
10	26.667 ± 12.00%	16.000 ± 7.00%	8.000 ± 7.00%
	23.467 ~ 29.867	14.880 ~ 17.120	7.440 ~ 8.560
15	40.000 ± 12.00%	24.000 ± 7.00%	12.000 ± 7.00%
	35.200 ~ 44.800	22.320 ~ 25.680	11.160 ~ 12.840
20	53.333 ± 12.00%	32.000 ± 7.00%	16.000 ± 7.00%
	46.933 ~ 59.733	29.760 ~ 34.240	14.880 ~ 17.120
30	80.000 ± 12.00%	48.000 ± 7.00%	24.000 ± 7.00%
	70.400 ~ 89.600	44.640 ~ 51.360	22.320 ~ 25.680
40	106.67 ± 12.00%	64.000 ± 7.00%	32.000 ± 7.00%
	93.867 ~ 119.47	59.520 ~ 68.480	29.760~ 34.240
50	133.33 ± 12.00%	80.000 ± 7.00%	40.000 ± 7.00%
	117.33 ~ 149.33	74.400 ~ 85.600	37.200 ~ 42.800

Note: The values shown in the upper column of each box represent the theoretical operation tome and error limit, and those in the lower column represent the permissible range
Refer to the *32 to *35.

Table 3.6 Operation time range for Definite time-delayed characteristic (DT01)

Unit: s

Operation time multiplier (M)	Input		
	300%	500%	1000%
0.25	0.050 ± 2.56%	0.050 ± 2.56%	0.050 ± 2.56%
	* 0.040 ~ 0.101	* 0.040 ~ 0.101	* 0.040 ~ 0.101
0.5	0.100 ± 2.63%	0.100 ± 2.63%	0.100 ± 2.63%
	0.048 ~ 0.153	0.048~ 0.153	0.048 ~ 0.153
1	0.200 ± 2.75%	0.200 ± 2.75%	0.200 ± 2.75%
	0.145 ~ 0.255	0.145 ~ 0.255	0.145 ~ 0.255
1.5	0.300 ± 2.88%	0.300 ± 2.88%	0.300 ± 2.88%
	0.243 ~ 0.358	0.243 ~ 0.358	0.243 ~ 0.358
2	0.400 ± 3.00%	0.400 ± 3.00%	0.400 ± 3.00%
	0.340 ~ 0.460	0.340 ~ 0.460	0.340 ~ 0.460
2.5	0.500 ± 3.13%	0.500 ± 3.13%	0.500 ± 3.13%
	0.438 ~ 0.563	0.438 ~ 0.563	0.438 ~ 0.563
3	0.600 ± 3.25%	0.600 ± 3.25%	0.600 ± 3.25%
	0.535 ~ 0.665	0.535 ~ 0.665	0.535 ~ 0.665
3.5	0.700 ± 3.38%	0.700 ± 3.38%	0.700 ± 3.38%
	0.633 ~ 0.768	0.633 ~ 0.768	0.633 ~ 0.768
4	0.800 ± 3.50%	0.800 ± 3.50%	0.800± 3.50%
	0.730 ~ 0.870	0.730 ~ 0.870	0.730 ~ 0.870
4.5	0.900 ± 3.63%	0.900 ± 3.63%	0.900 ± 3.63%
	0.828 ~ 0.973	0.828 ~ 0.973	0.828 ~ 0.973
5	1.000 ± 3.75%	1.000 ± 3.75%	1.000 ± 3.75%
	0.925 ~ 1.075	0.925 ~ 1.075	0.925 ~ 1.075
6	1.200 ± 4.00%	1.200 ± 4.00%	1.200 ± 4.00%
	1.120 ~ 1.280	1.120 ~ 1.280	1.120 ~ 1.280
7	1.400 ± 4.25%	1.400 ± 4.25%	1.400 ± 4.25%
	1.315 ~ 1.485	1.315 ~ 1.485	1.315 ~ 1.485
8	1.600 ± 4.50%	1.600 ± 4.50%	1.600 ± 4.50%
	1.510 ~ 1.690	1.510 ~ 1.690	1.510 ~ 1.690
9	1.800 ± 4.75%	1.800 ± 4.75%	1.800 ± 4.75%
	1.705 ~ 1.895	1.705 ~ 1.890	1.705 ~ 1.895
10	2.000 ± 5.00%	2.000 ± 5.00%	2.000 ± 5.00%
	1.900 ~ 2.100	1.900 ~ 2.100	1.900 ~ 2.100
15	3.000 ± 5.00%	3.000 ± 5.00%	3.000 ± 5.00%
	2.850 ~ 3.150	2.850 ~ 3.150	2.850 ~ 3.150
20	4.000 ± 5.00%	4.000 ± 5.00%	4.000 ± 5.00%
	3.800 ~ 4.200	3.800 ~ 4.200	3.800 ~ 4.200
30	6.000 ± 5.00%	6.000 ± 5.00%	6.000 ± 5.00%
	5.700 ~ 6.300	5.700 ~ 6.300	5.700 ~ 6.300
40	8.000 ± 5.00%	8.000 ± 5.00%	8.000 ± 5.00%
	7.600 ~ 8.400	7.600 ~ 8.400	7.600 ~ 8.400
50	10.000 ± 5.00%	10.000 ± 5.00%	10.000 ± 5.00%
	9.500 ~ 10.500	9.500 ~ 10.500	9.500 ~ 10.500

Note: The values shown in the upper column of each box represent the theoretical operation tome and error limit, and those in the lower column represent the permissible range
Refer to the *32 to *35.

Table 3.7 Operation time range for Normal inverse time-delayed characteristic (NI11)

Unit: s

Operation time multiplier (M)	Input		
	300%	500%	1000%
0.25	0.061 ± 5.50%	0.042 ± 3.75%	0.030 ± 0.05
	* 0.040 ~ 0.195	* 0.040 ~ 0.106	* 0.040 ~ 0.080
0.5	0.122 ± 5.67%	0.084 ± 3.83%	0.060 ± 0.05
	* 0.040 ~ 0.259	* 0.040 ~ 0.149	* 0.040 ~ 0.110
1	0.243 ± 6.00%	0.169 ± 4.00%	0.121 ± 0.05
	0.097 ~ 0.389	0.101 ~ 0.236	0.071 ~ 0.171
1.5	0.365 ± 6.33%	0.253 ± 4.17%	0.181 ± 4.17%
	0.211 ~ 0.519	0.183 ~ 0.324	0.131 ~ 0.231
2	0.486 ± 6.67%	0.338 ± 4.33%	0.241 ± 4.33%
	0.324 ~ 0.649	0.265 ~ 0.411	0.189 ~ 0.294
2.5	0.608 ± 7.00%	0.422 ± 4.50%	0.302 ± 4.50%
	0.438 ~ 0.778	0.346 ~ 0.498	0.247 ~ 0.356
3	0.730 ± 7.33%	0.506 ± 4.67%	0.362 ± 4.67%
	0.551 ~ 0.908	0.428 ~ 0.585	0.306 ~ 0.418
3.5	0.851 ± 7.67%	0.591 ± 4.83%	0.422 ± 4.83%
	0.665 ~ 1.038	0.509 ~ 0.673	0.364 ~ 0.481
4	0.973 ± 8.00%	0.675 ± 5.00%	0.483 ± 5.00%
	0.778 ~ 1.167	0.591 ~ 0.760	0.422 ~ 0.543
4.5	1.094 ± 8.33%	0.760 ± 5.17%	0.543 ± 5.17%
	0.892 ~ 1.297	0.673 ~ 0.847	0.481 ~ 0.605
5	1.216 ± 8.67%	0.844 ± 5.33%	0.603 ± 5.33%
	1.005 ~ 1.427	0.754 ~ 0.934	0.539 ~ 0.668
6	1.459 ± 9.33%	1.013 ± 5.67%	0.724 ± 5.67%
	1.232 ~ 1.686	0.917 ~ 1.109	0.656 ~ 0.792
7	1.703 ± 10.00%	1.182 ± 6.00%	0.845 ± 6.00%
	1.459 ~ 1.946	1.081 ~ 1.283	0.772 ~ 0.917
8	1.946 ± 10.67%	1.351 ± 6.33%	0.965 ± 6.33%
	1.686 ~ 2.205	1.244 ~ 1.458	0.889 ~ 1.042
9	2.189 ± 11.33%	1.519 ± 6.67%	1.086 ± 6.67%
	1.913 ~ 2.465	1.407 ~ 1.632	1.006 ~ 1.167
10	2.432 ± 12.00%	1.688 ± 7.00%	1.207 ± 7.00%
	2.140 ~ 2.724	1.570 ~ 1.807	1.122 ~ 1.291
15	3.648 ± 12.00%	2.532 ± 7.00%	1.810 ± 7.00%
	3.211 ~ 4.086	2.355 ~ 2.710	1.683 ~ 1.937
20	4.864 ± 12.00%	3.377 ± 7.00%	2.414 ± 7.00%
	4.281 ~ 5.448	3.140 ~ 3.613	2.245 ~ 2.582
30	7.297 ± 12.00%	5.065 ± 7.00%	3.620 ± 7.00%
	6.421 ~ 8.172	4.710 ~ 5.420	3.367~ 3.874
40	9.729 ± 12.00%	6.753 ± 7.00%	4.827 ± 7.00%
	8.561 ~ 10.896	6.281 ~ 7.226	4.489 ~ 5.165
50	12.161 ± 12.00%	8.442 ± 7.00%	6.034 ± 7.00%
	10.702 ~ 13.620	7.851 ~ 9.033	5.611 ~ 6.456

Note: The values shown in the upper column of each box represent the theoretical operation tome and error limit, and those in the lower column represent the permissible range
Refer to the *32 to *35.

Table 3.8 Operation time range for Extremely inverse time-delayed characteristic (EI11)

Unit: s

Operation time multiplier (M)	Input		
	300%	500%	1000%
0.25	0.074 ± 5.50%	0.033 ± 0.05	0.017 ± 0.05
	* 0.040 ~ 0.235	* 0.040 ~ 0.082	* 0.040 ~ 0.067
0.5	0.147 ± 5.67%	0.065 ± 3.83%	0.034 ± 0.05
	* 0.040 ~ 0.314	* 0.040 ~ 0.116	* 0.040 ~ 0.084
1	0.294 ± 6.00%	0.131 ± 4.00%	0.069 ± 0.05
	0.118 ~ 0.471	0.078 ~ 0.183	* 0.040 ~ 0.119
1.5	0.441 ± 6.33%	0.196 ± 4.17%	0.103 ± 0.05
	0.255 ~ 0.628	0.142 ~ 0.251	0.053 ~ 0.153
2	0.588 ± 6.67%	0.262 ± 4.33%	0.138 ± 0.05
	0.392 ~ 0.785	0.205 ~ 0.318	0.088 ~ 0.188
2.5	0.736 ± 7.00%	0.327 ± 4.50%	0.172 ± 0.05
	0.530 ~ 0.942	0.268 ~ 0.386	0.122 ~ 0.222
3	0.883 ± 7.33%	0.392 ± 4.67%	0.207 ± 0.05
	0.667 ~ 1.098	0.331 ~ 0.453	0.157 ~ 0.257
3.5	1.030 ± 7.67%	0.458 ± 4.83%	0.241 ± 0.05
	0.804 ~ 1.255	0.395 ~ 0.521	0.191 ~ 0.291
4	1.177 ± 8.00%	0.523 ± 5.00%	0.276 ± 0.05
	0.942~ 1.412	0.458 ~ 0.589	0.226 ~ 0.326
4.5	1.324 ± 8.33%	0.589 ± 5.17%	0.310 ± 0.05
	1.079 ~ 1.569	0.521 ~ 0.656	0.260 ~ 0.360
5	1.471 ± 8.67%	0.654 ± 5.33%	0.345 ± 0.05
	1.216 ~ 1.726	0.584 ~ 0.724	0.295 ~ 0.395
6	1.765 ± 9.33%	0.785 ± 5.67%	0.413 ± 0.05
	1.491 ~ 2.040	0.711 ~ 0.859	0.363 ~ 0.463
7	2.060 ± 10.00%	0.916 ± 6.00%	0.482 ± 0.05
	1.765 ~ 2.354	0.837 ~ 0.994	0.432 ~ 0.532
8	2.354 ± 10.67%	1.046 ± 6.33%	0.551 ± 0.05
	2.040 ~ 2.668	0.964 ~ 1.129	0.501 ~ 0.601
9	2.648 ± 11.33%	1.177 ± 6.67%	0.620 ± 0.05
	2.315 ~ 2.981	1.090 ~ 1.264	0.570 ~ 0.670
10	2.942 ± 12.00%	1.308 ± 7.00%	0.689 ± 0.05
	2.589 ~ 3.295	1.217 ~ 1.400	0.639 ~ 0.739
15	4.413 ± 12.00%	1.962 ± 7.00%	1.034 ± 7.00%
	3.884 ~ 4.943	1.825 ~ 2.099	0.961 ~ 1.106
20	5.885 ± 12.00%	2.616 ± 7.00%	1.378 ± 7.00%
	5.178 ~ 6.591	2.433 ~ 2.799	1.282 ~ 1.475
30	8.827 ± 12.00%	3.924 ± 7.00%	2.067 ± 7.00%
	7.768 ~ 9.886	3.650 ~ 4.199	1.923 ~ 2.212
40	11.769 ± 12.00%	5.232 ± 7.00%	2.756 ± 7.00%
	10.357 ~ 13.181	4.866 ~ 5.599	2.563 ~ 2.949
50	14.711 ± 12.00%	6.540 ± 7.00%	3.445 ± 7.00%
	12.946 ~ 16.477	6.083 ~ 6.998	3.204 ~ 3.687

Note: The values shown in the upper column of each box represent the theoretical operation tome and error limit, and those in the lower column represent the permissible range
Refer to the *32 to *35.

Table 3.9 Operation time range for Extremely inverse time-delayed characteristic (EI12)

Unit: s

Operation time multiplier (M)	Input		
	300%	500%	1000%
0.25	0.091 ± 5.50%	0.032 ± 0.05	0.010 ± 0.05
	* 0.040 ~ 0.292	* 0.040 ~ 0.082	* 0.040 ~ 0.060
0.5	0.182 ± 5.67%	0.065 ± 3.83%	0.020 ± 0.05
	* 0.040 ~ 0.389	* 0.040 ~ 0.115	* 0.040 ~ 0.070
1	0.365 ± 6.00%	0.130 ± 4.00%	0.041 ± 0.05
	0.146 ~ 0.583	0.078 ~ 0.182	* 0.040 ~ 0.091
1.5	0.547 ± 6.33%	0.195 ± 4.17%	0.061 ± 0.05
	0.316 ~ 0.778	0.140 ~ 0.249	* 0.040 ~ 0.111
2	0.729 ± 6.67%	0.259 ± 4.33%	0.081 ± 0.05
	0.486 ~ 0.972	0.203 ~ 0.316	* 0.040 ~ 0.131
2.5	0.912 ± 7.00%	0.324 ± 4.50%	0.102 ± 0.05
	0.656 ~ 1.167	0.266 ~ 0.383	0.052 ~ 0.152
3	1.094 ± 7.33%	0.389 ± 4.67%	0.122 ± 0.05
	0.827 ~ 1.361	0.328 ~ 0.450	0.072 ~ 0.172
3.5	1.276 ± 7.67%	0.454 ± 4.83%	0.142 ± 0.05
	0.997 ~ 1.556	0.391 ~ 0.517	0.092 ~ 0.192
4	1.459 ± 8.00%	0.519 ± 5.00%	0.163 ± 0.05
	1.167 ~ 1.750	0.454 ~ 0.584	0.113 ~ 0.213
4.5	1.641 ± 8.33%	0.584 ± 5.17%	0.183 ± 0.05
	1.337 ~ 1.945	0.517 ~ 0.651	0.133 ~ 0.233
5	1.823 ± 8.67%	0.648 ± 5.33%	0.203 ± 0.05
	1.507 ~ 2.139	0.579 ~ 0.718	0.153 ~ 0.253
6	2.188 ± 9.33%	0.778 ± 5.67%	0.244 ± 0.05
	1.848 ~ 2.528	0.705 ~ 0.851	0.194 ~ 0.294
7	2.553 ± 10.00%	0.908 ± 6.00%	0.285 ± 0.05
	2.188 ~ 2.917	0.830 ~ 0.985	0.235 ~ 0.335
8	2.917 ± 10.67%	1.037 ± 6.33%	0.325 ± 0.05
	2.528 ~ 3.306	0.955 ~ 1.119	0.275 ~ 0.375
9	3.282 ± 11.33%	1.167 ± 6.67%	0.366 ± 0.05
	2.869 ~ 3.695	1.081 ~ 1.253	0.316 ~ 0.416
10	3.647 ± 12.00%	1.297 ± 7.00%	0.407 ± 0.05
	3.209 ~ 4.084	1.206 ~ 1.387	0.357 ~ 0.457
15	5.470 ± 12.00%	1.945 ± 7.00%	0.610 ± 0.05
	4.814 ~ 6.126	1.809 ~ 2.081	0.560 ~ 0.660
20	7.293 ± 12.00%	2.593 ± 7.00%	0.813 ± 7.00%
	6.418 ~ 8.169	2.412 ~ 2.775	0.756 ~ 0.870
30	10.940 ± 12.00%	3.890 ± 7.00%	1.220 ± 7.00%
	9.627 ~ 12.253	3.618 ~ 4.162	1.134 ~ 1.305
40	14.587 ± 12.00%	5.187 ± 7.00%	1.626 ± 7.00%
	12.836 ~ 16.337	4.824 ~ 5.550	1.512 ~ 1.740
50	18.234 ± 12.00%	6.484 ± 7.00%	2.033 ± 7.00%
	16.045 ~ 20.422	6.030 ~ 6.937	1.890 ~ 2.175

Note: The values shown in the upper column of each box represent the theoretical operation tome and error limit, and those in the lower column represent the permissible range
Refer to the *32 to *35.

