MITSUBISHI ELECTRIC

# Digital Protection Relay

# MULTICAP-C Series
# PHASE FAULT DISTANCE RELAY

**MODEL**

# CDZ1-10-M3

# INSTRUCTION MANUAL

**Request**

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

MULTICAP (Multiple Control and Protection Modular System) means a series of static relay units which can apply to the control and protection systems. Based on our proven digital relay technologies, this MULTICAP Series have achieved excellent performance, high reliability, effective cost reduction and further miniatualization.

MULTICAP is so designed that relay sub-units can be drawn out of the case. The CT circuit is provided with a CT short circuit mechanism which automatically operates when the sub-unit is drawn out.

The Series can serve as a single-unit relay, housed in an exclusive case, to form a system in combination with other equipment or devices, or it is also possible that several sub-units are packaged in a standard case to form a modular system.

## 1. Features

Type CDZ1-10-M3 phase fault distance relay has the following features:

(1) For the protection against short-sircuit trouble in two protective zones, quadrilateral type phase fault distance elements (2 zones, 3 phases for each zone) and over-current elements (for 3 phases) are incorporated, to provide the distance-operation time protective characteristics.

(2) Memory operation characteristics are provided so that the relay can operate steadily in the event of short-circuit trouble with a close terminal.

(3) The blinder angle can be set to 60° or 75° according to the conditions of a protection system. The operation current sensitivity can also be set to 20 to 200% × rated current.

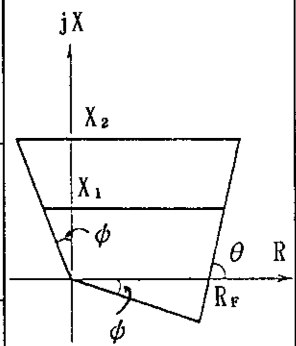
(4) Automatic self check provides high reliability.

(5) Relay operation can be checked by means of the test switch with ease.

(6) Turned into static type, the relay has improved its earthquakeproof capability. The design is also conformable to JEAG 5003-1980.

(7) As draw-out type, it allows to draw out sub-units from a case being mounted to the panel. It is not necessary to open the CT secondary circuit, as CT short circuit piece is provided.

## 2. Specifications

<table>
<tr><td colspan="3">Type</td><td colspan="2">CDZ1-10-M3</td></tr>
<tr><td colspan="3">Incorporated factors</td><td colspan="2">ZS : Phase fault distance element<br>(Quadrilateral type element, Zone 1 & 2 for 3 phases)<br>OC : Overcurrent element for 3 phases</td></tr>
<tr><td rowspan="4">Rating</td><td colspan="2">Frequency</td><td colspan="2">50Hz or 60Hz</td></tr>
<tr><td colspan="2">CT circuit($I_R$)</td><td colspan="2">5A or 1A</td></tr>
<tr><td colspan="2">PT circuit</td><td colspan="2">110V</td></tr>
<tr><td colspan="2">Power supply voltage</td><td colspan="2">DC 110V/125V (DC 24V, 48V or 220/250V are also available)</td></tr>
<tr><td rowspan="10">Setting</td><td rowspan="6">Phase fault distance element (ZS)</td><td>Zone 1 reactance reach (X1)</td><td>5A relay :<br>0.1 to 10Ω (0.1Ω-steps)<br>1A relay :<br>0.5 to 50Ω (0.5Ω-steps)</td><td rowspan="6">

Phase characteristics</td></tr>
<tr><td>Zone 2 reactance reach (X2)</td><td>5A relay :<br>0.2 to 20Ω (0.2Ω-steps)<br>1A relay :<br>1.0 to 100Ω (1.0Ω-steps)</td></tr>
<tr><td>Blinder reach ($R_F$)</td><td>5A relay :<br>0.5 to 5Ω (0.5Ω-steps)<br>1A relay :<br>2.5 to 25Ω (2.5Ω-steps)</td></tr>
<tr><td>Blinder angle ($\theta$)</td><td>60°, 75°</td></tr>
<tr><td>Direction-al angle ($\phi$)</td><td>22.5° (fixed)</td></tr>
<tr><td>Sensitivi-ty</td><td>Current:0.1×$I_R$[rated current]<br>Voltage:0V (with memory)</td></tr>
<tr><td>Over-current element (OC)</td><td>Operation current</td><td colspan="2">20 to 200% (20%-steps) ×$I_R$[rated current]</td></tr>
<tr><td colspan="2">Operation time</td><td colspan="2">within 50ms (Zone Timer=0ms)</td></tr>
<tr><td colspan="2">Zone timer (T1, T2)</td><td colspan="2">LOCK, 0 to 4.45 sec (50msec-steps)</td></tr>
<tr><td colspan="2">Reset time</td><td colspan="2">200ms</td></tr>
</table>

NOTE 1: This relay requires a DC power supply.
(If not provided, the relay does not work.)
NOTE 2: "LOCK" of setting means to lock the relevant element to prevent its operation.

| Type | | CDZ1-10-M3 |
| --- | --- | --- |
| Output contact capacity | Closed circuit | DC110V 15A 0.5 sec. (L/R = 0 sec.)<br>DC220V 10A 0.5 sec. (L/R = 0 sec.) |
| | Open circuit | DC110V 0.3 A (L/R = 0.04 sec.)<br>DC220V 0.15A (L/R = 0.04 sec.) |
| Output contact | | Trip (T) : 2a<br>Zone 1 Distance element (Z1) : 1a<br>Zone 2 Distance element (Z2) : 1a<br>Overcurrent element (OC) : 1a<br>Alarm output : 1b<br>(Always in open state, being excited.) |
| Operation display (with mechanical memory function) | | ZONE 1 TRIP (ZONE 1)<br>ZONE 2 TRIP (ZONE 2)<br>PHASE AB TRIP (AB)<br>PHASE BC TRIP (BC)<br>PHASE CA TRIP (CA) |
| Display (LED) | | ZONE 1 ELEMENT per phase (ZS1AB, ZS1BC, ZS1CA)<br>ZONE 2 ELEMENT per phase (ZS2AB, ZS2BC, ZS2CA)<br>OVERCURRENT ELEMENT (OC)<br>RUN<br>ALARM |
| Test | | By means of front panel switches. |
| Automatic self check | | Monitors the electronic circuits and built-in power supply unit. |
| Load | CT circuit | 0.5 VA or less (5A rating)<br>0.1 VA or less (1A rating) |
| | PT circuit | 0.3 VA or less |
| | Power supply voltage | 18W or less (no operation)<br>23W or less (in operation) |
| Dielectric strength | | AC2000V commercial frequency 1 min. |
| Mass | | 6 kg or less (without case),<br>10 kg or less (with MU-3 case) |

3. Characteristics

| Item | | Guaranteed condition | Guaranteed performance |
|---|---|---|---|
| Operating value | Common conditions | (1) Rated frequency<br>(2) Ambient temperature 20℃<br>(3) Power supply voltage = Rated voltage | —— |
| | Phase fault distance element (ZS) | Current: 0.1×Rated current or more<br>Voltage: 1V or more<br>Reactance axis direction<br>Voltage: 90° advance with regard to current<br>Resistance axis direction<br>Voltage: In phase with current | ± 5% |
| | Overcurrent element (OC) | —— | ± 5% |
| Reset value | Common conditions | (1) Rated frequency<br>(2) Ambient temperature 20℃<br>(3) Power supply voltage = Rated voltage | —— |
| | Phase fault distance element (ZS) | Same conditions as those of operation value measurement | 105% or less of operation value |
| | Overcurrent element (OC) | —— | 95% or more of operation value |

| Item | | Guaranteed condition | Guaranteed performance |
|---|---|---|---|
| Operation time | Phase fault distance element (ZS) | Current: 0A→200% of rating<br>Voltage: Rating→80% fault voltage<br>Phase : 0°→θ° (voltage advance)<br>Timer setting = 0 ms | 50 ms or less |
| | Overcurrent element (OC) | Current: 0A→200% of set value | 40 ms or less |
| | Timer for trip (T1, T2) | Current: 0A→200% of rating<br>Voltage: Rating→80% fault voltage<br>Phase : 0°→θ° (voltage advance) | Timer setting<br>(1) 0 ms ··· 50 ms or less<br>(2) 50ms to 0.4sec··· Within ±20 ms<br>(3) 0.4sec or more ··· Within ±5% |
| Reset time | Phase fault distance element (ZS) | Current: 200% of rating→0A<br>Voltage: 80% fault voltage→Rating<br>Phase : θ°→0° | Within 60 ms |
| | Overcurrent element (OC) | Current: 300% of rating→0A | Within 60 ms |
| | Contact for trip | Same conditions as those of ZS | 200 ms ± 20% |