Table 3.10 Operation time range for Normal inverse time-delayed characteristic (NI21)

Unit: s

Operation time multiplier (M)	Input		
	300%	500%	1000%
0.25	0.139 ± 5.50%	0.096 ± 3.75%	0.070 ± 3.75%
	* 0.040 ~ 0.444	* 0.040 ~ 0.241	* 0.040 ~ 0.174
0.5	0.277 ± 5.67%	0.193 ± 3.83%	0.139 ± 3.83%
	* 0.040 ~ 0.592	0.045 ~ 0.341	* 0.040 ~ 0.246
1	0.555 ± 6.00%	0.386 ± 4.00%	0.279 ± 4.00%
	0.222 ~ 0.888	0.231 ~ 0.540	0.167 ~ 0.390
1.5	0.832 ± 6.33%	0.578 ± 4.17%	0.418 ± 4.17%
	0.481 ~ 1.184	0.418 ~ 0.739	0.302 ~ 0.534
2	1.110 ± 6.67%	0.771 ± 4.33%	0.557 ± 4.33%
	0.740 ~ 1.480	0.604 ~ 0.938	0.437 ~ 0.678
2.5	1.387 ± 7.00%	0.964 ± 4.50%	0.697 ± 4.50%
	0.999 ~ 1.776	0.790 ~ 1.137	0.571 ~ 0.822
3	1.665 ± 7.33%	1.157 ± 4.67%	0.836 ± 4.67%
	1.258 ~ 2.072	0.977 ~ 1.337	0.706 ~ 0.966
3.5	1.942 ± 7.67%	1.350 ± 4.83%	0.976 ± 4.83%
	1.517 ~ 2.368	1.163 ~ 1.536	0.841 ~ 1.110
4	2.220 ± 8.00%	1.542 ± 5.00%	1.115 ± 5.00%
	1.776 ~ 2.664	1.350 ~ 1.735	0.976 ~1.254
4.5	2.497 ± 8.33%	1.735 ± 5.17%	1.254 ± 5.17%
	2.035 ~ 2.959	1.536 ~ 1.934	1.110 ~ 1.398
5	2.775 ± 8.67%	1.928 ± 5.33%	1.394 ± 5.33%
	2.294 ~ 3.255	1.722 ~ 2.134	1.245 ~ 1.542
6	3.329 ± 9.33%	2.314 ± 5.67%	1.672 ± 5.67%
	2.812 ~ 3.847	2.095 ~ 2.532	1.514 ~ 1.830
7	3.884 ± 10.00%	2.699 ± 6.00%	1.951 ± 6.00%
	3.329 ~ 4.439	2.468 ~ 2.930	1.784 ~ 2.118
8	4.439 ± 10.67%	3.085 ± 6.33%	2.230 ± 6.33%
	3.847 ~ 5.031	2.841 ~ 3.329	2.053 ~ 2.406
9	4.994 ± 11.33%	3.470 ± 6.67%	2.509 ± 6.67%
	4.365 ~ 5.623	3.213 ~ 3.727	2.323 ~ 2.695
10	5.549 ± 12.00%	3.856 ± 7.00%	2.787 ± 7.00%
	4.883 ~ 6.215	3.586 ~ 4.126	2.592 ~ 2.983
15	8.324 ± 12.00%	5.784 ± 7.00%	4.181 ± 7.00%
	7.325 ~ 9.322	5.379 ~ 6.189	3.888 ~ 4.474
20	11.098 ± 12.00%	7.712 ± 7.00%	5.575 ± 7.00%
	9.766 ~ 12.430	7.172 ~ 8.252	5.185 ~ 5.965
30	16.647 ± 12.00%	11.568 ± 7.00%	8.362 ± 7.00%
	14.649 ~ 18.645	10.758 ~ 12.377	7.777 ~ 8.948
40	22.196 ± 12.00%	15.424 ± 7.00%	11.150 ± 7.00%
	19.533 ~ 24.860	14.344 ~ 16.503	10.369 ~ 11.930
50	27.745 ± 12.00%	19.279 ± 7.00%	13.937 ± 7.00%
	24.416 ~ 31.075	17.930 ~ 20.629	12.962 ~ 14.913

Note: The values shown in the upper column of each box represent the theoretical operation tome and error limit, and those in the lower column represent the permissible range
Refer to the *32 to *35.

Table 3.11 Operation time range for Very inverse time-delayed characteristic (VI21)

Unit: s

Operation time multiplier (M)	Input		
	300%	500%	1000%
0.25	0.210 ± 5.50%	0.110 ± 3.75%	0.054 ± 3.75%
	* 0.040 ~ 0.672	* 0.040 ~ 0.275	* 0.040 ~ 0.136
0.5	0.420 ± 5.67%	0.220 ± 3.83%	0.109 ± 3.83%
	* 0.040 ~ 0.896	0.051 ~ 0.389	* 0.040 ~ 0.192
1	0.840 ± 6.00%	0.440 ± 4.00%	0.218 ± 4.00%
	0.336 ~ 1.344	0.264 ~ 0.616	0.131 ~ 0.305
1.5	1.260 ± 6.33%	0.660 ± 4.17%	0.327 ± 4.17%
	0.728 ~ 1.792	0.477 ~ 0.843	0.236 ~ 0.417
2	1.680 ± 6.67%	0.880 ± 4.33%	0.436 ± 4.33%
	1.120 ~ 2.240	0.689 ~ 1.071	0.341 ~ 0.530
2.5	2.100 ± 7.00%	1.100 ± 4.50%	0.544 ± 4.50%
	1.512 ~ 2.688	0.902 ~ 1.298	0.446 ~ 0.642
3	2.520 ± 7.33%	1.320 ± 4.67%	0.653 ± 4.67%
	1.904 ~ 3.136	1.115 ~ 1.525	0.552 ~ 0.755
3.5	2.940 ± 7.67%	1.540 ± 4.83%	0.762 ± 4.83%
	2.296 ~ 3.584	1.327 ~ 1.753	0.657 ~ 0.867
4	3.360 ± 8.00%	1.760 ± 5.00%	0.871 ± 5.00%
	2.688 ~ 4.032	1.540 ~ 1.980	0.762 ~ 0.980
4.5	3.780 ± 8.33%	1.980 ± 5.17%	0.980 ± 5.17%
	3.080 ~ 4.480	1.753 ~ 2.207	0.867 ~ 1.093
5	4.200 ± 8.67%	2.200 ± 5.33%	1.089 ± 5.33%
	3.472 ~ 4.928	1.965 ~ 2.435	0.973 ~ 1.205
6	5.040 ± 9.33%	2.640 ± 5.67%	1.307 ± 5.67%
	4.256 ~ 5.824	2.391 ~ 2.889	1.183 ~ 1.430
7	5.880 ± 10.00%	3.080 ± 6.00%	1.524 ± 6.00%
	5.040 ~ 6.720	2.816 ~ 3.344	1.394 ~ 1.655
8	6.720 ± 10.67%	3.520 ± 6.33%	1.742 ± 6.33%
	5.824 ~ 7.616	3.241 ~ 3.799	1.604 ~ 1.880
9	7.560 ± 11.33%	3.960 ± 6.67%	1.960 ± 6.67%
	6.608 ~ 8.512	3.667 ~ 4.253	1.815 ~ 2.105
10	8.400 ± 12.00%	4.400 ± 7.00%	2.178 ± 7.00%
	7.392 ~ 9.408	4.092 ~ 4.708	2.025 ~ 2.330
15	12.600 ± 12.00%	6.600 ± 7.00%	3.267 ± 7.00%
	11.088 ~ 14.112	6.138 ~ 7.062	3.038 ~ 3.495
20	16.800 ± 12.00%	8.800 ± 7.00%	4.356 ± 7.00%
	14.784 ~ 18.816	8.184 ~ 9.416	4.051 ~ 4.660
30	25.200 ± 12.00%	13.200 ± 7.00%	6.533 ± 7.00%
	22.176 ~ 28.224	12.276 ~ 14.124	6.076 ~ 6.991
40	33.600 ± 12.00%	17.600 ± 7.00%	8.711 ± 7.00%
	29.568 ~ 37.632	16.368 ~ 18.832	8.101 ~ 9.321
50	42.000 ± 12.00%	22.000 ± 7.00%	10.889 ± 7.00%
	36.960 ~ 47.040	20.460 ~ 23.540	10.127 ~ 11.651

Note: The values shown in the upper column of each box represent the theoretical operation tome and error limit, and those in the lower column represent the permissible range
Refer to the *32 to *35.

Table 3.12 Operation time range for Long inverse time-delayed characteristic (LI21)

Unit: s

Operation time multiplier (M)	Input		
	300%	500%	1000%
0.25	0.750 ± 5.50%	0.375 ± 3.75%	0.167 ± 3.75%
	* 0.040 ~ 2.400	* 0.040 ~ 0.938	* 0.040 ~ 0.417
0.5	1.500 ± 5.67%	0.750 ± 3.83%	0.333 ± 3.83%
	* 0.040 ~ 3.200	0.175 ~ 1.325	0.078 ~ 0.589
1	3.000 ± 6.00%	1.500 ± 4.00%	0.667 ± 4.00%
	1.200 ~ 4.800	0.900 ~ 2.100	0.400 ~ 0.933
1.5	4.500 ± 6.33%	2.250 ± 4.17%	1.000 ± 4.17%
	2.600 ~ 6.400	1.625 ~ 2.875	0.722 ~ 1.278
2	6.000 ± 6.67%	3.000 ± 4.33%	1.333 ± 4.33%
	4.000 ~ 8.000	2.350 ~ 3.650	1.044 ~ 1.622
2.5	7.500 ± 7.00%	3.750 ± 4.50%	1.667 ± 4.50%
	5.400 ~ 9.600	3.075 ~ 4.425	1.367 ~ 1.967
3	9.000 ± 7.33%	4.500 ± 4.67%	2.000 ± 4.67%
	6.800 ~ 11.200	3.800 ~ 5.200	1.689 ~ 2.311
3.5	10.500 ± 7.67%	5.250 ± 4.83%	2.333 ± 4.83%
	8.200 ~ 12.800	4.525 ~ 5.975	2.011 ~ 2.656
4	12.000 ± 8.00%	6.000 ± 5.00%	2.667 ± 5.00%
	9.600 ~14.400	5.250 ~ 6.750	2.333 ~ 3.000
4.5	13.500 ± 8.33%	6.750 ± 5.17%	3.000 ± 5.17%
	11.000 ~ 16.000	5.975 ~ 7.525	2.656 ~ 3.344
5	15.000 ± 8.67%	7.500 ± 5.33%	3.333 ± 5.33%
	12.400 ~ 17.600	6.700 ~ 8.300	2.978 ~ 3.689
6	18.000 ± 9.33%	9.000 ± 5.67%	4.000 ± 5.67%
	15.200 ~ 20.800	8.150 ~ 9.850	3.622 ~ 4.378
7	21.000 ± 10.00%	10.500 ± 6.00%	4.667 ± 6.00%
	18.000 ~ 24.000	9.600 ~ 11.400	4.267 ~ 5.067
8	24.000 ± 10.67%	12.000 ± 6.33%	5.333 ± 6.33%
	20.800 ~ 27.200	11.050 ~ 12.950	4.911 ~ 5.756
9	27.000 ± 11.33%	13.500 ± 6.67%	6.000 ± 6.67%
	23.600 ~ 30.400	12.500 ~ 14.500	5.556 ~ 6.444
10	30.000 ± 12.00%	15.000 ± 7.00%	6.667 ± 7.00%
	26.400 ~ 33.600	13.950 ~ 16.050	6.200 ~ 7.133
15	45.000 ± 12.00%	22.500 ± 7.00%	10.000 ± 7.00%
	39.600 ~ 50.400	20.925 ~ 24.075	9.300 ~ 10.700
20	60.000 ± 12.00%	30.000 ± 7.00%	13.333 ± 7.00%
	52.800 ~ 67.200	27.900 ~ 32.100	12.400 ~ 14.267
30	90.000 ± 12.00%	45.000 ± 7.00%	20.000 ± 7.00%
	79.200 ~ 100.80	41.850 ~ 48.150	18.600 ~ 21.400
40	120.00 ± 12.00%	60.000 ± 7.00%	26.667 ± 7.00%
	105.60 ~ 134.4	55.800 ~ 64.200	24.800 ~ 28.533
50	150.00 ± 12.00%	75.000 ± 7.00%	33.333 ± 7.00%
	132.00 ~ 168.00	69.750 ~ 80.250	31.000 ~ 35.667

Note: The values shown in the upper column of each box represent the theoretical operation tome and error limit, and those in the lower column represent the permissible range
Refer to the *32 to *35.

Table 3.13 Reset time characteristic

Input: Setting value×300% →0

	Output contact	Reset of operation timer inside relay
01 : Definite time-delayed (200 ms)	200ms ± 25ms	Immediately
11 : Inverse time-delayed	200ms ± 25ms	Approx. 8 s (M=10 , I=0)*36
21 : Definite time-delayed (50 ms)	50ms or less	Immediately

Note:

*32 The numbers “300%”, “500%” and “1000%” represent multiples against the current setting.

*33 The values shown in the upper column of each box in the table represent the theoretical operation time and error limit, and those in the lower column represent the permissible range (see the formula below).

a. Operation time multiplier “M” ≤10	b. Operation time multiplier “M” > 10
$\varepsilon = \frac{T_M - \frac{M}{10} \cdot T_{10}}{T_{10}} \cdot 100$	$\varepsilon = \frac{T_M - \frac{M}{10} \cdot T_{10}}{\frac{M}{10} \cdot T_{10}} \cdot 100$

where;

T_{10} : Nominal operation time for reference operation time setting (M = 10)

T_M : Actual measurement of operation time for operation time setting “M”

ε : Error (%)

M : Operation time multiplier

If an error range determined using the formula above is smaller the lower error limit of ± 50ms, this lower error limit should be used as the error range.

34 “40ms” given at the underlined part (marked with “”) in the table indicates the time determined as minimum operation time.

*35 The table is prepared on the basis of minimum operation setting under normal temperature, and the operation time ranges change as condition varies.

*36 The elapsed time of reset of the operation timer can be checked through the “Elapse of time-delayed timer (LAPSE) indicator”.

4 Functions

4.1 Protection

4.1.1. Phase fault elements

Fig. 4.1 “Phase fault element internal function block diagram” shows operation of the Phase fault elements.

The time-delayed element compares input currents with the operation setting in each phase. If an input current is larger than the specified operation level, the element outputs an operation signal when the time-delayed timer expires. The expiring time depends on the input current amount and the setting in the operation time characteristic.

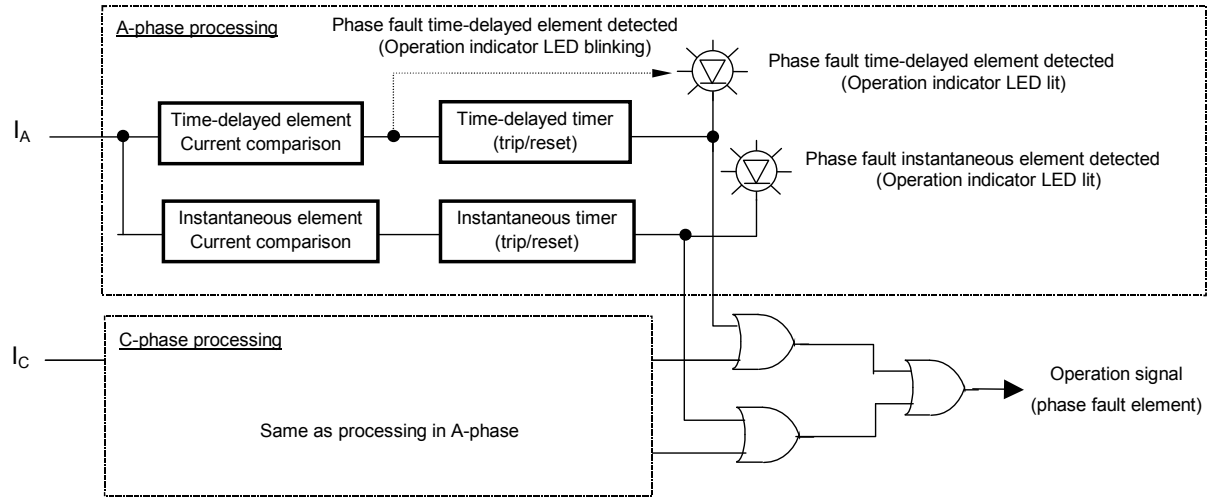


Figure 4.1 Phase fault element Internal function diagram

Like the time-delayed element, the instantaneous element also compares the input current with the operation setting to output an operation signal when a period of time set in the instantaneous timer has elapsed.

(1) Setting of operation current

The operation current settings for the instantaneous and time-delayed elements are indicated with current values [A].

When the setting “Lock”, the elements selected are locked for operation.

(2) Setting of operation time multiplier

This parameter is indicated with a multiplier against the basic operation time characteristic (value for the letter “M” in the operation characteristic formula shown in Figure 3.1).

(3) Setting of operation time characteristic

A time-delayed element includes 11 types of inverse and a type of definite time-delayed characteristics for trip action that meet the requirements specified by IEC60255-3. One of them can be selected by operation time characteristic setting.

Figures 3.1 and 3.2 show the operation time characteristic curves and operation time characteristic formulas.

(4) Setting of reset time characteristic

A time-delayed element includes a type of inverse and two types of definite time-delayed

characteristics for reset action that meet the requirements specified by IEC60255-3. One of them can be selected by reset time characteristic setting.

Figure 3.3 shows the reset time characteristic curves and reset time characteristic formula.

Characteristic		Reset when relay input is less than operation setting		Response to intermittent inputs
Designation	Symbol	Reset of time-delayed timer inside relay	Output contact	
Definite time-delayed	01	Quick reset	Definite time-delayed of 200ms	Unlikely to operate
	21	Quick reset	Definite time-delayed of 50ms	
Inverse time-delayed	11	Inverse time-delayed reset according to the formula below: $t_r = \frac{8}{1-I^2} \times \frac{M}{10}(s)$	Definite time-delayed of 200ms	Likely to operate

For the definite time-delayed reset characteristic, the internal timer will reset quickly when the input current becomes less than the operation setting. The definite time-delayed reset characteristic is not suitable for detecting intermittent overloads which are likely to occur in starting a motor or intermittent earth fault. For the inverse time-delayed reset characteristic in turn, the internal timer will reset according to an inverse time-delayed reset characteristic even when the input current becomes less than the operating setting by following the principle of resetting the electromagnetic mechanical type induction disc. Therefore, it is relatively easy for the inverse time-delayed reset characteristic to detect intermittent phenomena. Select either depending on your application.

Note that the output contact will reset after a definite period of time whichever characteristic is selected for resetting.

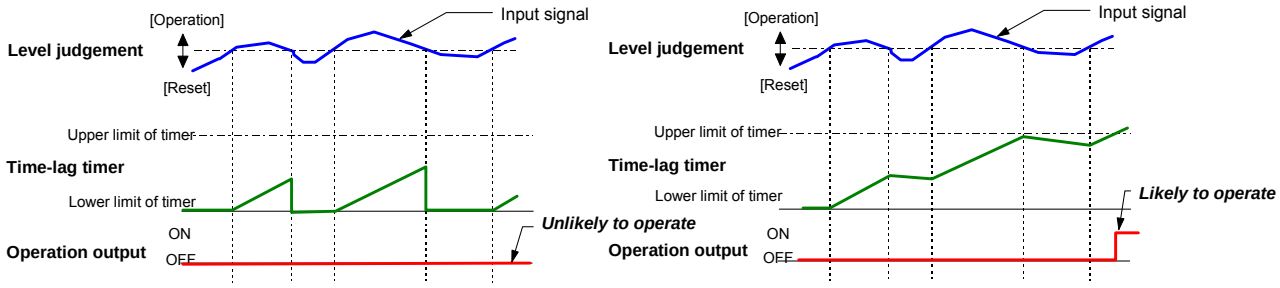


Figure 4.2 Comparison of relay operation with intermittent overload input between two reset characteristics

(5) Display of elapsed time of time-delayed timer

For the time-delayed elements, the elapsed time of the internal operation timer is indicated in the display. As the elapsed time is counted, operators may imagine the current status of the electromagnetic mechanical induction disc, which will help detect the starting value.

When an input current is detected to have reached the operation setting or more, “0” will appear in the display. Counting will be made by dividing the operation time equally into ten parts and starting from “1”, “2” to ”9” and “10”. An operation signal will be output as soon as the counter reaches “10”.

4.1.2 Earth fault directional elements

Fig. 4.3 “Earth fault directional element internal function block diagram” shows operation principle of the earth fault directional elements.

The levels of zero-phase current and zero-phase voltage are detected through comparing input current and voltage with the operation setting values. In addition, from the phase relation between zero-phase current and zero-phase voltage the fault direction is distinguished. (see the Fig. 4.4 phase characteristics). When all of these three inputs of AND gate are enable, the element outputs an operation signal after the time-delayed timer expires.

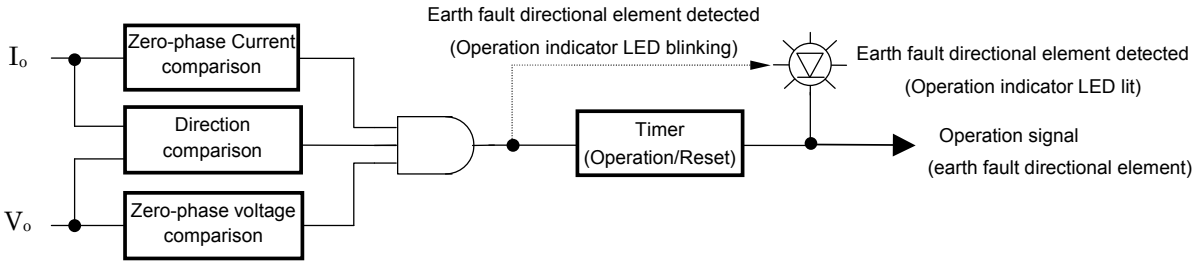


Figure 4.3 Earth fault directional element internal function diagram

(1) Setting of I_0 Operation current

The I_0 operation current settings are indicated with current values [mA].

When the setting “Lock”, the elements selected are locked for operation.

(2) Setting of V_0 Operation voltage

The V_0 operation voltage settings are indicated with voltage values [V].

When the setting “Lock”, the elements selected are locked for operation.

(3) Setting of operation time

The operation time settings are indicated with time value [s].

(4) Setting of characteristic angle

The characteristic angle settings are indicated with angle value [°].

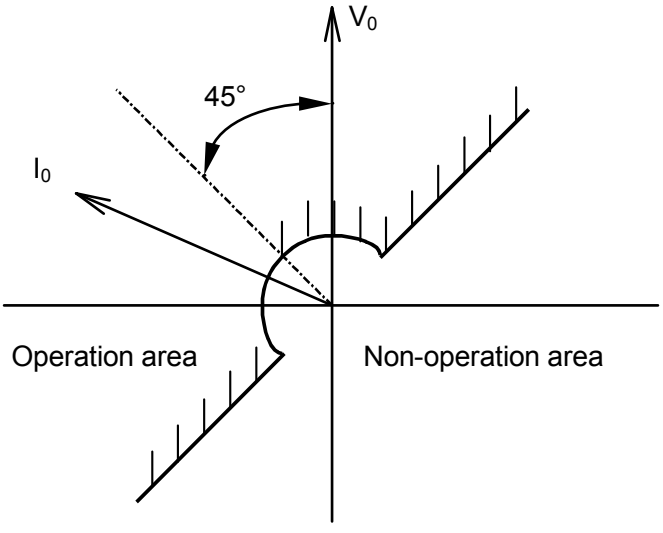


Figure 4.4 Phase characteristic of earth fault directional element

characteristic angle: 45° setting)

(5) ZCT error correction

This protection relay provides a function that it can correct the error of ZCT transformation ratio. Through this function improving relay's composite characteristic is achieved. ZCT having transformation ratio within range of 200mA/1.5mA ~ 4.1mA (±0 ~ +2.6mA) can be used with this relay together. Here, ZCT error is corrected based on nominal transformation ratio 200mA / 1.5mA of specification JEC-1201.

If an enable status of ZCT error correction was desired, it is necessary to remember the ZCT secondary effective current value by holding a 200mA rated zero-phase current into ZCT connected with relay at first. And then, after setting the error correction status "on", the I_0 can be corrected according to the following contents and formulas: (reference the "General operation manual", please)

a. The correction of I_0 measurement indication value

A ZCT error correction concept of I_0 measurement indication value is shown in Figure 4.5 and the below formula. Through time the relay input current value by ZCT actual measured ratio it is realized to access to an input and output linearity characteristic which is necessary for meter function to display the I_0 measurement indication value.

Note: The max. measurement indication value is 600mA (Values more than 600mA will be displayed at 600mA).

I_0 measurement indication value (primary conversion)

=(Relay I_0 input current)×(ZCT actual measurement ratio)

=(Relay I_0 input current)×(200/ZCT 2ry output actual measured value)

b. The correction of I_0 operation setting value

A ZCT error correction concept of I_0 operation setting value is shown in Figure 4.5 and the below formula. In order to achieve the correction target that when input 200mA into ZCT primary the relay can operate correctly with 1.5mA setting, to add the difference value (correction value of operation setting) between actual measured value and 1.5mA upon the operation setting value to access to error correction.

Note: For the other setting except 1.5mA, due to the same correction value of operation setting be added, therefore there are differential correction errors with differential setting value. And it also brings correction error for the I_0 measurement indication value described in above a. Please pay attention to.

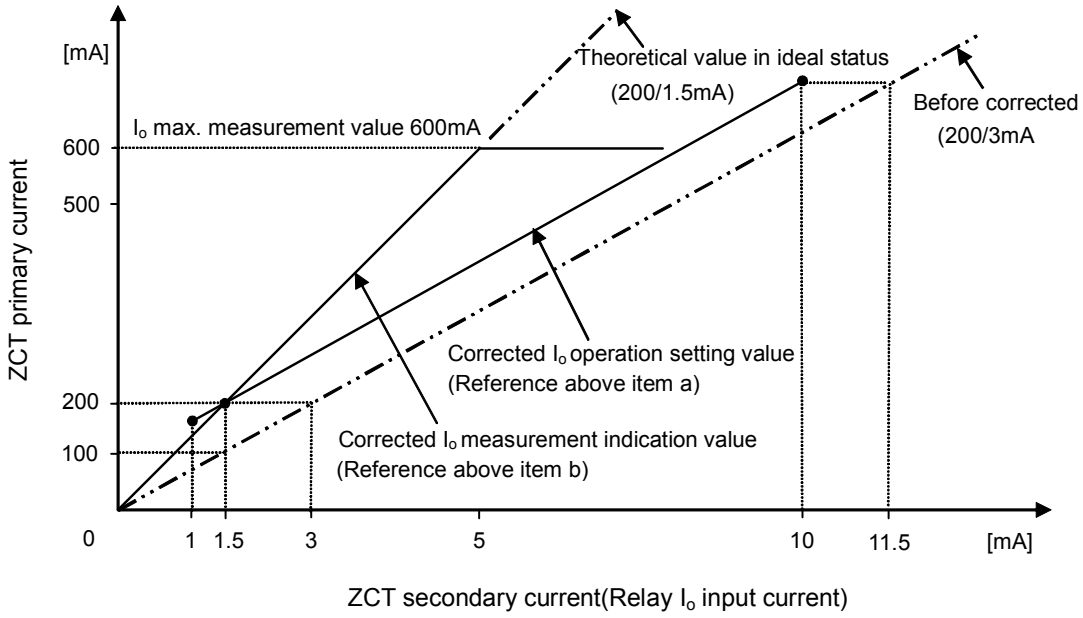
I_0 operation value (primary conversuion)

$= \{(I_0 \text{ operation setting value}) + (\text{operation setting correction value})\} \times (\text{ZCT actual measured ratio})$

$= \{(I_0 \text{ operation setting value}) + (\text{ZCT 2ry actual measured value} - 1.5)\} \times (200/\text{ZCT 2ry actual measured value})$

⚠ In CFP1-A02 type, since the sensitivity for input current is low and 1/10 of CFP1-A01 type. The input at the time of adjustment needs to set at 2A which is 10 times the CFP1-A01 type. In adjustment, please transpose all the above-mentioned current values to one 10 times the value of them.

The maximum measurement range is 6A also 10 times the above-mentioned value.



ZCT secondary [mA]			ZCT primary [mA]				
Operation setting value			Theoretical value	Measurement indication value		Operation value	
Corrected		No corrected		No corrected	Corrected	No corrected	Corrected
1.0	->	2.5	133.3	66.67(-50%)	133.3 (± 0%)	66.67(-50%)	166.7(+25%)
1.5	->	3.0	200	100 (-50%)	200 (± 0%)	100 (-50%)	200 (± 0%)
2.0	->	3.5	266.7	133.3(-50%)	266.7 (± 0%)	133.3(-50%)	233.3(-12.5%)
5.0	->	6.5	666.7	333.3(-50%)	>600	333.3(-50%)	433.3(-34%)
10	->	11.5	1333.3	666.7(-50%)	>600	666.7(-50%)	766.7(-42.5%)

Figure 4.5 ZCT error correction concept (Example: correction for 200/3mA product)

If an unavailable status of ZCT error correction was desired, please set the error correction status "oF".

Note: the ZCT secondary actual measurement value is set at 1.5mA and the ZCT error correction status is set at "oF" in advance before shipment.

⚠ In CFP1-A02 type, since the sensitivity for input current is low and 1/10 of CFP1-A01 type.

In adjustment, please transpose all the above-mentioned current values to one 10 times the value of them.

4.1.3 General functions

(1) Operation display

For the time-delayed element, when the input current becomes larger than the operation setting, the corresponding operation indicator LED will blink to allow you check the starting value.

The LED lamp will come on as soon as an operation output is made when a period of operation time has elapsed.

For the instantaneous element in turn, the LED lamp will come on at the same time when an operation output is made.

The operation indicator LED has been set to “self-hold” in the factory. This setting can be freely changed to “auto reset”.

With the “self-hold” setting, data of the latest operation indication will be stored in the internal memory even if the auxiliary power supply runs down.

The data stored will be cleared when the “indicator reset” switch is pressed.

Up to latest five phenomena can be stored and displayed as a history record. (Older data than the latest five phenomena will automatically be cleared).

Item No.	History	Sequence of recording
311	1st phenomena	Latest fault record data
312	2nd phenomena	↓
313	3rd phenomena	↓
314	4th phenomena	↓
315	5th phenomena	Oldest fault record data

(2) Output contacts

The signaling outputs X_0 to X_3 and trip outputs X_4 and X_5 are all programmable type.