| Item | Guaranteed condition | Guaranteed performance |
|---|---|---|
| Power supply voltage characteristics | (1) Rated frequency<br>(2) Ambient temperature 20℃<br>(3) Power supply voltage fluctuation range<br>DC 17V to 31V(24V rating)<br>DC 34V to 62V(48V rating)<br>DC 77V to 143V(110/125V rating)<br>DC 175V to 275V (220/250V rating) | Operation value<br>Within ± 5% of the value at rated voltage |
| | | Operation time<br>Within ± 10% of the value at rated voltage |
| | | Phase<br>Within ± 5° of the value at rated voltage |
| Frequency characteristics | (1) Ambient temperature 20℃<br>(2) Power supply voltage = Rated voltage<br>(3) Frequency fluctuation range<br>Rated frequency ±5% | Operation value<br>(See Note 1.)<br>Within ± 10% of the value at rated frequency |
| | | Operation time<br>Within ± 10% of the value at rated frequency |
| | | Phase<br>Within ± 5° of the value at rated frequency |
| Temperature characteristics | (1) Rated frequency<br>(2) Power supply voltage = Rated voltage<br>(3) Ambient temperature fluctuation range<br>20℃ ± 20℃ | Operation value<br>Within ± 5% of the value at 20℃ |
| | | Operation time<br>Within ± 10% of the value at 20℃ |
| | | Phase<br>Within ± 5° of the value at 20℃ |
| | (1) Rated frequency<br>(2) Power supply voltage = Rated voltage<br>(3) Ambient temperature fluctuation range<br>20℃ ± 30℃ | Operation value<br>Within ± 10% of the value at 20℃ |
| | | Operation time<br>Within ± 20% of the value at 20℃ |
| | | Phase<br>Within ± 10° of the value at 20℃ |

NOTE 1) The system impedance, where the frequency is used as a variable, varies according to the frequency fluctuation.
The actual reactance reach is therefore equal to "the value at the rated frequency" × "system frequency"/"rated frequency".
Also, the blinder reach is equal to the value at the rated frequency.
The measurement reach of this relay is ± 5% of this value.

<table>
<tr><th>Item</th><th colspan="2">Guaranteed condition</th><th>Guaranteed performance</th></tr>
<tr><td rowspan="3">Overload withstanding capacity</td><td colspan="2">(1) CT circuit<br>Rated current × 40 times<br>To be applied for 1 second twice at intervals of 1 minute</td><td rowspan="3">No abnormality</td></tr>
<tr><td colspan="2">(2) PT circuit<br>Rated voltage×1.15 times<br>To be applied for 3 hours once</td></tr>
<tr><td colspan="2">(3) DC circuit<br>Max. permissible voltage<br>To be applied for 3 hours once</td></tr>
<tr><td rowspan="2">Insulation resistance</td><td rowspan="2">With a DC 500V megger</td><td>Between electrical circuits in batch and case</td><td>10 MΩ or more</td></tr>
<tr><td>Between circuits each, between contacts each</td><td>5 MΩ or more</td></tr>
<tr><td>Dielectric strength</td><td colspan="2">AC 2000V, commercial frequency, 1 min.<br>(1) Between all electrical circuits and case<br>(2) Between independent circuits each</td><td>No abnormality</td></tr>
<tr><td rowspan="2">Vibration</td><td colspan="2"><table>
<tr><th rowspan="2">Frquency<br>(Hz)</th><th colspan="3">Double amplitude mm</th><th rowspan="2">Oscil-lation time s in each direc-tion</th></tr>
<tr><th>Back & forth</th><th>Right& left</th><th>Up & down</th></tr>
<tr><td>Resonance point at 3 to 10Hz or 10Hz</td><td colspan="2">5</td><td>2.5</td><td>30</td></tr>
<tr><td>16.7Hz</td><td colspan="3">0.4</td><td>600</td></tr>
</table>(JEC2500)</td><td rowspan="2">No abnormality</td></tr>
<tr><td colspan="2">Resonance point at $14.7m/s^2$, 0.5Hz to 10Hz or 0.5Hz, 10Hz<br>(JEAG 5003-1980)</td></tr>
<tr><td>Shock</td><td colspan="2">(1) Shock acceleration $294m/s^2$<br>(2) Shock direction<br>Back & forth, Left & right, Up & down } three directions<br>(3) Shock times<br>3 times</td><td>No abnormality</td></tr>
</table>

## 4. Functions

### 4.1 Phase fault distance element

(1) Configuration of phase fault distance element

Fig. 4-1 shows the functional block diagram of an AB phase fault distance element. (The BC phase or CA phase has the same functional block diagram.)

AS shown in the figure, direct impedance arithmetic and directional judgement are made using the voltage of phase AB and currents of phase A and phase B. The operational judgement is also made using the impedance $[R.X]_{AB}$ obtained from the direct impedance arithmetic, result of the directional judgement, reach (X1, X2, $R_F$) selected for the setting of the phase fault distance element and blinder angle ($\theta$). If any short-circuit trouble occurs in the protective zone, the operation command will be given.

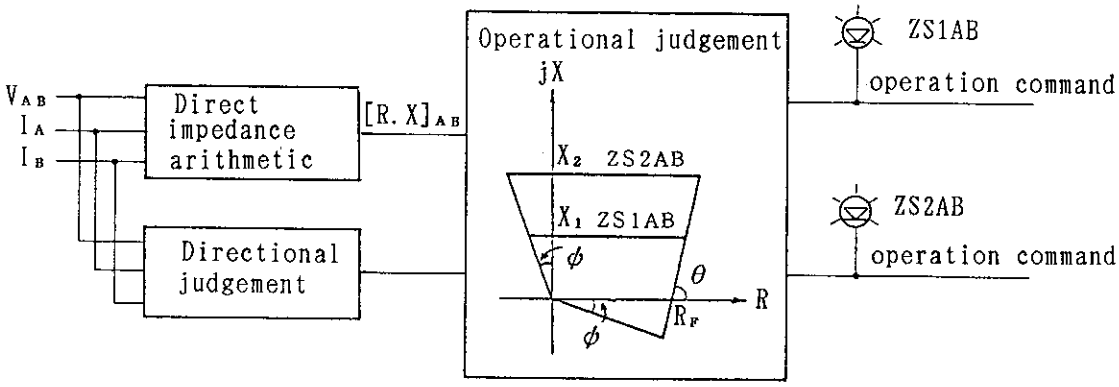


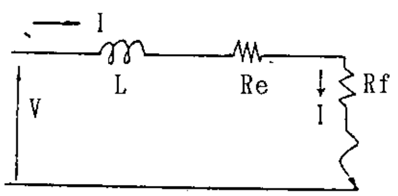

Fig.4-1 Functional Block Diagram of Phase Fault Distance Element

(2) Direct impedance arithmetic

For the direct impedance arithmetic, R and X are directly obtained from the circuit equation which is always applicable to the system frequency.

This relay is therefore characterized by a very trifling error in regard to distorted wave input compared with the conventional relay. This method secures a reaction to an increase in distorted wave component and decrease in frequency caused by an increase in charging capacity.

The principle of this method is described below.