The factory default setting of the arrangement of these outputs is as shown in the internal function block diagram of Figure 5.2. This setting can be freely changed by specifying outputs of the internal elements based on the OR logic.

All the outputs have been set to “auto reset” in the factory. Any of them can be changed to “self hold”.

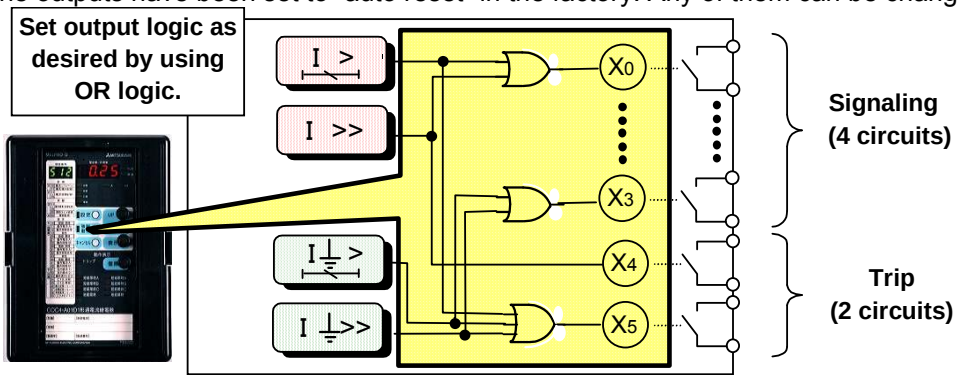


Figure 4.6 Schematic image of Programmable Outputs (example: COC4-A01)

(3) Forced operation

It is possible to carry out forced operation of any of the signaling outputs X_0 to X_3 and trip outputs X_4 and X_5 independently. Forced operation is useful for checking the wiring.

When forced operation is carried out, the corresponding LED lamps will come on to show the current status of the programmable outputs. Checking the lamp status will be useful not only for wiring check but also to check the programmable outputs arrangement.

4.2 Measurement

Currents input to the relay are measured and converted into freely set CT primary currents, then indicated on the display.

(1) Real time measurement

The effective values of input current and 2f ratio are displayed for each phase.

(2) Max. record

The maximum effective current is recorded and stored for each phase.

The max. record will be all cleared when “aux. power supply OFF” or “max. record reset” operation is made.

(3) Fault record

In the event of system fault, the effective current and waveform data that have been measured at the time when one of the protection elements operates to issue an output signal are stored. Data of up to five phenomena can be stored and displayed for each phase.

With “aux. power supply OFF”, only the waveform data will be cleared and the effective current data will remain. With “fault record reset” operation, however, both of the data items will be all cleared.

(Records older than the 5th phenomenon will automatically be cleared.)

Item No.	History	Sequence of recording
211	1st phenomena	Latest fault record data
212	2nd phenomena	↓
213	3rd phenomena	↓
214	4th phenomena	↓
215	5th phenomena	Oldest fault record data

The following fault wave form data can be collected if a communication card is installed:

Item	Specification
Data sampling cycle	Fixed to the electric angle of 30°of rated frequency
Data storing capacity (for a phenomenon)	224 cycles of rated frequency (Data point: 224×360°/30° = 2688 points)
Permissible setting range	224 cycles before trip ~ 224 cycles after trip
Collected data	The range for data collection can be set by cycle within the “data storing capacity” in the “permissible set range”.

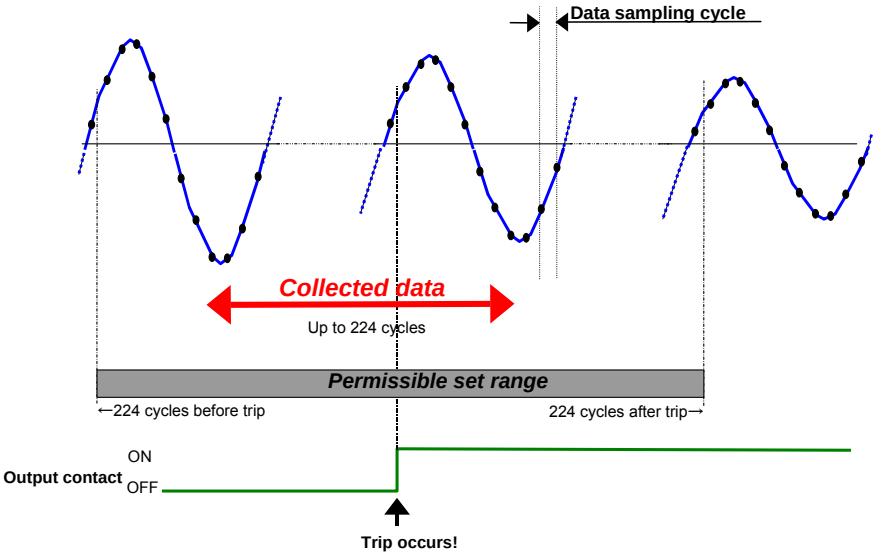


Figure 4.7 Concept of recording fault waveform

4.3 Self-diagnosis

The self-diagnosis function monitors the electronic circuit and built-in power source continuously. If an abnormal condition occurs, the protection elements will be locked for operation. Also, the RUN LED lamp will go off and the self-diagnosis output contact (break contact) will be closed.

(1) Checking defect code at failure detection

When a failure is detected, the defect code will be recorded. This defect code can be checked through the self-diagnosis (ALARM) status indication.

(2) Resetting self-diagnosis output

If a failure is detected, **the failure status may be reset by turning off/on the power**.

In this case, **be sure to lock the trip circuit on the external wiring of the relay** before resetting. (If the failure persists, an erroneous output may be caused).

(3) Clearing the defect code

The defect code data stored at failure detection can not be cleared only by carrying out the power on/off procedure in the item (2) above. All the defect code numbers that have been detected since the previous "self-diagnosis reset" (RESET ALARM) operation was made are accumulated in the memory. **To clear the record data, carry out "self-diagnosis reset" (RESET ALARM) operation**.

Table 4.1 Output for protection relay failures

Status	Detected items	Output			
		Display		ALARM (break contact)	Operation output lock
		RUN	Defect code		
Normal	—	On	No display	Open	Not locked
Power circuit failure	—	Off		Closed	Locked
CPU failure	—				＊45
Monitor error	ROM check		0001		Locked
	RAM check		0002		
	A/D accuracy check		0003		
	A/I check		0004		
	A/D check		0005		
	SRAM check		0006		
	D/O status check		0008		
	D/O operation check		0009		
	Analog filter check		0010		
	A/I double check		0011		
	D/I check ＊41		0012		
	E^2PROM check		0013		
	Computing function check		0014		
	WDT check		0015		
	Data transfer check ＊42		0016		
	Differential current check ＊43		0017		
	Communication card check ＊44	On	0028	Open	Not locked
	Communication card channel No. switch setting error ＊44		0029		
	Communication card baud rate switch setting error ＊44		0030		
	Communication card channel No. switch change error ＊44		0031		
	Communication card baud rate switch change error ＊44		0032		

＊41 Monitored only in the models with built-in D/I function.
＊42 Monitored only in the models with D2 unit.
＊43 Monitored only the biased differential relay.
＊44 Monitored only when the relay is installed with communication card.
＊45 No necessary to lock the operation output as any signals can't be output in case of CPU stop.

4.4 Communication

Figure 4.8 shows an example of network system configuration.

For more information on the communication facilities, see the materials shown in the introduction (page 2):

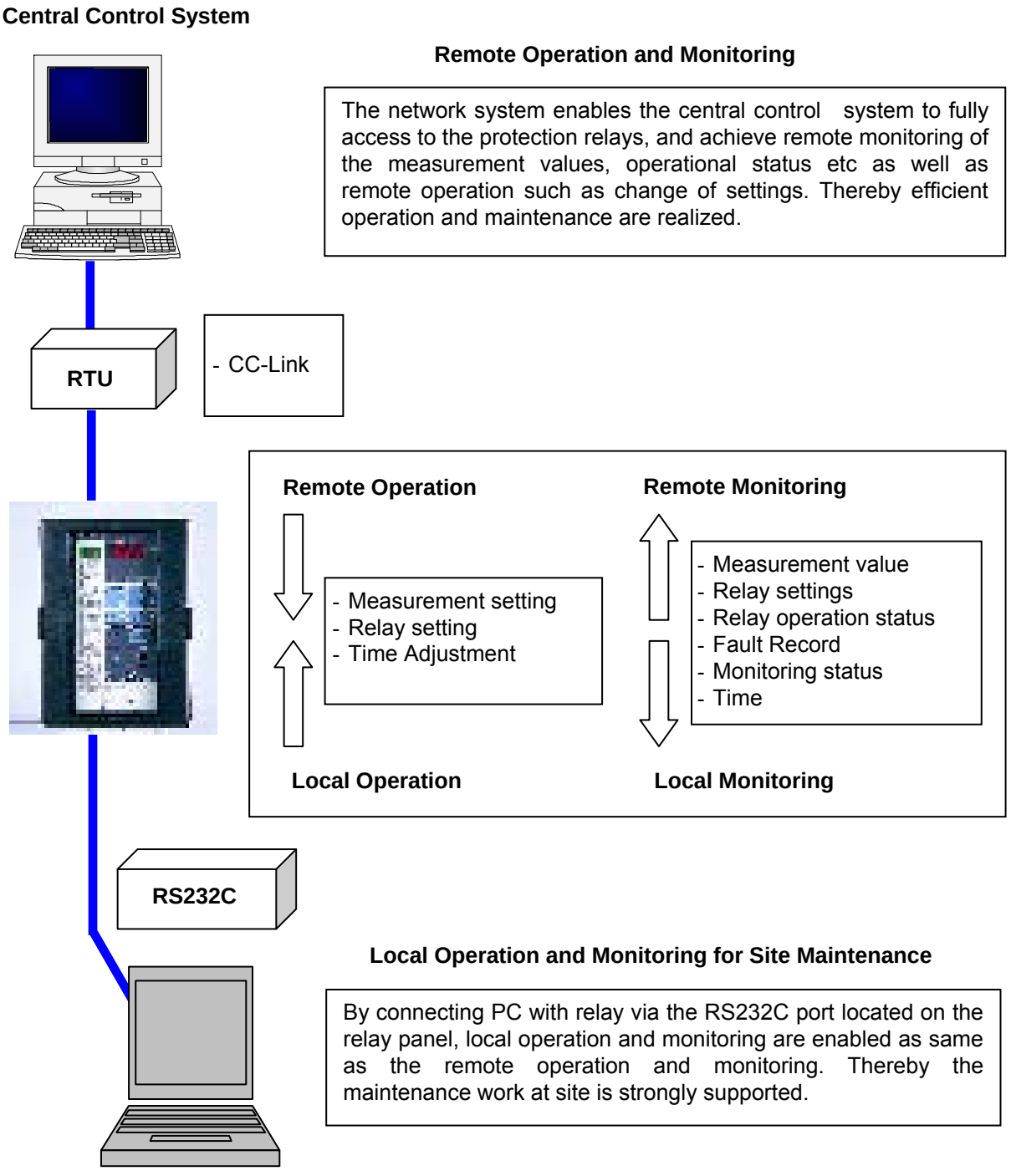


Figure 4.8 Example of communication network system configuration

Using the communication facilitates, it is possible to perform Remote Monitoring and Remote Operation with the various useful functions shown in Table 4.2.

Table 4.2 Outline of functions enabled by communication network

Direction of communication	Item	Description
Remote Monitoring RTU ⇐ Protection relay	Setting	Read the settings stored in the protection relay.
	Measurement	Read the measurements stored in the protection relay.
	Max. value	Read the max. values stored in the protection relay.
	Fault record	Read the measurements at the time of trip.
	Self-diagnosis (ALARM)	Read the result of self-diagnosis.
	Operation element	Read the elements that operated at the time of trip.
	Operation time	Read the time at the time of trip.
	Current time	Read the internal time of the communication card.
	Waveform record	Read the wave form at the time of trip.
Remote Operation RTU ⇒ Protection relay	Setting	Change the setting of the protection relay.
	Indicator reset	Reset the LED lamp that came on at the time of trip.
	Self-diagnosis (ALARM) reset	Clear the result of self-diagnosis.
	Fault record reset	Clear the fault record, operation elements and operation time data.
	Max. record reset	Clear the max. record.
	Forced operation	Carry out forced operation of output contact.
	Time	Set time of communicate card.

5 Configuration

5.1 Internal configuration

(1) I/O and CPU circuits

Fig. 5.1 shows the internal block diagram of the model CFP1-A02D1.

Current and voltage inputs are converted into AC signals at the electronic circuit level via the auxiliary transformer and filter circuits. These signals are retained as a form of DC signal in the sample hold circuit on each channel sharing a same time. The multiplexer selects a channel to take the signal and sends it to an A/D converter. The signals are converted to digital signals sequentially in the converter to be sent to the CPU.

The setting circuit is used to input setting data into the CPU.

These inputs will be used to carry out the functions shown in Fig. 5.2 “Internal function block diagram”, then issue output signals to the display and output relay.

(2) Self-diagnosis circuit

When the self-diagnosis function detects that the electronic and power circuits are normal, the output relay will be energized to open the self-diagnosis output contact (break contact).

The self-diagnosis output contact (break contact) will be closed when a failure occurs in the circuits above or when the built-in power fuse burns.