L : Inductance of transmission line up to fault point

R e : Resistance of transmission line up to fault point

R f : Arc resistance

V : Voltage at relay installation point

I : Current at relay installation point

Fig. 4-2 System Fault Equivalent Circuit

A system fault can be shown by the equivalent circuit in Fig. 4-2.
Let the current and voltage sampled at a certain time of day be i(t) and v(t), respectively. Then, the circuit in Fig. 4-2 is also expressed by equation (1).

$$v(t) = (Re+Rf) \cdot i(t) + L \cdot \frac{d}{dt} i(t)$$
$$= R \cdot i(t) + L \cdot \frac{d}{dt} i(t) \quad \cdots\cdots (1)$$

Whare R = Re + Rf

Let the time of day before one sampling be t − T. Similarly, equation (2) is also valid.

$$v(t-T) = R \cdot i(t-T) + L \cdot \frac{d}{dt} i(t-T) \quad \cdots\cdots (2)$$

R and L can be obtained by solving equations (1) and (2). The inductance and resistance including arc resistance corresponding to the distance up to the fault point can also be obtained.
Solve (1) and (2) to obtain R and L. Equations (3) and (4) are then given.

$$R = \frac{v(t-T) \cdot \frac{di(t)}{dt} - v(t) \cdot \frac{di(t-T)}{dt}}{i(t-T) \cdot \frac{di(t)}{dt} - i(t) \cdot \frac{di(t-T)}{dt}} \quad \cdots\cdots (3)$$

$$L = \frac{v(t) \cdot i(t-T) - v(t-T) \cdot i(t)}{i(t-T) \cdot \frac{di(t)}{dt} - i(t) \cdot \frac{di(t-T)}{dt}} \quad \cdots\cdots (4)$$

Equations (3) and (4) are valid irrespective of a distorted wave componet. Theoretically, the obtained L and R do not include any error due to distorted wave input. (Actually, however, there occurs an error, which is very trifling compared with the conventional relay.)

(3) Directional judgement

Fig. 4-3 shows the block diagram of the internal function of the directional judgement in Fig. 4-1.
AS shown in the figure, a phase difference between the voltage of phase AB and line current obtained from the currents of phase A and phase B is calculated through phase difference arithmetic. Then, the directional angle ($\phi$) of the phase fault distance element is judged.
A memory function is provided to secure a reaction to the result of the phase difference arithmetic even when the voltage is lost due to short-circuit trouble with a close terminal. This memory function will be reset when the voltage is about 1V or more or when the current level judgement is invalid.
A judgement on whether the currents of phase A and phase B are in excess of the current sensitivity (0.1 × rated current) is made by means of the level judgement. When these two AND conditions are established, the operation command will be outputted.

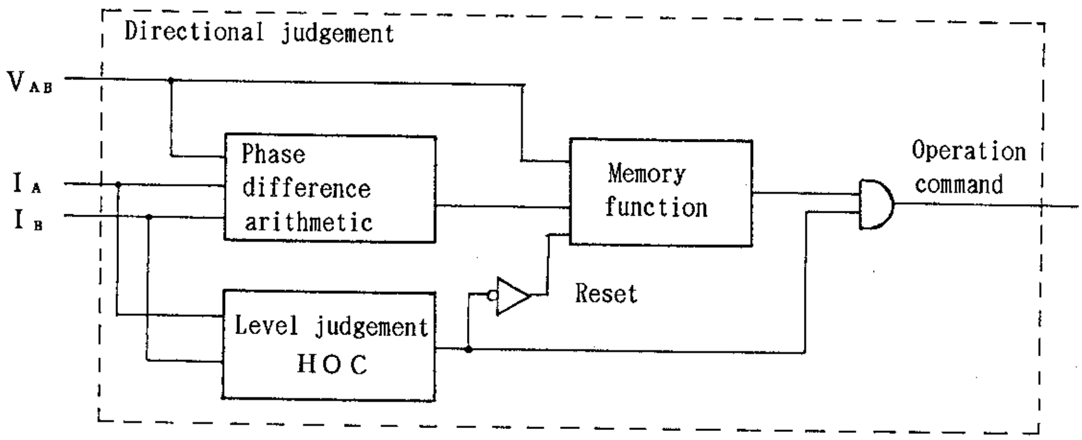



Fig. 4-3 Block Diagram of Directional Judgement Internal Function

4.2 Overcurrent element

If the input current exceeds the setting current, as shown in Fig. 4-4, the level judgement results will be collated several times and the operation command will be outputted.

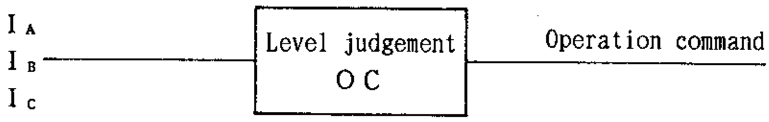



Fig. 4-4 Block Diagram of Overcurrent Element Function

4.3 Automatic self check

Electronic circuits and built-in power supply unit are monitored.
If any failure is detected, the alarm lamp is lighted, alarm output (contact output) is given, and any other output is locked.

If monitor abnormality output is given, it may be released by depressing the CPU reset switch; but, if the CPU reset switch is depressed while the monitor abnormality continues, operation output may be given; therefore, in such case, make sure to lock the trip circuit on the panel side before realizing the CPU reset operation.

## 5. Settings

The impedance of the positive phase circuit of a transmission line in the protective zone is given by equation (1).

$$Z = Re + jL \ (\Omega)$$
$$\theta_L = \tan^{-1} \frac{L}{Re} \ (°) \quad \cdots\cdots (1)$$

where Re: Transmission line resistance, L: Transmission line inductance

Also, the relation between the primary impedance and secondary impedance is shown by equation (2).

$$\text{Secondary impedance } (Z_L) = \text{Primary impedance } (Z) \times \frac{\text{CT ratio}}{\text{PT ratio}} \quad \cdots\cdots (2)$$

To calculate the setting of the phase fault distance element, the above $Z_L$ and $\theta_L$ are used.

### 5.1 Zone 1 reactance reach (X1) setting

The measurement error in phase fault distance element including CT and PT errors is about 10%. Usually, about 80% of a protective zone is therefore selected for the setting value so that no operation will take place out of the protective zone.

The setting value is calculated using equation (3).

$$\text{Zone 1 reactance reach } (X1) = 0.8 \times L \ \text{(secondary conversion)} \quad \cdots\cdots (3)$$

### 5.2 Zone 2 reactance reach (X2) setting

As shown in Fig.5-1, the zone 2 at the terminal A is set shorter than the zone 1 at the terminal B so that any failure at F can be eliminated in the zone 1 at the terminal B during the timer setting (T2) time even when the zone 2 phase fault distance element at the terminal A is actuated. About 140 to 160% of the protective zone is usually selected for the setting value.

The setting value is therefore calculated using equation (4).

$$\text{Zone 2 reactance reach } (X2) = 1.4 \text{ to } 1.6 \times L \ \text{(secondary conversion)} \cdots (4)$$

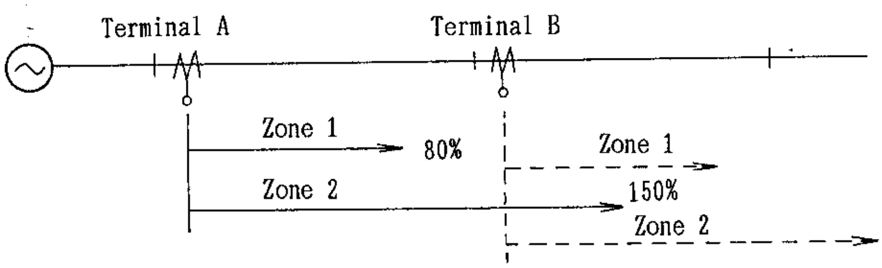



Fig.5-1 Example of Reach Settings

## 5.3 Blinder angle ($\theta$)

Although noting special is specified for the blinder angle ($\theta$), it is set to a value close to the positive impedance angle of a transmission line in the protective zone in order to keep the detected value of are resistance constant. The setting value is therefore calculated using equation (5).

$$\text{Blinder angle } (\theta) = Q_L = \tan^{-1} L/R_e \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (5)$$

## 5.4 Blinder reach ($R_F$)

As shown in Fig.5-2, the blinder reach ($R_F$) is set in such a way that it does not intersect with the maximum power flow. The measurement error in phase fault distance element including CT and PT errors is about 10%. The reach is therefore set redundantly to 70% or less in regard to the maximum power flow. The setting value is calculated using equation (6).

$$\text{Blinder reach } (R_F) < 0.7 \times Z_{Ld} \times \sin\phi_L \times (\cot\phi_L - \cot\theta) \quad \cdots\cdots\cdots \quad (6)$$