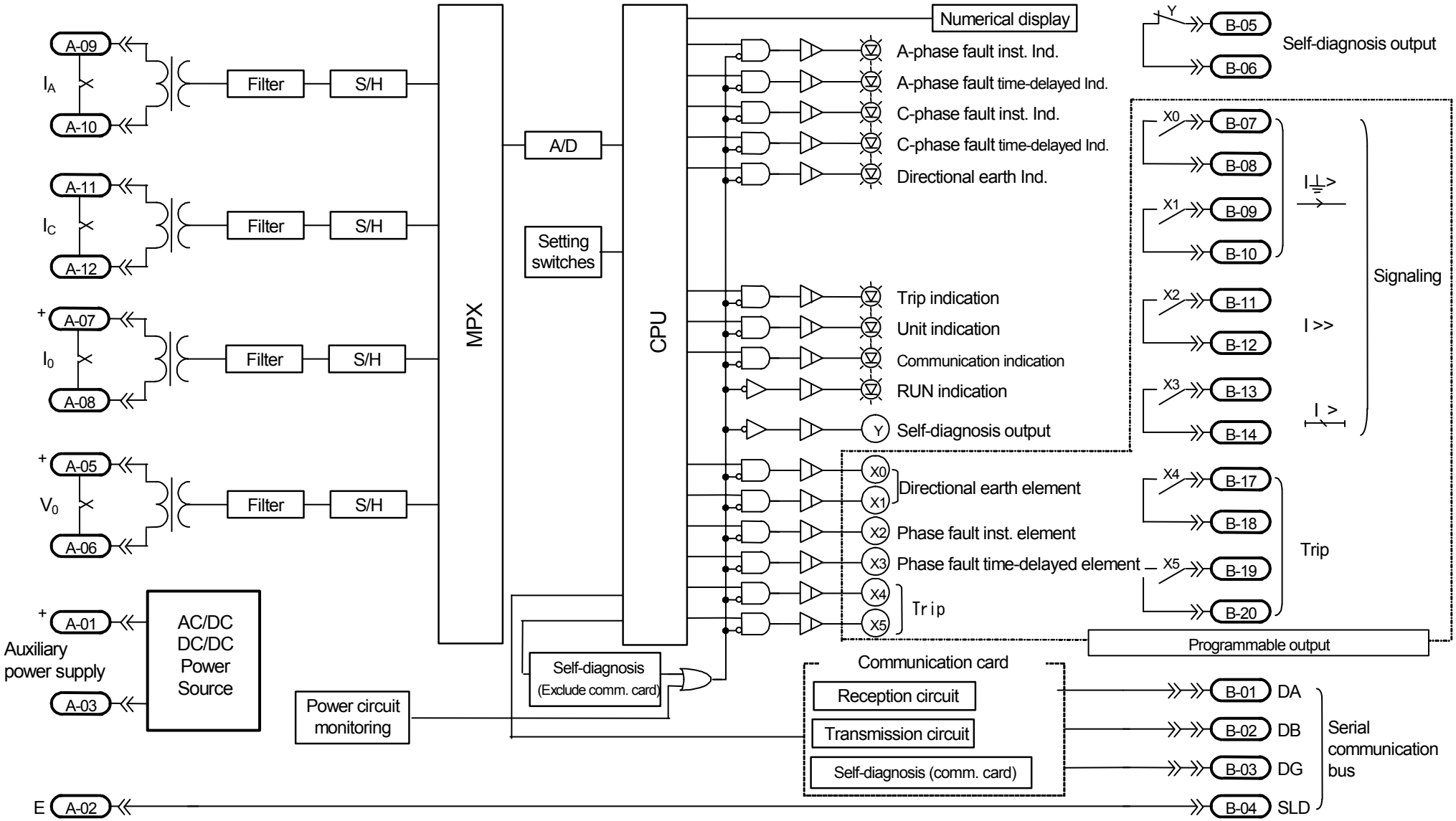


Figure 5.1 Internal block diagram of Type CFP1-A02D1 relay

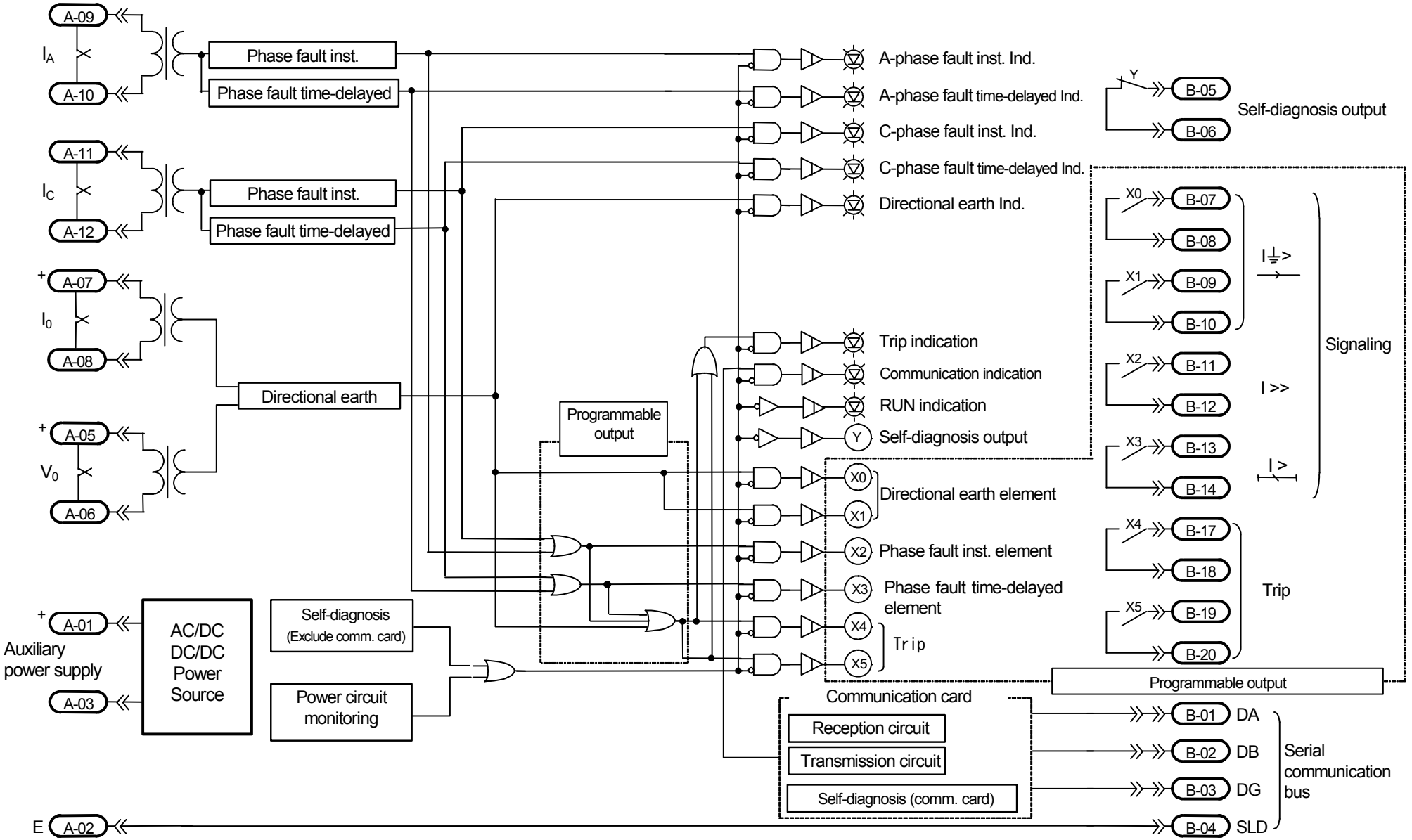


Figure 5.2 Internal function block diagram of Type CFP1-A02D1 relay

5.2 External connection

(1) Connection diagram

Figures 5.4 shows examples of input circuit (AC circuit) connection, Figure 5.5 an example of control circuit (DC circuit) connection and Figure 5.6 a terminal arrangement.

In the terminals, M3.5 screws should be used and wires of 2 mm^2 or less are recommended using.

(2) Precautions for wiring work

a. Important facilities should be provided with fail safe measures such as dual system to improve reliability of the facilities.

b. Effects of external surge

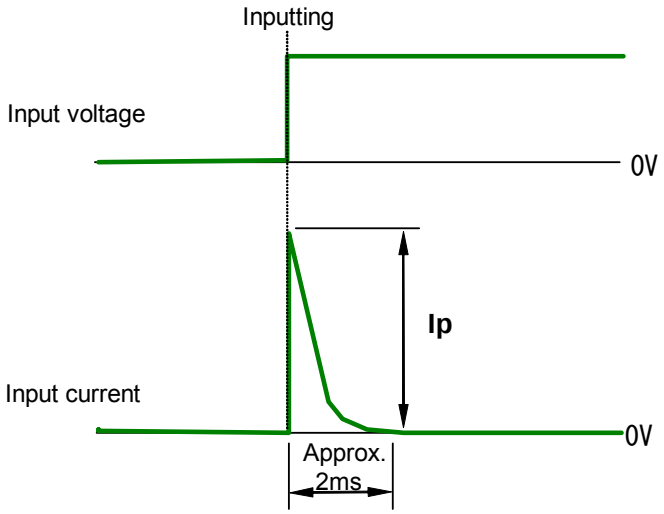
Some type of surge with a certain condition may inversely affect the relay. If so, take it into account to install **MF type surge absorbers made by Mitsubishi Electric**.

c. Guarantee of AC auxiliary power supply against power interruption

The AC auxiliary power supply of the relay is not **guaranteed against power interruption**. When you do not have an uninterruptible AC power source, use an **AC/DC converter of CPS1 type manufactured by Mitsubishi Electric** or uninterruptible power source (UPS) that is commercially available.

d. Inrush current of auxiliary supply

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



Input voltage		Inrush current Ip
DC	110V	**Approx. 20A**
	220V	**Approx. 55A**
AC	100V	**Approx. 25A**
	220V	**Approx. 65A**

Figure 5.3 Inrush current of auxiliary power supply

e. Trip circuit

Only the contacts X_4 and X_5 can be used for the trip circuit. Please keep in mind that the contacts X_0 to X_3 can not 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.

f. Self-diagnosis output circuit

The self-diagnosis output contact is so configured that the auxiliary relay can be energized (break contact) with normal result of monitoring, in order to be able to continue monitoring even if the

built-in power fuse burns. Therefore, connect the timer to the external wiring. (See Fig. 5.5 “DC circuit connection diagram”)

g. Earth circuit

Be sure to earth the earth terminal located on the back of the relay according to the Class D earth wiring method.

h. ZCT circuit

It is necessary to block the surge and noise entry into relays, thus the 2-cores shielded wire (core size 0.75～1mm^2) must be used for connecting ZCT and relay, and must connect the shield wire to earth terminal of relay or panel.

Be sure of that the burden of shielded wire with two-way must be less than 5Ω.

(Such as: for 0.75mm^2 wire, approx 100m by one-way)

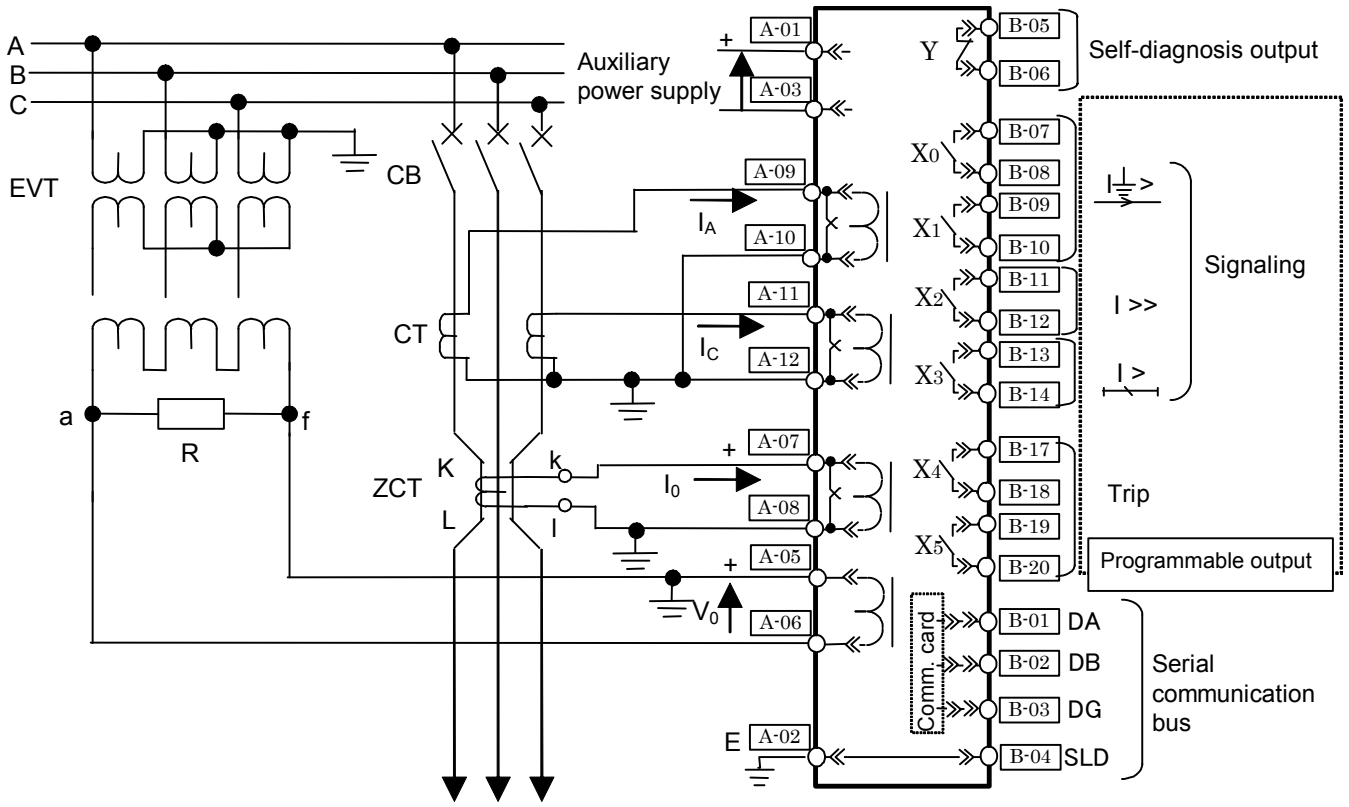
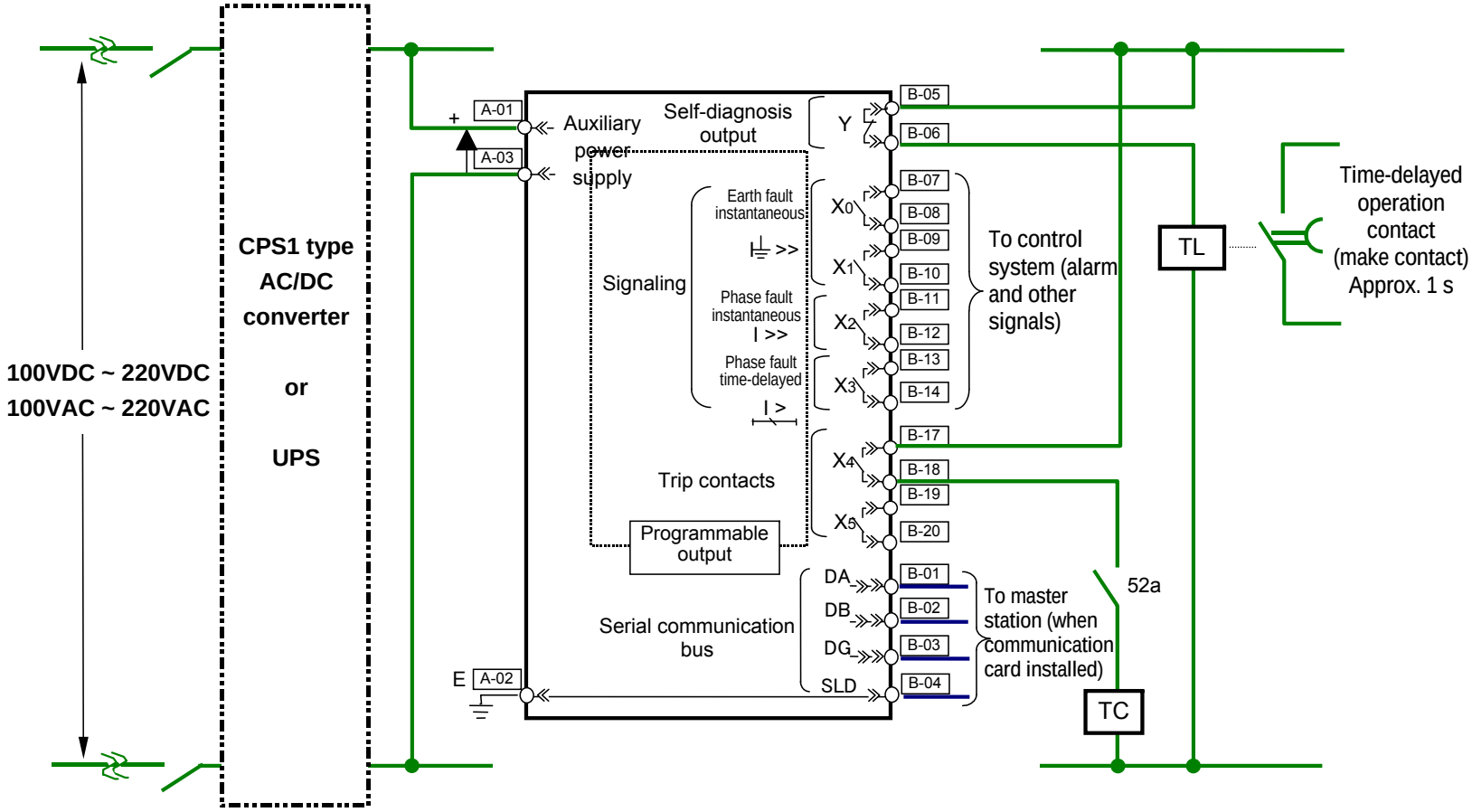


Figure 5.4 External connection diagram for CFP1-A02D1 relay



Note 1) The self-diagnosis output contact is so configured that the auxiliary relay can be energized ("break contact" opened) when normal result of self-diagnosis is received. This type of contact will allow the relay to continue automatic self-check even after the built-in power fuse burns. Therefore, the "break contact" is closed when the power is applied and will be opened after about 50ms. If the auxiliary power supply of the relay and the self-diagnosis output contact shares a same power source, **the "break contact" will be closed temporarily after the auxiliary power supply is turned on**. In the case where the phenomenon stated in the above would conflict with your system requirement, it is recommended that the self-diagnosis output contact should be **connected via the time-delayed timer** as shown in the left of the figure.

Note 2) Regarding to the type CPS1 AC/DC converter or commercially available uninterruptible power supply (UPS), refer to the note *21 in the section 2.1 General information.