(Note) $\phi_L$ is usually set up to about 30°

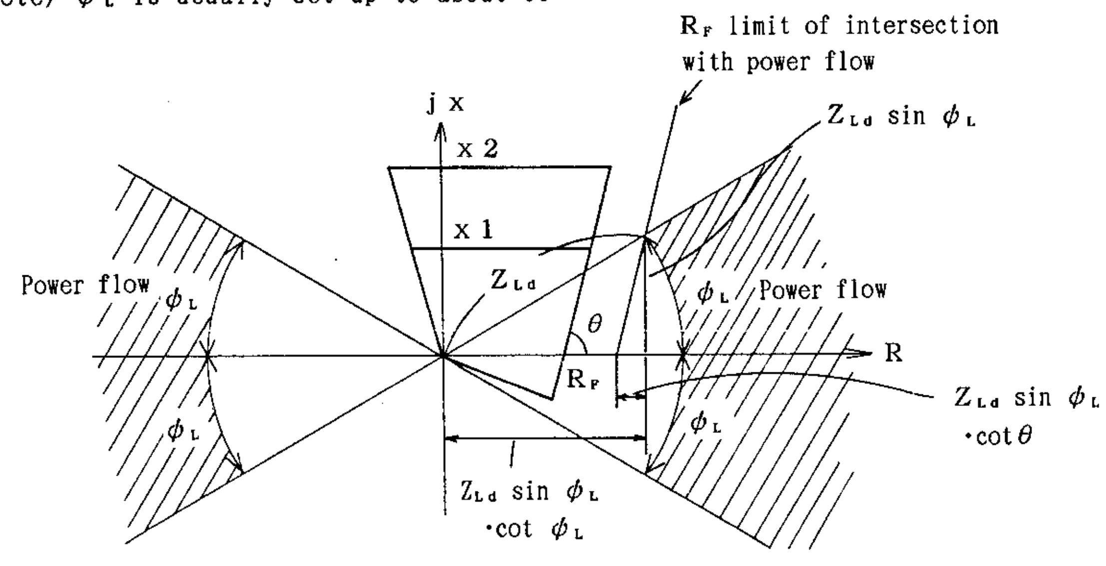


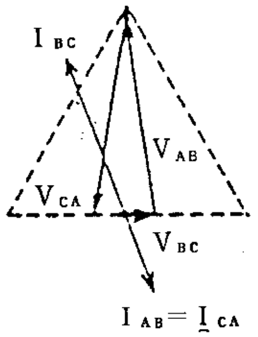

Fig.5-2 Blinder Reach ($R_F$) Setting 1

For short-circuit trouble behind the protection direction, as shown in Fig.5-3, there is some possibility that a certain setting value of the blinder reach ($R_F$) will cause a phase fault distance element other than that for the fault phase to be unnecessarily actuated. The setting value is therefore calculated with equation (7) taken into account.

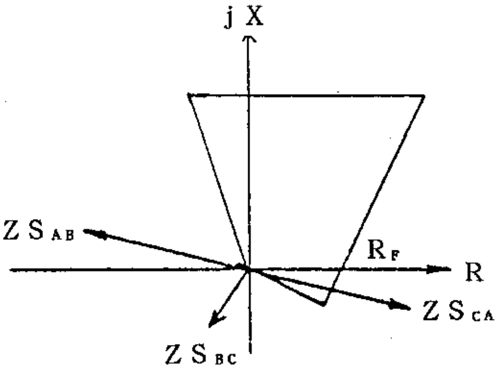
$$R_F < \frac{\sqrt{3}V_N/2}{I_f 2\phi S} \times 0.7(\text{redundancy}) \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (7)$$

where $V_N$: Rated line voltage, $I_f 2\phi S$ : Maximum backward short-circuit current

Current/voltage vector diagram for backward 2$\phi$S BC




Impedance viewed from each phase element for backward 2$\phi$S BC




(Note) If the $R_F$ reach is large, the $ZS_{CA}$ reach point may enter the operation range. The $R_F$ reach must be set to a small value.

Fig. 5-3 Blinder Reach ($R_F$) Setting 2

## 5.5 Timer setting (T1, T2)

The zone 1 phase fault distance element is usually used as an instantaneous element. The zone 1 timer (T1) is therefore set to 0 or 0.05 sec.

The zone 2 timer (T2) is set to a sufficiently long time so that it will be distinguishable from the longest zone 1 fault elimination time and the longest instantaneous fault elimination time of any other protection which overlaps with the zone 2 reach setting.

About 0.3 sec is usually set as shown in equation (8).

Zone 2 timer setting (T2) = Zone 1 element operation time + CB trip time + Zone 2 element reset time + redundancy ······················· (8)
= 50 ms + 3 to 5 c/s + 60 ms + redundancy 5 c/s ≒ 0.3sec

The use of "LOCK" of the timer settings (T1, T2) allows the zone 1 and zone 2 phase fault distance elements to be locked to prevent them from operating individually.

## 5.6 Operation current (OC)

The operation current (OC) of an overcurrent element is a determinant of the minimum operation current sensitivity of this relay.

As shown in equation (9), the operation current is usually set to 1/2 or less of the minimum short-circuit current.

Operation current (OC) < 1/2 × minimum short-circuit current ···· (9)

## 6. Internal structure

Fig.6-1 shows the internal block diagram of type CDZ1-10-M3.
AC voltage and current input are connected to the multiplexer through the filter circuit and the sample hold circuit. Signals selected by the multiplexer are digitalized by the A/D converter and then read by the microcomputer.
This microcomputer is also connected with switches for settings.
With these inputs, type CDZ1-10-M3 performs the functions shown in the internal block diagram of Fig.6-2, and outputs signals to the display relay and the auxiliary relay.
For the alarm output, adopted method is that if the result of monitoring of electronic circuits and power supply unit is normal, the auxiliary relay is excited to turn off the output (use of b-contact). For handling this output, refer to Chapter 7. If a fuse of built-in DC-DC power supply has blown, fault monitor output also comes into action.