Figure 5.5 Auxiliary supply circuit connection example of type CFP1-A02D1 relay

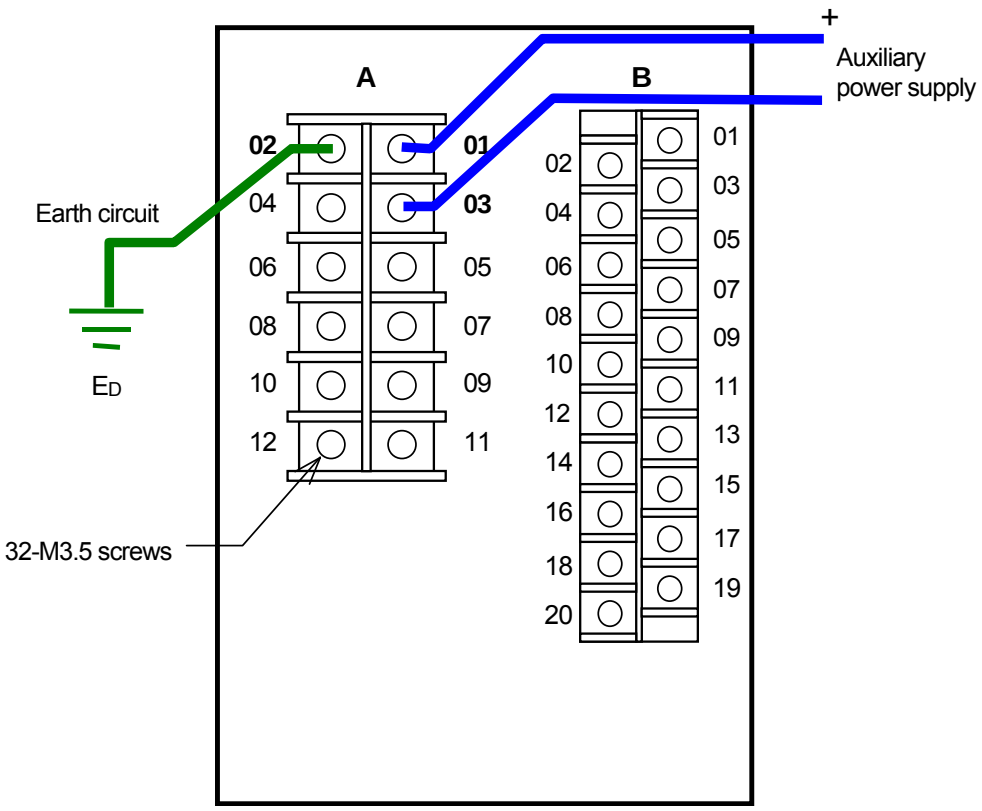


Figure 5.6 Rear view of type CFP1-A02D1 relay

6 Handling

6.1 Unpacking

Usually this relay is packed in a D1 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.

6.2 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.

6.3 Appearance and how to pull sub unit out

The relay is so constructed that the sub unit can be drawn out, in order to facilitate inspection or test. It is possible to pull the sub unit out without disconnecting the external wiring.

Note that the sub unit should not be drawn out with the line hot. Before drawing out, be sure to take the following actions.

- Lock the tripping circuit including breakers.
- Stop the main circuit.
- Shorten and isolate the CT circuit.
- Open the auxiliary power supply circuit.

Bear in mind that careless opening of circuits may result in opening the other control circuits too to impair the protective function. Be sure to only shut off the concerned circuit.

The CT circuit is provided with an automatic short circuit mechanism. In case that you have pulled the sub unit out without isolating the CT circuit by mistake, the automatic short circuit mechanism will work to prevent the CT secondary circuit from opening.

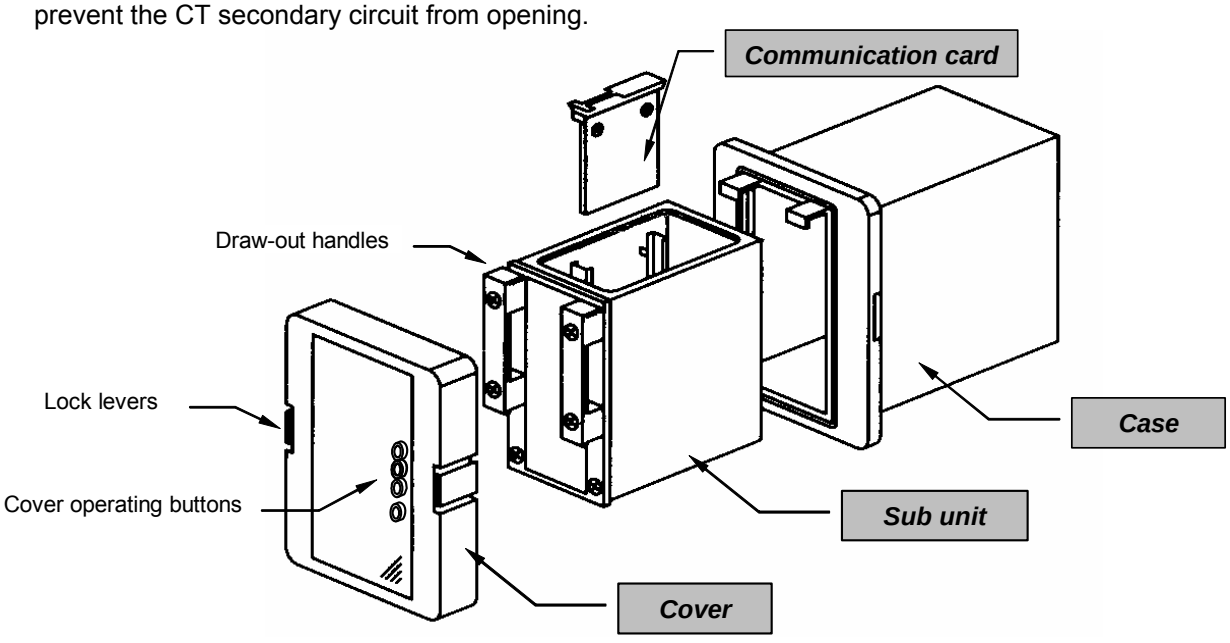
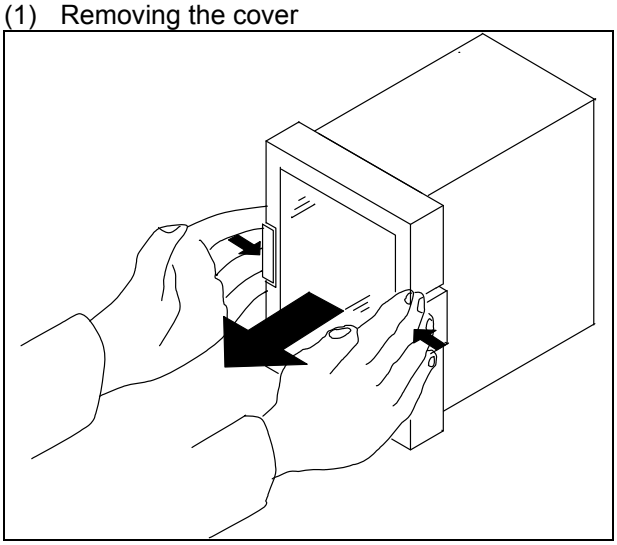


Figure 6.1 Outside view of type CFP1-A02D1 relay

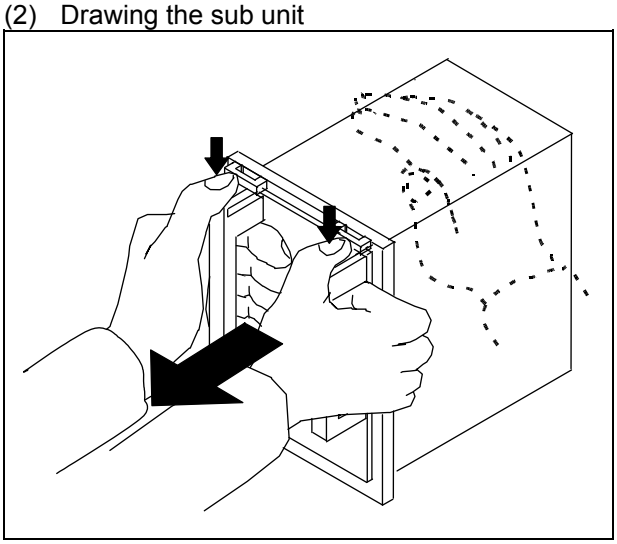
6.3.1 How to draw sub unit out

(1) Removing the cover



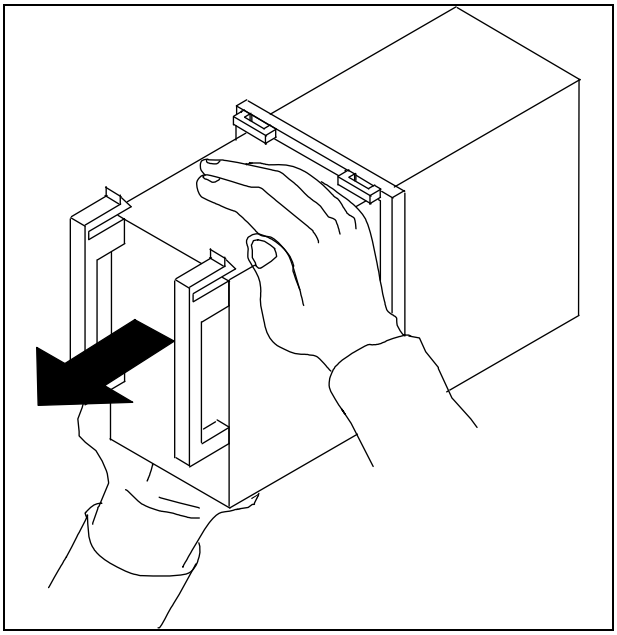
Hold the **lock levers**, which are located at both sides of the cover, on their front sections. Take off the cover **straight toward you** while pushing the levers **inwards**.

(2) Drawing the sub unit



Grip the draw-out handles (located at both sides of the front of the sub unit). **Press the locking pieces installed in the upper portion of the draw-out handles with your thumbs to pull the sub unit towards you.**

Note) The sub unit is so designed that it can not be removed unless it is pulled out with a relatively strong force, in consideration of quake-proof measures. When the relay unit is to be removed independently, it is recommended to draw it out with the case held by other operator.

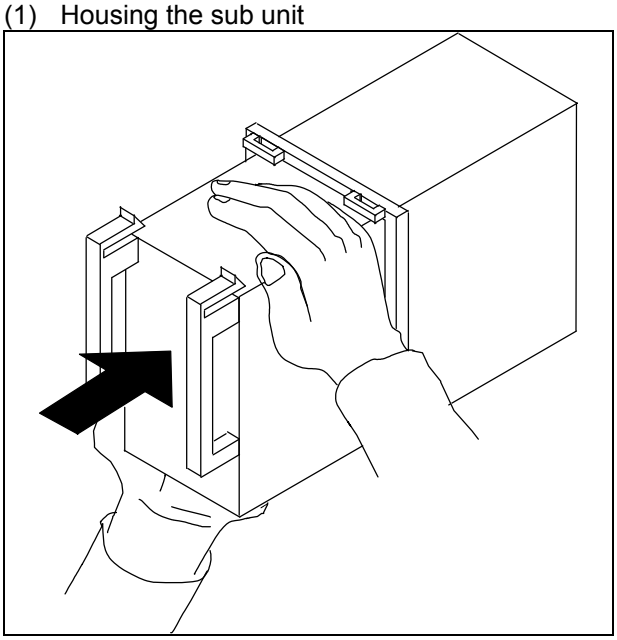


When about a half portion of the sub unit is pulled out of the case, just stop the drawing motion. Then, **hold the top and bottom of the sub unit to pull it out completely**, in order to prevent the unit from falling.

Note) Be careful not to touch the printed circuit board and parts inside the sub unit.

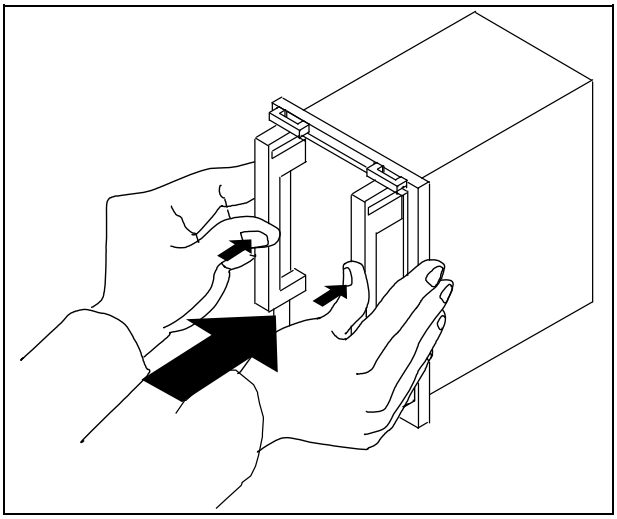
6.3.2 Housing the sub unit

(1) Housing the sub unit



Hold the sub unit on the top and bottom to push the unit into the case approx. a half of the unit.

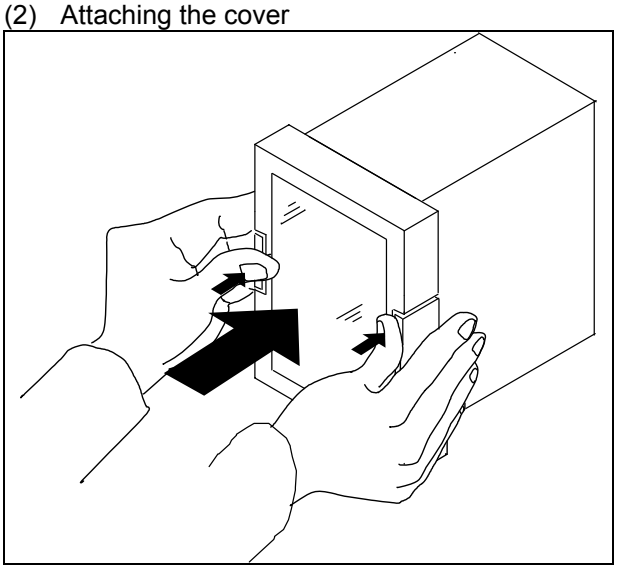
Note)
- Be careful not to touch the PCB and parts inside the sub unit.
- The sub unit is so constructed that it can not be housed in the case upside down.



Fully insert the sub unit into the case until you hear a click while pressing the handles located on both sides of the front of the sub unit.

Note) Please note that inserting the sub-unit incompletely may only establish a poor contact of the terminals located on the back of the unit, which may cause operational failure or heating.

(2) Attaching the cover



Fit the cover straight to the case. Hold the cover frame to **fully push the cover until it is clicked** and locked.

Note) After setting the cover, check if the buttons can be smoothly pressed from over the cover.