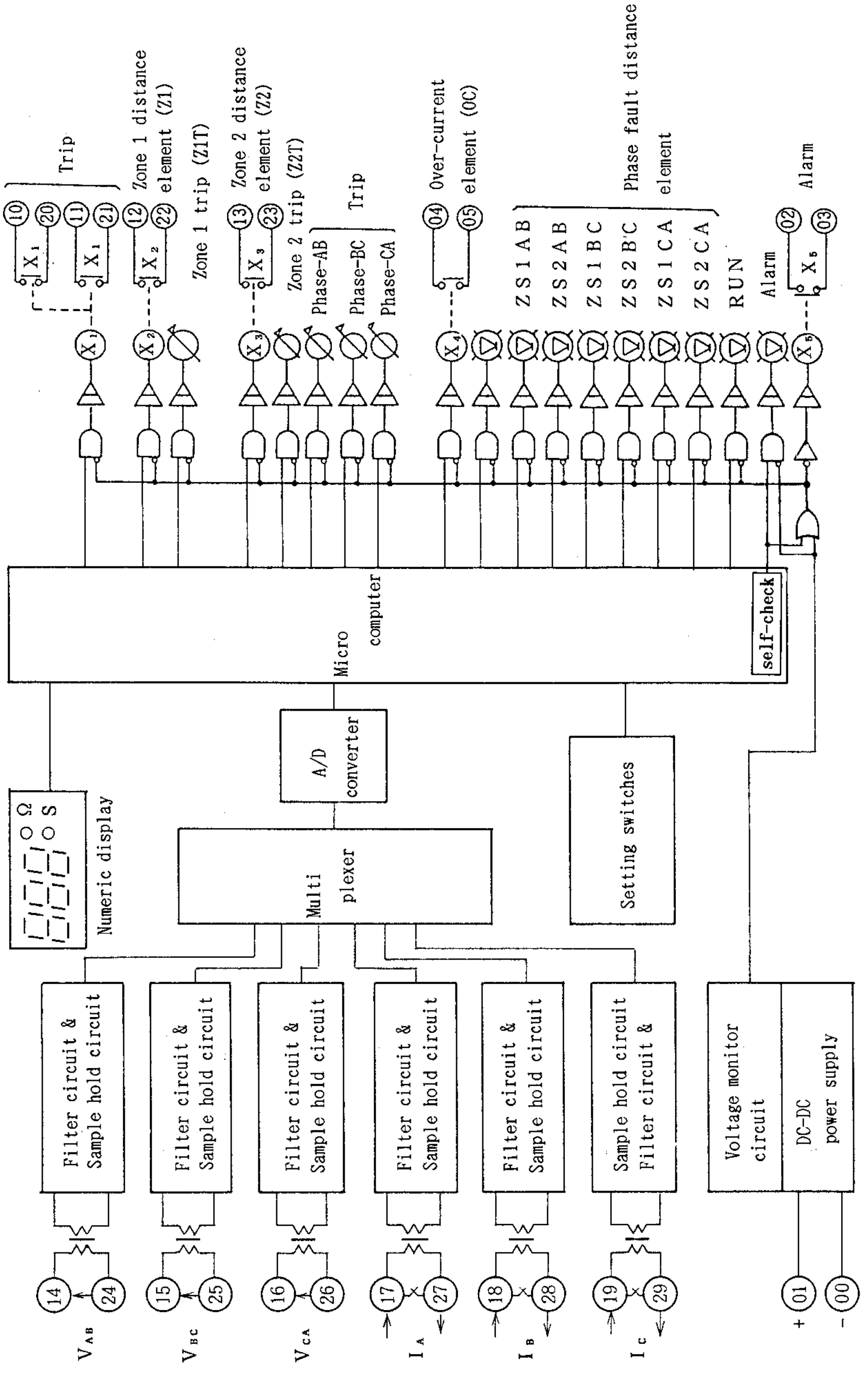



Fig.6-1 Internal Block Diagram of CDZ1-10-M3

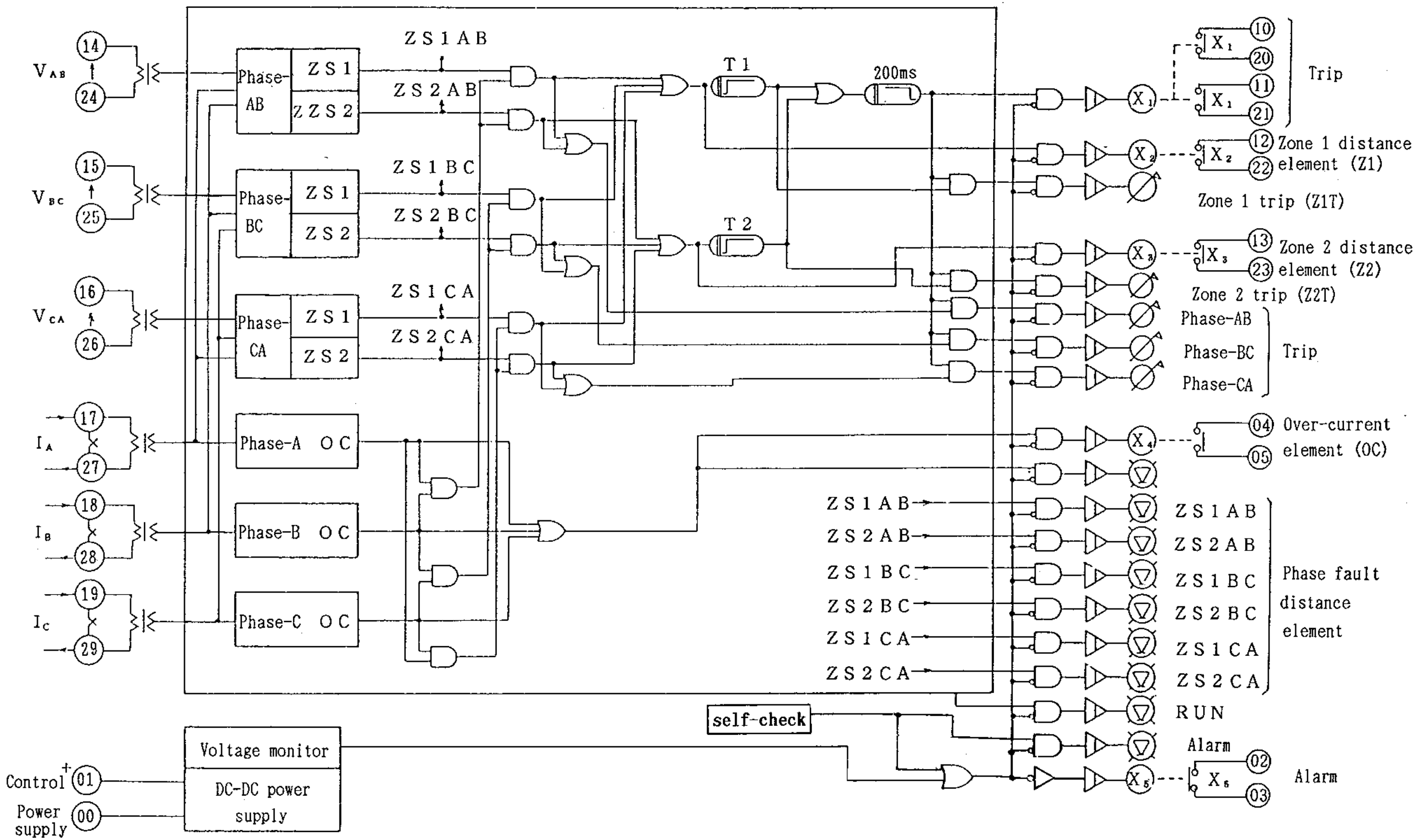



Fig. 6-2 Internal Connection Diagram of CDZ1-10-M3

7. Application

Fig.7-1 shows a typical connection of AC circuit.
Fig.7-2 shows a typical connection of DC circuit.
To use the alarm output, connect an operation timer of 1 sec or more.
Fig.7-3 shows the back view; connection must be made at the terminal No. positions specified here.
In this case, the relay incorporates no self-holding circuit. If necessary, self-holding circuit should be provided externally.
Be sure to connect case earth terminal Ⓔ to earth of the panel.

When the unit is used in an important circuit where uninterruptive power supply is desired, you are asked to study about introducing measures for improving system reliability, for instance by mounting a failsafe relay from the equipment composition viewpoint.

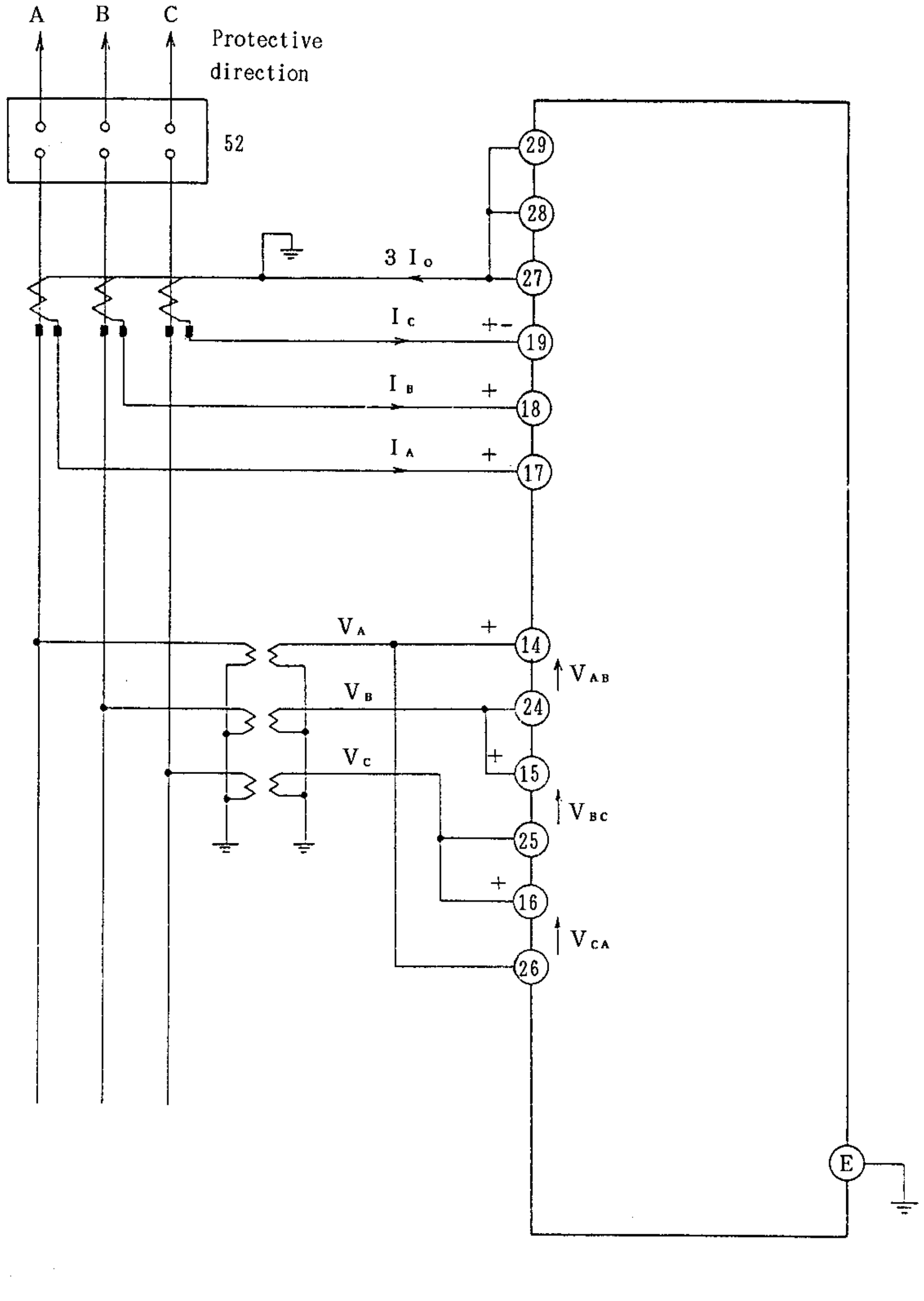
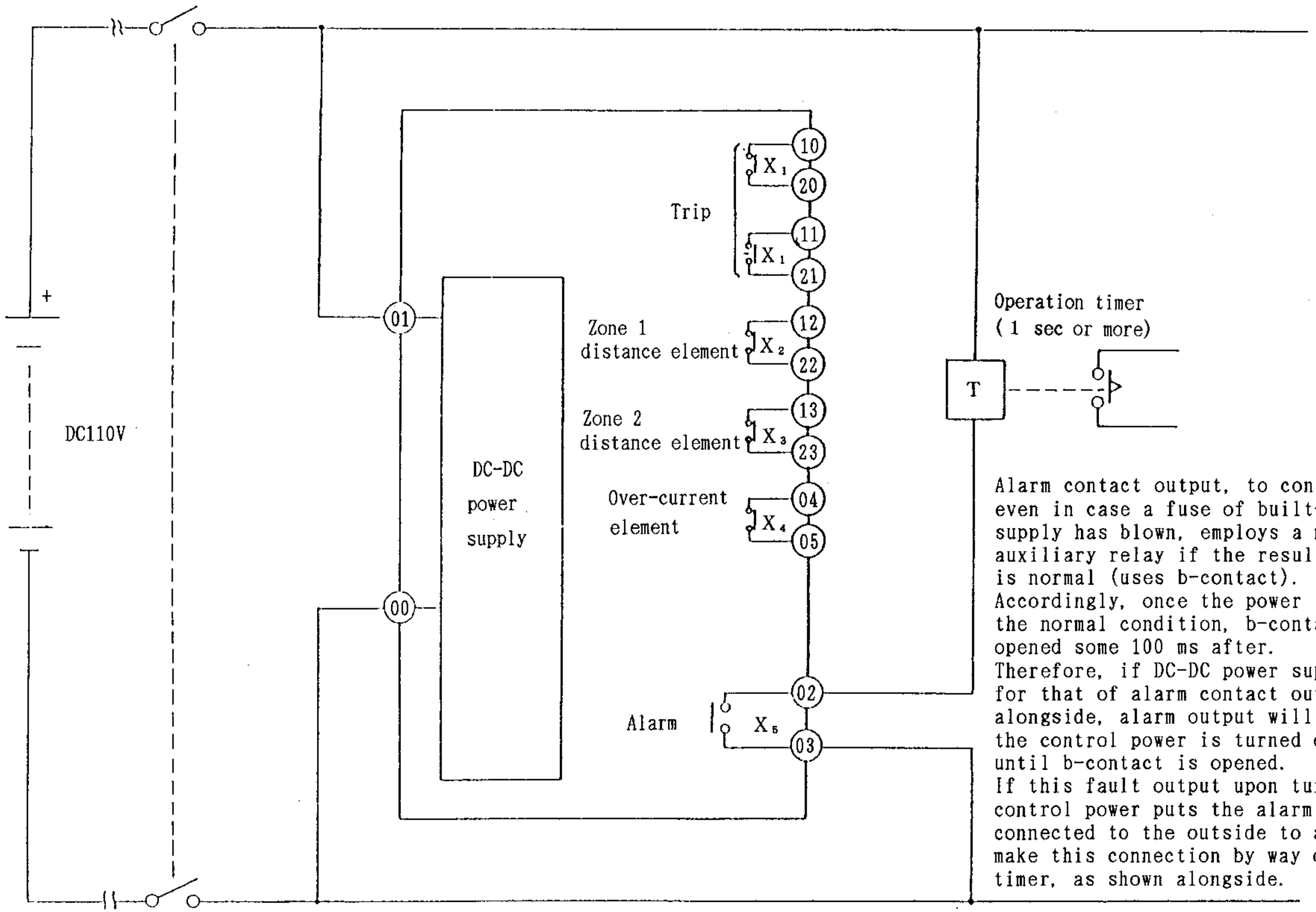



Fig. 7-1 AC Circuit Connection of CDZ1-10-M3 (example)




Alarm contact output, to continue monitoring even in case a fuse of built-in DC-DC power supply has blown, employs a method to excite auxiliary relay if the result of monitoring is normal (uses b-contact).
Accordingly, once the power is supplied, in the normal condition, b-contact will be opened some 100 ms after.
Therefore, if DC-DC power supply is also used for that of alarm contact output, as shown alongside, alarm output will come out when the control power is turned on, and continue until b-contact is opened.
If this fault output upon turning on the control power puts the alarm circuit, etc. connected to the outside to any inconvenience, make this connection by way of an operation timer, as shown alongside.

Fig. 7-2 DC Circuit Connection of CDZ1-10-M3 (example)