6.4 How to use front control panel

6.4.1 Front control panel layout

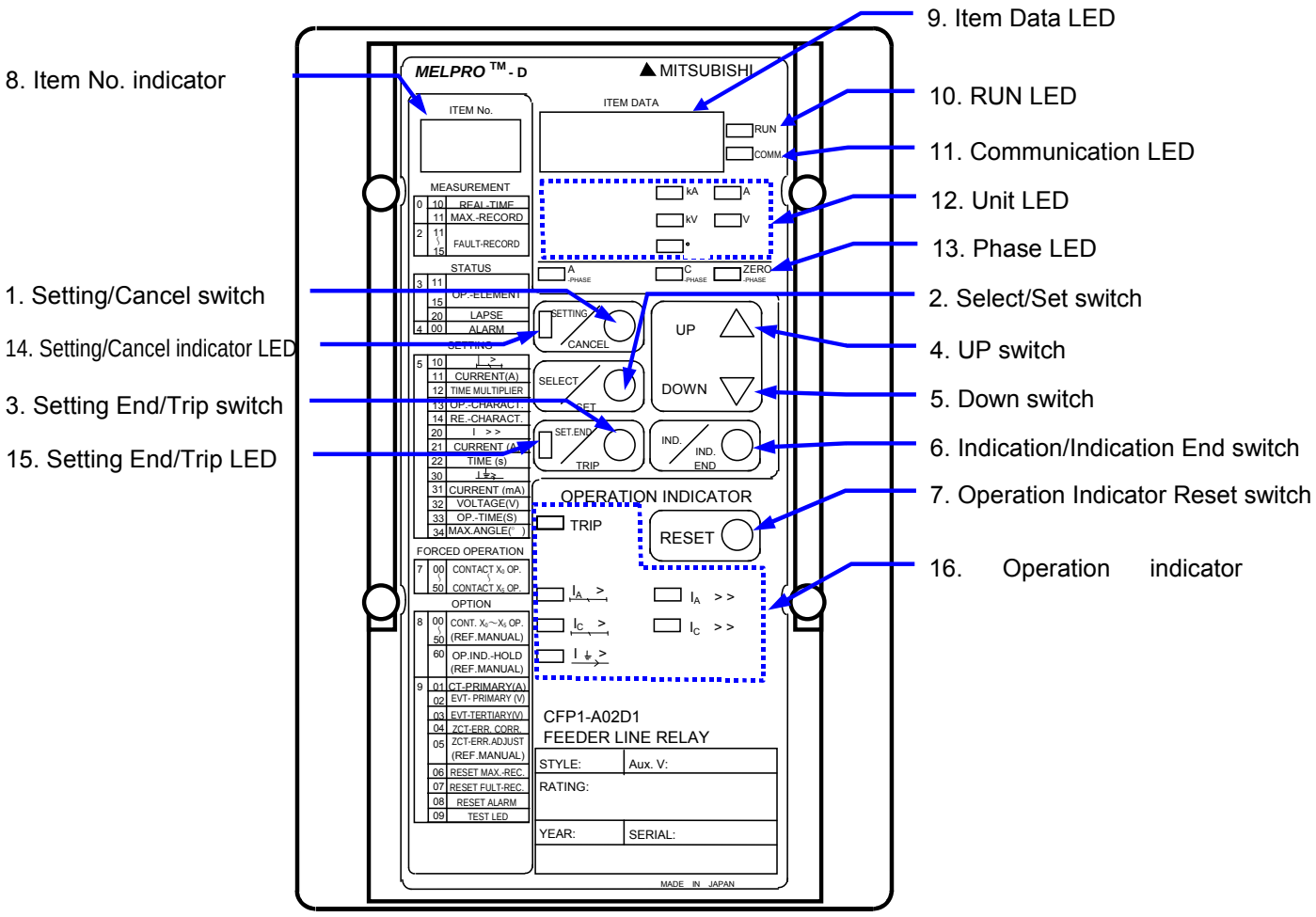
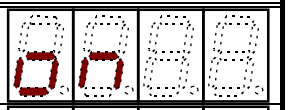
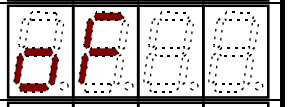
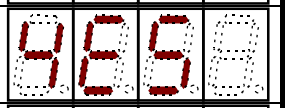
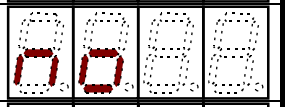
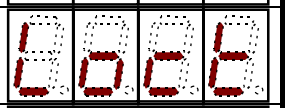
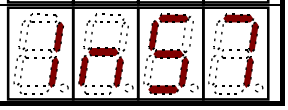


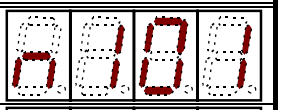
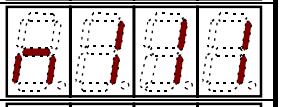
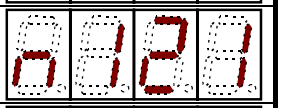
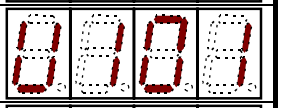
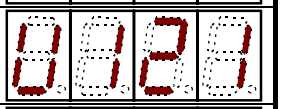
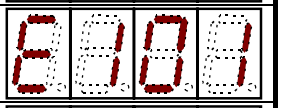
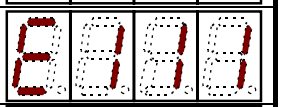
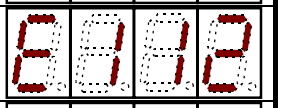
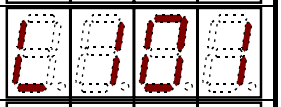
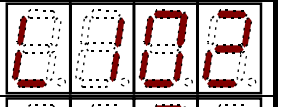
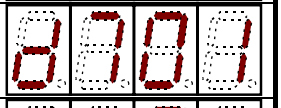
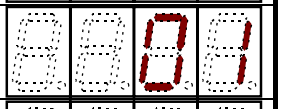
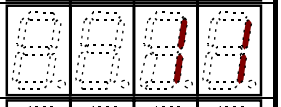
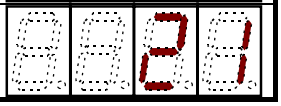
Figure 6.2 Front view of type CFP1-A02D1 relay

Table 6.1 Front control panel guide

No.	Designation			Symbol	Description
1	Operational key switches	Setting / Cancel		SETTING/CANCEL	Pressing this switch will start the procedure for setting, forced operation or option. When this switch is pressed again instead of the SET.END/TRIP switch, data that has been programmed will be all cleared to terminate the selected procedure. The SETTING/CANCEL indicator LED is lit during the procedure.
2		Select / Set		SELECT/SET	This switch is used to select an item number and to program item data during setting, forced operation or option procedure. When data is programmed to be ready for replacing the currently used setting, the SET.END/TRIP LED will blink.
3		Setting End / Trip		SET. END/TRIP	When the SET.END/TRIP switch is pressed with its LED blinking during setting, forced operation or option procedure, the currently enabled setting will be replaced by data given by programming. The new setting will be thus enabled.
4		UP select		UP	These switches are used for selecting data elements. Pressing these switches for a while will allow fast forwarding. With the cover operating buttons, you can use the switches without removing the cover.
5		DOWN select		DOWN	
6		Indication / Indication End		IND./IND.END	Pressing this switch will start or end the display of settings and measurements. With the cover operating button, you can use the switch without removing the cover.
7		Reset		RESET	Pressing this switch will reset output contacts after the relay operated and extinguish the operation indicator LEDs. With the cover operating button, you can use the switch without removing the cover.
8	Indicator LEDs	Item No.	Green	–	A number allocated to the selected setting, forced operation or option item is indicated here.
9		Item Data	Red	–	Data that corresponds to the item number selected is displayed here. For the indication of individual letters, see the Table 6.2.
10		RUN	Green	–	Indicate the result of the automatic self-check. The lamp will be lit for normal results while off for abnormal.
11		Communication	Green	–	Indicate the operational status of the communication card. - With a communication card installed: the lamp will be lit for normal conditions, blinking during communication and off for abnormal conditions. - With a communication card not installed: the lamp will be off.
12		Unit	Yellow	–	Indicate the unit used for the item data.
13		Phase	Yellow	–	Indicate the phase that corresponds to the item data.
14		Setting / Cancel	Yellow	–	This lamp will be lit during setting, forced operation or option procedure.
15		Setting End / Trip	Yellow	–	This lamp will blink when new data is programmed to be ready for replacing the currently enabled setting.
16		Operation	Red	–	Indicate the corresponding operation elements and phases of the relay.

Table 6.2 Letter representation of item data indicator LEDs

Item		Display in item data box
Designation	Letters	
On	ON	
Off	OFF	
Yes	YES	
No	NO	
Operation lock	LOCK	
Instantaneous	INST	

Item			Display in item data box
Designation		Letters	
Operation characteristics	Normal inverse time-delayed	NI01	
		NI11	
		NI21	
	Very inverse time-delayed	VI01	
		VI21	
	Extremely inverse time-delayed	EI01	
		EI11	
		EI12	
	Long inverse time-delayed	LI01	
		LI02	
		LI21	
	Definite time-delayed	DT01	
Reset characteristics	Definite time-delayed	01	
	Inverse time-delayed	11	
	Definite time-delayed	21	

6.4.2 Operational procedure

For more information about the operational procedure shown below, see the MELPRO-D Series General Operation Manual (JEP0-IL9416).

6.4.2.1 Relay without RS232C communication I/F

Table 6.3 Operational procedure

Item					Corresponding section of general operation manual	
No.	Designation			Description	Indication mode	Setting/forced operation/option mode
010	Measurement	Real time		Measure and display effective input value of current / voltage / phase at real time.	A-1	
011		Max. records		Display the max. effective current value.	A-2	
211		Fault record	1st phenomena	Record and display effective value of current /voltage/phase for up to 5 latest phenomena of relay trip caused by system fault. The 1st phenomena is the latest trip and the 5th the oldest one.	A-3	
212			2nd phenomena			
213			3rd phenomena			
214			4th phenomena			
215			5th phenomena			
311	Status	Operation elements	1st phenomena	Record and display the status of the operation indicator LEDs for up to five latest phenomena of relay trip caused by system fault. The 1st phenomena is the latest trip and the 5th the oldest one.	A-4	
312			2nd phenomena			
313			3rd phenomena			
314			4th phenomena			
315			5th phenomena			
320		Elapse of time-delayed timer (LAPSE)		Display the count of the elapsed time of operation of time-delayed elements.	A-5	
400		Self-diagnosis (ALARM)		Keep in record and display defect codes in the case where an abnormal condition is detected by the self-diagnosis.	A-6	
511	Settings	Phase fault	Time-delayed	Operation current [A]	Set and display settings.	A-7	B-1
512				Operation time multiplier			
513				Operation characteristic			
514				Reset characteristic			
521			Instantaneous	Operation current [A]			
522				Operation time [s]			
531		E - fault Direction		Operation current [mA]			
532				Operation voltage [V]			
533				Operation time [s]			
534				Characteristic angle [°]			
700	Forced operation	Contact X_0 operation		Carry out forced operation of output contacts individually. The setting of the programmable outputs can be checked through the operation indicator LEDs.		C-1
710		Contact X_1 operation				
720		Contact X_2 operation				
730		Contact X_3 operation				
740		Contact X_4 operation				
750		Contact X_5 operation				
800	Option	Contact arrangement	Contact X_0	Configure the programmable outputs. Also, set and display self-hold/reset setting of the programmable outputs. For the guide for setting, see the section 6.4.2.3 (1) below.	A-7	D-1
810			Contact X_1			
820			Contact X_2			
830			Contact X_3			
840			Contact X_4			
850			Contact X_5			
860		Operation indicator LED hold		Set and display self-hold/auto reset setting of the operation indicator LEDs. For the guide for setting, see the section 6.4.2.3 (2) below.		D-2
901		CT primary side [A]		Set the CT primary current of the phase circuit.		D-3
902		EVT primary side [V]		Set the EVT primary voltage of the zero-phase.		
903		EVT tertiary side [V]		Set the EVT tertiary voltage of the zero-phase.		
904		ZCT error correction option		Set the ZCT error correction on/off status.		D-7
905		ZCT error adjustment		Set the ZCT error correction value.		D-6
906		Max. record reset		Clear the data of the max. records.		D-4
907		Fault record reset		Clear the data of the fault records.		
908		Self-diagnosis (ALARM) reset		Clear data of the self-diagnosis records.		
909		LED lamp test		Carry out forced illumination of all the LED lamps on the front of the relay unit.		D-5

6.4.2.2 Relay with RS232C communication I/F

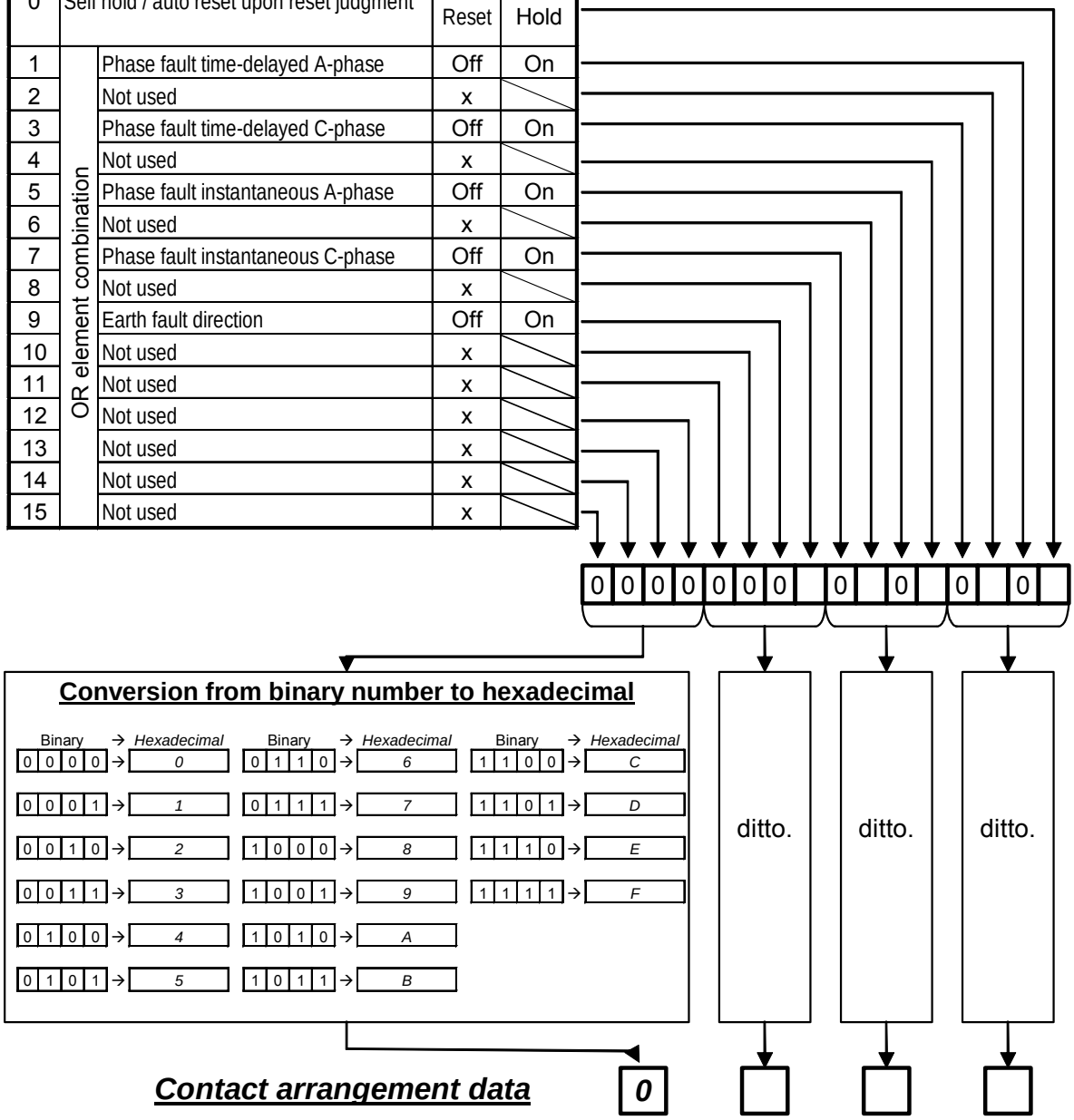
Item				Corresponding section of general operation manual	
No.		Designation	Description	Indication mode	Setting / forced operation / option mode
As the same as Table 6.3 described in item 6.4.2.1 about the No. 010~860.					
901	Option	CT primary side [A]	Set the CT primary current of the phase circuit.	A-7	D-3
902		EVT primary side [V]	Set the EVT primary voltage of the zero-phase.		
903		EVT tertiary side [V]	Set the EVT tertiary voltage of the zero-phase.		
904		ZCT error correction option	Set the ZCT error correction on/off status.		D-7
905		ZCT error adjustment	Set the ZCT error correction value.		D-6
906		Relay password enable/disable option	Set relay password enable or disable for setting.		D-9
907		Max. record reset	Clear data of the max. record.		D-4
908		Fault record reset	Clear data of the fault record.		
909		Self-diagnosis (ALARM) reset	Clear data of the self-diagnosis record.		
910		LED lamp test	Carry out forced illumination of all the LED lamps on the front of the relay unit.		D-5

6.4.2.3 Guide for option function

(1) Specifying contact arrangement data of output contacts

The table below shows the setting guide table. See the section D-1 of the general operation manual for the detailed procedure.

Digit No.	Setting item		Input 0	Input 1
0	Self hold / auto reset upon reset judgment		Reset	Hold
1	OR element combination	Phase fault time-delayed A-phase	Off	On
2		Not used	x	
3		Phase fault time-delayed C-phase	Off	On
4		Not used	x	
5		Phase fault instantaneous A-phase	Off	On
6		Not used	x	
7		Phase fault instantaneous C-phase	Off	On
8		Not used	x	
9		Earth fault direction	Off	On
10		Not used	x	
11		Not used	x	
12		Not used	x	
13		Not used	x	
14		Not used	x	
15		Not used	x	



When the product is shipped from the factory, contact arrangement data are set as follows.