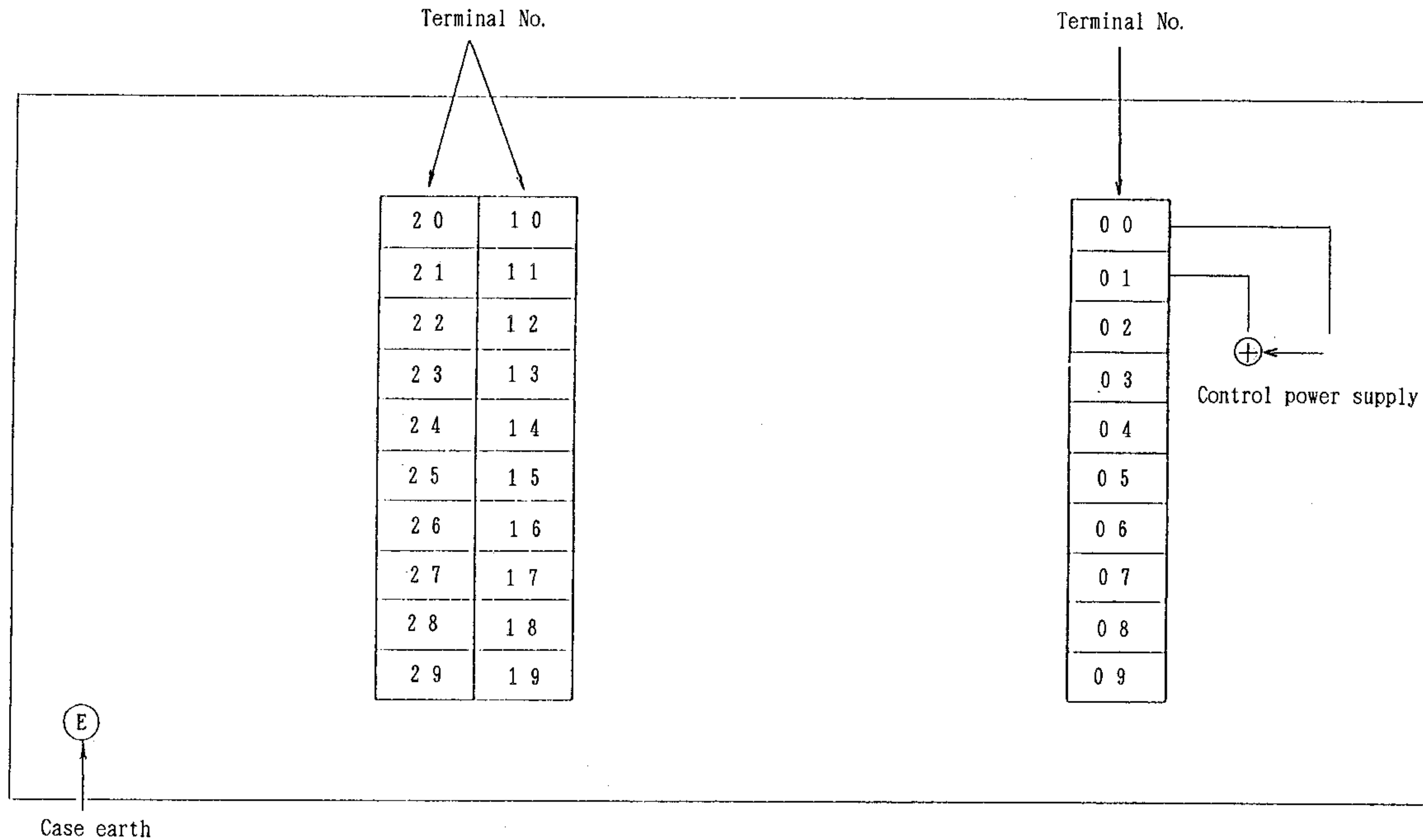



Fig. 7-3 CDZ1-10-M3 Back View (MU-3 case)

## 8. Handling

### 8.1 Unpacking

Relay element is usually packaged in a horizontal (MU) case and shipped. When a sub-unit alone is transported for repair or other purpose, after unpackings fully brush any dust off the inside of the sub-unit, and check if the front and side parts of the sub-unit have no break and damage.

### 8.2 Carrying and storage

When carrying a sub-unit in a place for use, please be careful in handling it so as to cause no deformation or breakdown of the front and side parts of the sub-unit. For storage of sub-unit, chose a dust-free, less-humid place. When sub-unit relay element is drawn out from the case and left as it is for a long time, put a suitable dustproof cover over it for protection against dust.

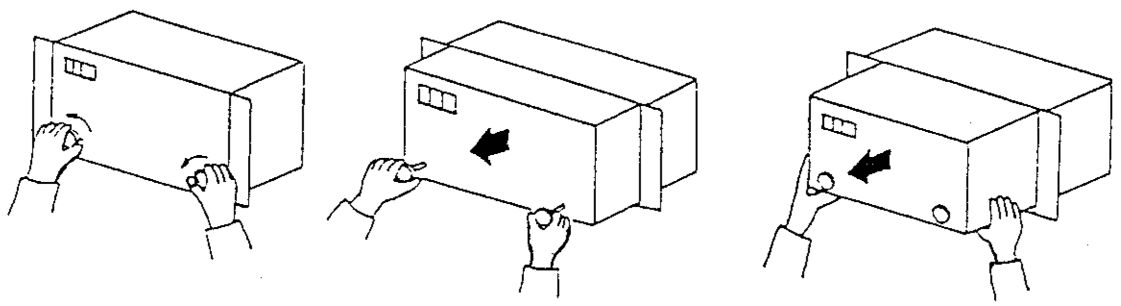
### 8.3 Handling and operating methods

(1) Handling

Having a draw-out structure to facilitate inspections and tests, sub-unit relay element can be drawn out from a horizontal (MU) case without disconnecting external cables.

Fig.8-1 shows the drawing-out procedures.

① ② ③



① Unlock the screws

② Pull the screws to your side so that the sub-unit is half drawn out.

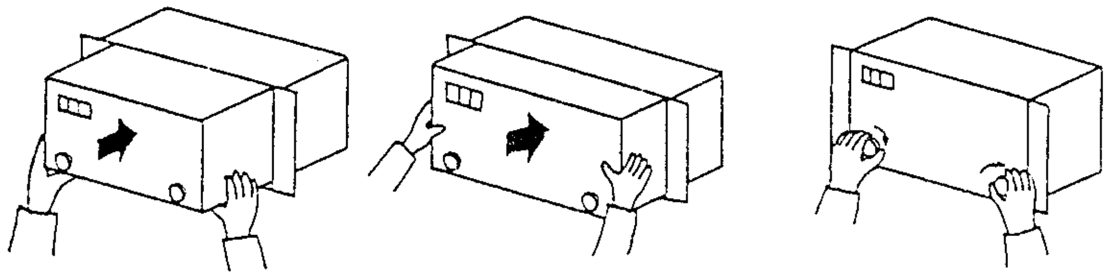
③ Then, fully draw out the sub-unit, supporting from the bottom.

Caution: Be careful not to let it fall !

Fig.8-1 Sub-unit Drawing-out Procedures

Fig. 8-2 shows the housing procedure.

①　　　　②　　　　③



① Support the sub-unit from the bottom and put it half into the case.

② Fully house it in the case, pushing both side edges.

③ Lock the screws completely.

Caution: Push no other parts than both side edges !

Fig. 8-2 Sub-unit Housing Procedure

However, avoid doing the draw-out work under the live-line condition, as mentioned in Technical Material No.156 "Protection Relay Test Manual" of the Electrical Machinery Industries' Association, for which you should be careful with the following points.

- Lock the trip circuit.
- Off the main circuit.
- Disconnect the CT circuit.
- Disconnect the PT circuit.
- Open the control power circuit.

(Careless opening may cause other control circuits to open also, bringing about a non-protected state. Please be careful to open the relevant circuit alone.)

When you make a change in setting value under the operating condition, it may happen to carelessly pass a setting value on the way, depending on the turning direction of rotary switch. So, lock the trip circuit during the changing work.

(2) Switch operations

| No. in Fig.8-3 | Switch Name | Description |
|---|---|---|
| ① | X1 | Zone 1 reactance reach switch for phase fault distance element |
| ② | X2 | Zone 2 reactance reach switch for phase fault distance element |
| ③ | RF | Blinder reach switch for phase fault distance element |
| ④ | θ | Blinder angle switch for phase fault distance element |
| ⑤ | T1 | Zone 1 timer switch for phase fault distance element<br>The zone 1 phase fault distance element is locked at "LOCK" position. |
| ⑥ | T2 | Zone 2 timer switch for phase fault distance element<br>The zone 2 phase fault distance element is locked at "LOCK" position. |
| ⑦ | OC | Operation current setting switch for over-current element |
| ⑧ | TEST | NORMAL: A position for normal use<br>OC: Forcibly operates over-current elements of phases A, B and C.<br>Z1-OC-AB: Forcibly operates over-current elements of phases A and B, and zone 1 phase fault distance element of phase AB.<br>Z1-OC-BC: Forcibly operates over-current elements of phases B and C, and zone 1 phase fault distance element of phase BC.<br>Z1-OC-CA: Forcibly operates over-current elements of phases C and A, and zone 1 phase fault distance element of phase CA.<br>Z2-OC-AB, -BC, -CA:<br>Like the above Z1-OC-AB, BC and CA, forcibly operates over-current element of each phase and zone 2 phase fault distance element of each phase.<br>(Note) Only the selected subject is operated forcibly.<br>Operation is executed after lapse of the setting time.<br>Element of which function is locked is not operated forcibly. |
| ⑨ | FUNCTION | X1<br>X2<br>RF<br>θ<br>T1<br>T2<br>OC } Display of setting value<br>OFF: Light goes off |
| ⑩ | RESET (operation display) | Resetting switch for operation display ⑫ |
| ⑪ | RESET(CPU) | Resetting switch ,or digital processing |