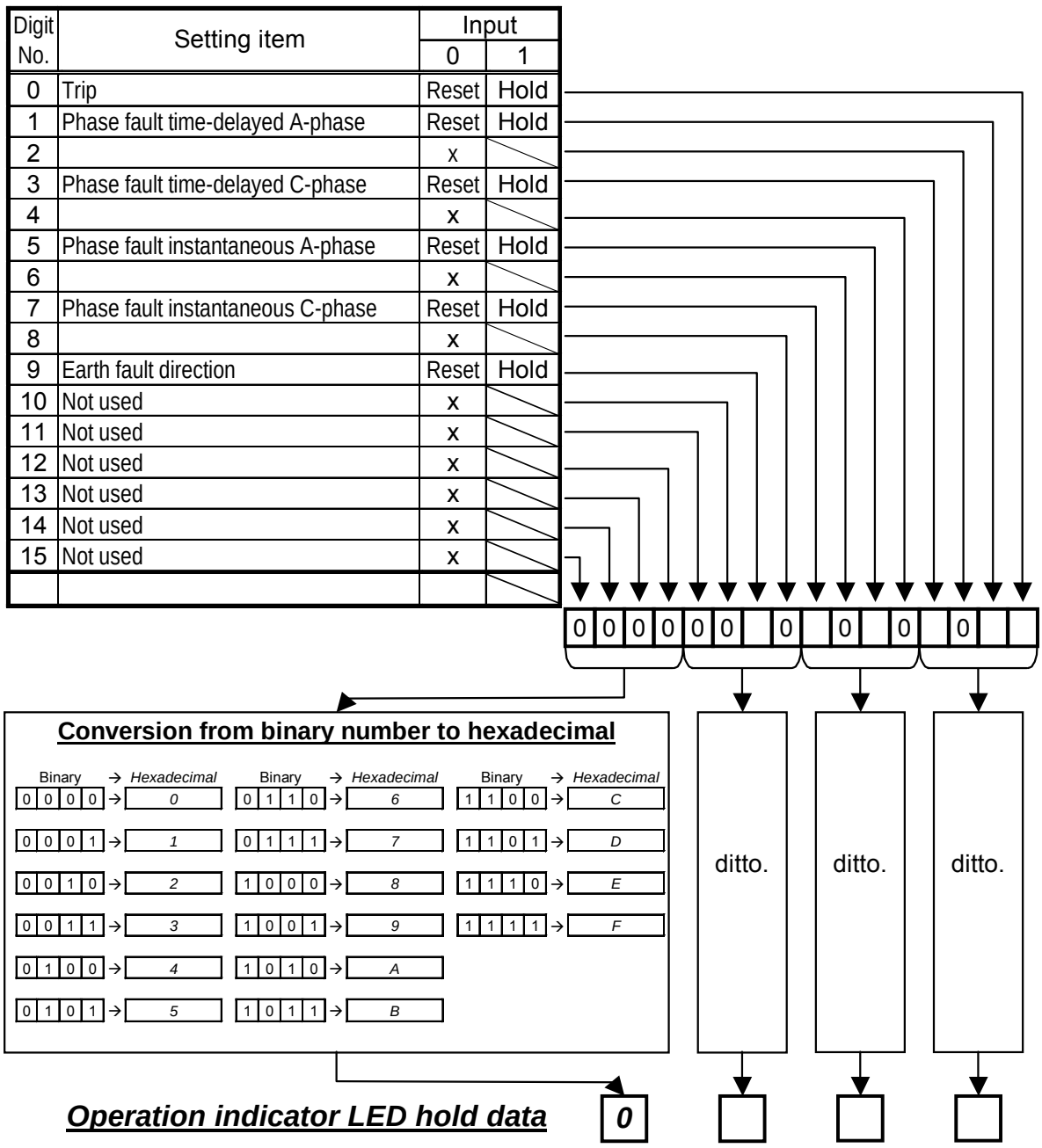
Contact	Item number	Contact arrangement data	Setting of the element	Contact	Item number	Contact arrangement data	Setting of the element
X0	800	0200	Earth fault direction	X3	830	000A	Phase fault time-delayed
X1	810	0200	Earth fault direction	X4	840	02AA	OR of all the elements
X2	820	00A0	Phase fault instantaneous	X5	850	02AA	OR of all the elements

*The “Self hold/auto reset” setting are “Reset” (auto reset) for all contacts.

(2) Specifying operation indicator LED hold data

The table below shows the setting guide table. See the section D-2 in the general operation manual for the detailed procedure.

Digit No.	Setting item	Input 0	Input 1
0	Trip	Reset	Hold
1	Phase fault time-delayed A-phase	Reset	Hold
2		x	
3	Phase fault time-delayed C-phase	Reset	Hold
4		x	
5	Phase fault instantaneous A-phase	Reset	Hold
6		x	
7	Phase fault instantaneous C-phase	Reset	Hold
8		x	
9	Earth fault direction	Reset	Hold
10	Not used	x	
11	Not used	x	
12	Not used	x	
13	Not used	x	
14	Not used	x	
15	Not used	x	



When the product is shipped from the factory, all LEDs are set to self-hold.

Item number	Operation indicator LED hold data
860	02AB

7 Mounting

7.1 Mounting dimension

Mount the case to the panel according to Fig. 7.1 “Mounting dimension”.

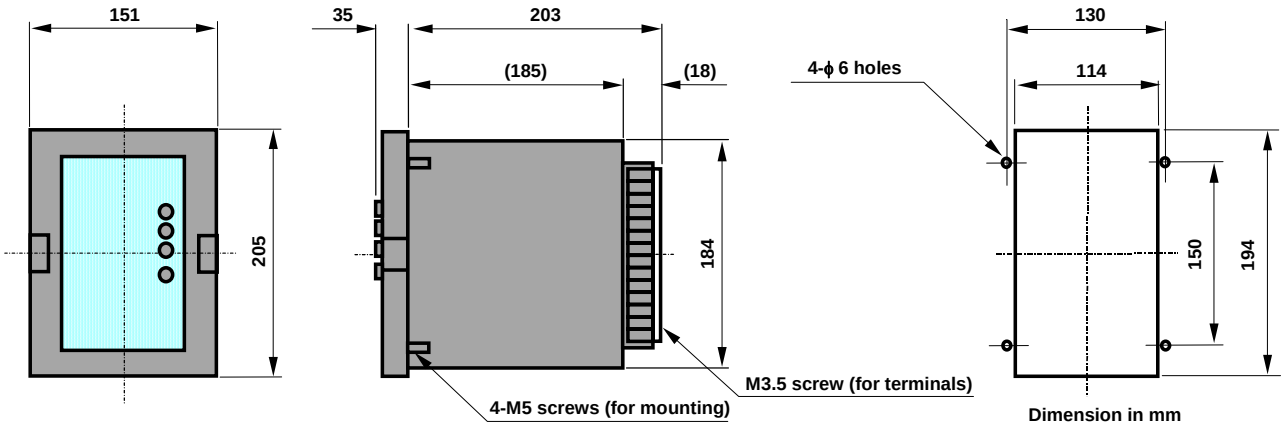


Figure 7.1 Outside dimension /drilling drawing

7.2 Standard operating environment

Install the relay in the environment described in section 3.3 Common technical data. In addition, the following conditions should be kept:

- Abnormal vibration, shock, inclination or magnetic field should be avoided.
- Harmful smoke or gas, salt gas, excessive humidity, water drop or vapor, excessive dust or fine powder, rain and wind should be avoided.

8 Test

The relay has been fully tested prior to shipment. However, it is recommended to carry out a test again by referring to the following test guide before use.

8.1 Appearance inspection

Check the relay for appearance according to the following procedure:

Objects		Check points
Unit	Coil/conductor	(1) Discoloring and burning due to overheat. (2) Abnormal conditions including loosened screws.
	Printed card	(1) Discoloring of the printed card due to overheated parts. (2) Contact between the printed card and connector
	Mechanism	(1) Deformation (2) Operation of the operating key switches. (3) Damage of the draw-out lever of the sub unit. (4) Discoloring and deformation of the name plate on the front panel. (5) Damage of the terminal section.
Case/cover		(1) Damage of the cover. (2) Stain of the cover. (3) Clouding of the cover. (4) Damage of the lock lever of the cover. (5) Damage of the operating buttons of the cover. (6) Operation of the operating buttons of the cover. (7) Damage of the terminal section.
Others		Invasion of foreign matters including dust and iron chips.

8.2 Characteristic test

8.2.1 Precautions in testing

(1) Standard test conditions

Ensure the following test conditions whenever possible:

Note that carrying out a test under an environment that significantly differs from the following conditions may produce an incorrect result.

- Ambient temperature : 20°C±10°C
- Rated frequency : ± 5%
- Waveform (AC) : 2% (distortion ratio)
- Auxiliary power supply voltage : rated voltage ± 2%

(2) Characteristic control point

See the section 3 “Characteristics”.

The characteristic control point refers to the characteristic of a relay unit only. Note that, when a characteristic test is carried out on a relay system connected with external equipment such as CT and ZCT, the result obtained would be a combined characteristic added with the fluctuation of the external equipment.

For special control in terms of a specific control point (for instance, using the operation setting), first carry out a test at “Characteristic control point” at the time when the relay is received or put in service to determine the acceptance/rejection. Thereafter, perform another test at each control point, so that the data obtained can be used for future reference.

(3) Changing setting

Change the setting according to the section 6 “Handling”.

(4) Operation judgment

Determine the operation currents and time and other values of the relay unit basically by turning on and off the corresponding output relay contact of each element.

To determine the starting value of the time-delayed elements of overcurrent relay, which cannot be checked through the output contact, read the display of “elapsed time of time-delayed timer”.

(5) Communication card

Whatever the communication card is inside or not, for the test of withstand voltage and lightning impulse withstand voltage, please avoid inputting test voltage to the serial communication network circuit (DA, DB, DG, SLD terminals).

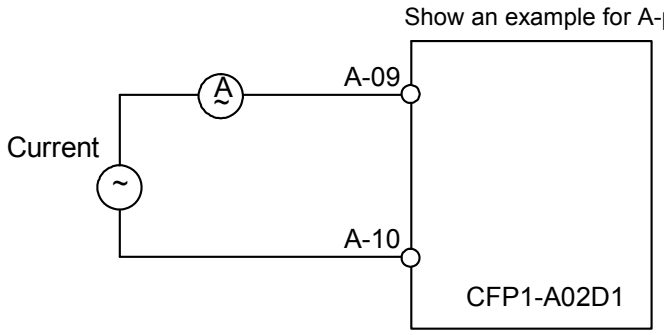
Note: it is not necessary to take the communication card out when test if the communication card was inside unit.

8.2.2 Characteristic test

(1) Test circuit

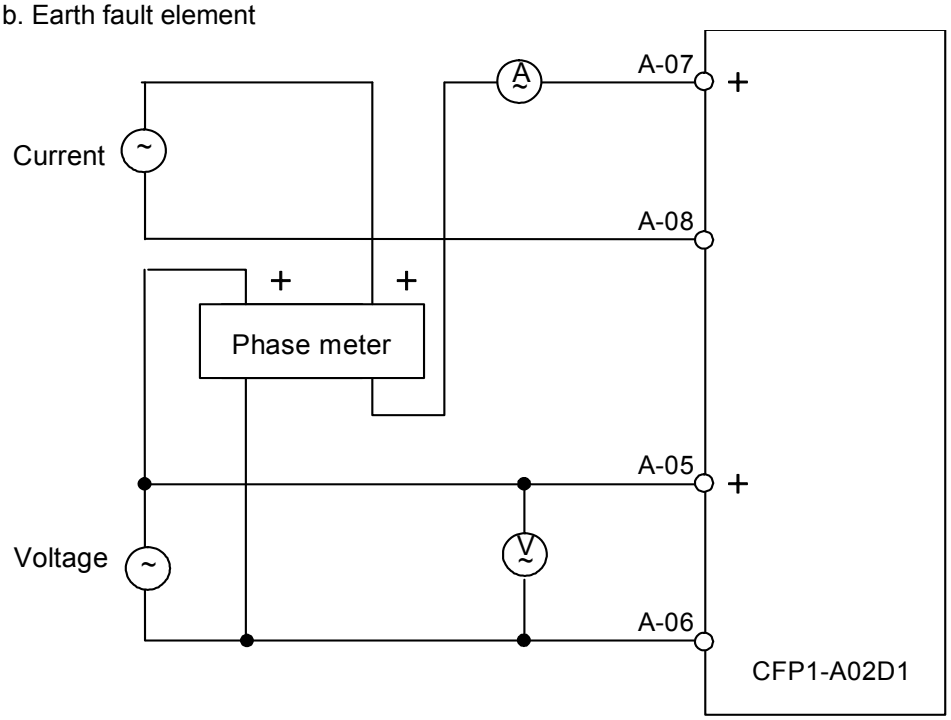
Connect the external wiring referring to the AC input circuit diagram shown below:

a. Phase fault element



Test Phase	Terminal No.
Phase A	A-09~A-10
Phase C	A-11~A-12

b. Earth fault element



(2) Test items and characteristic control point

a. Forced operation test

See “Front control panel operational procedure” in the section 6 “Handling”.

b. Operation value test

See the item “Operation and reset values” in the section 3 “Characteristics”.

c. Operation time test

See the item “Operation time” in the section 3 “Characteristics”.

d. Reset time test

See the item “Reset time” in the section 3 “Characteristics”.

e. Phase test

See the item “Reset time” in the section 3 “Characteristics”.

9 Maintenance

9.1 Daily inspection

Take every opportunity to carry out the following inspection:

- Check that the cover is not damaged and is attached properly.
- Check that no dust or iron chips have invaded into the unit.
- Check that the cover is not clouded notably.
- Check that abnormal noise is not generated.
- Check that the RUN LED lamp is lit.

9.2 Periodical inspection

It is recommended to carry out periodic inspections to check the relay for proper function.

For periodical inspections, perform the appearance inspection and characteristic test in accordance with the section 8 “Test”.

10 Ordering

The product and specification shown in this manual may subject to changes (including specification change and production suspend) without notice. It is advisory to inquire the nearest Mitsubishi Electric's branch or sales office, if required, to confirm that the latest information is given in the manual, prior to placing an order.

Notify the following items when placing an order.

Item	Example of order	Remarks
Model	CFP1-A02D1	For more information, see the section 2 "Rating and specification".
Frequency	50 Hz	Select 50Hz or 60Hz.
Rating	Phase current: 5A, Zero-phase current: 1A	For more information, see the section 2 "Rating and specification".
Setting range	Phase time-delayed element (51) : 1 ~ 12A Phase fault instantaneous element (50): 2 ~ 80A Earth fault directional element (67N) : Io 10 ~ 100mA Vo 5 ~ 60V	For more information, see the section 2 "Rating and specification".
Communication card	One of the followings can be selected: a. CC-Link communication card (Manual No.: JEP0-IL9417,JEP0-IL9418) b. No communication card	Only purchasing a communication card separately will allow customer to add the communication facilities. If customer does not need the communication facilitates at the time of introducing the system, just purchase the relay unit without communication card. Customer can add the communication facilities whenever he/she needs to introduce them. This will help decrease the initial cost and upgrade the system in stages.

11. Guarantee

11.1 Period of guarantee

The guarantee period for this product should be one year after delivery.

11.2 Range of guarantee

When any fault or defect is detected during the period of guarantee shown above, and such fault or defect is proved to be caused apparently at the responsibility of Mitsubishi Electric, the defective unit concered will be repaired or replaced with a substitute. In such a case, contact the nearest Mitsubishi electric's branch or sales office.

It is to be ackowledged that the following faults and defects will not be covered by the guarantee:

- When the fault or defect results from modification or repair carried out by any other entity than Mitsubishi Electric and those who are authorized to carry out repair by Mitsubishi electric.
- When the fault or defect results from the use of the equipment at the range exceeding the condition/environment requirements stated in the manual.
- When the fault or defect results from user's carelessness.
- When the fault or defect results from an act of God such as natural calamity or disaster.
- When the fault or defect results from a phenomenon which can not be predicted with the technology put into practical use at the time of purchase or contract.

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