(3) Display

| No. in Fig. 8-3 | Display | Description |
|---|---|---|
| ⑫ | Operation display<br>Z1 trip<br>Z2 trip<br>Phase-AB trip<br>Phase-BC trip<br>Phase-CA trip | Orange-LED display for relay in operation<br>As mechanical memory function is provided, in the state of no operation output, it is possible to reset by switch ⑩. |
| ⑬ | Detection display<br>Zone 1 distance element ZS1AB<br>ZS1BC<br>ZS1CA<br>Zone 2 distance element ZS2AB<br>ZS2BC<br>ZS2CA | The lamp illuminates when each phase fault distance element operates. The lamp goes off when the relay is not operated. |
| | Over-current element (OC) | When any of the over-current elements of phases A, B and C operates, the lamp illuminates. The lamp goes off when none of the three phases are operated. |
| ⑭ | RUN | Lighted when the relay unit is normal. |
| ⑮ | ALARM | Lighted when full-time monitoring has detected a fault. |
| ⑯ | Numeric display | Display of setting value<br>Format: 1 → 1.00<br>0.5 → 0.50<br>:<br>etc.<br>LOCK → 999 |
| ⑰ | Unit display (Ω, S) | The lamp for setting value unit illuminates. |

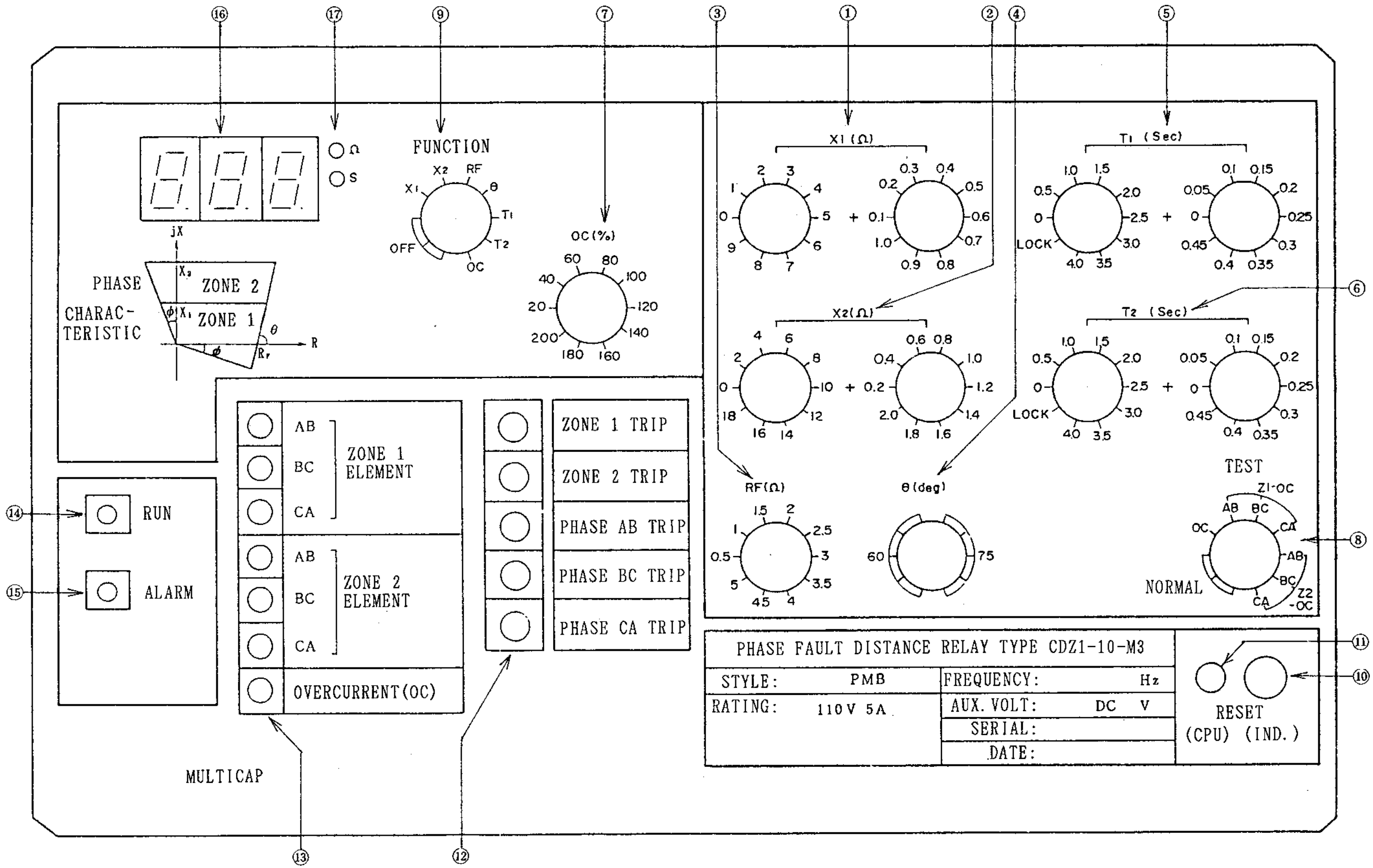



Fig. 8-3 CDZ1-10-M3 Front View

## 9. Installation

### 9.1 Fitting hole dimensions

For installing horizontal (MU-3) case to the panel refer to the fitting dimensions shown in Fig. 9-1.

### 9.2 Installation environment

The relay unit should be installed in a place that can meet the normal use conditions mentioned below.

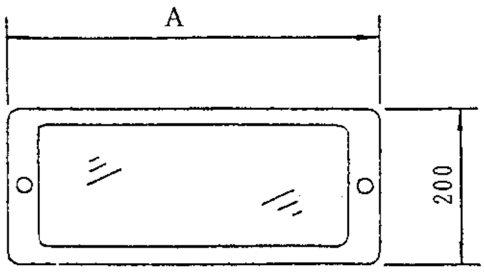
(1) Power supply voltage fluctuation
Within DC 17 V to 31 V (DC 24 V specification)
Within DC 34 V to 62 V (DC 48 V specification)
Within DC 77 V to 143 V (DC 110 V/125 V specification)
Within DC 175 V to 275 V (DC 220 V/250 V specification)

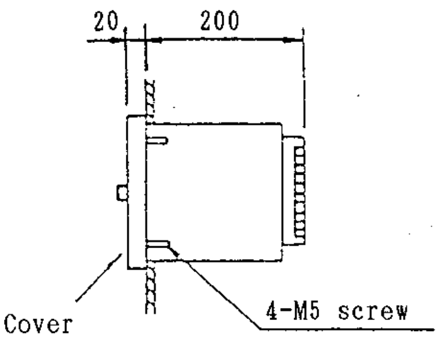
(2) Frequency fluctuation
Within ± 5% of rated frequency

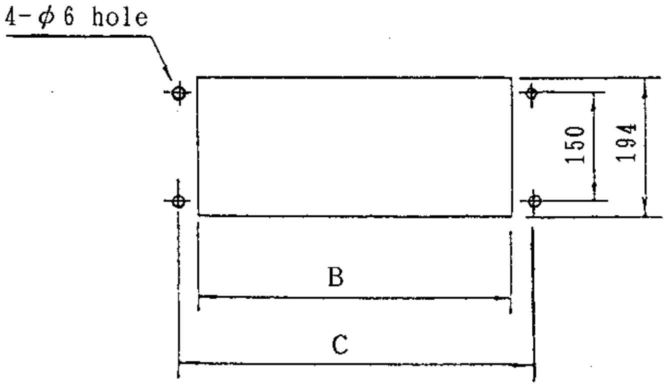
(3) Ambient temperature fluctuation
Within -10 ℃ to 50 ℃ (However, without freezing and dew condensation)

(4) The unit shall be free from abnormal vibration, shock, inclination and magnetic field.

(5) The unit shall not be exposed to harmful smoke or gas, saline gas, excessive temperature, water drops or steam, excessive dust or minute particles, or wind and rain.




| Type of Case | A | B | C |
|---|---|---|---|
| MU-1 | 150 | 114 | 130 |
| MU-2 | 250 | 214 | 230 |
| MU-3 | 350 | 314 | 330 |
| MU-4 | 480 | 414 | 460 |
| MU-6 | 656 | 614 | 640 |

Fig. 9-1 Outline and Panel Drilling Dimensions (Unit: mm)

## 10. Tests

The relay elements are strictly tested in our factory before shipping. However, we recommend you to conduct further check and tests for their main characteristics before use.

### 10.1 Outward appearance check

Prior to test, check if there is no breakdown or deformation.
Thereafter, if no abnormality is observed, conduct the following tests.

### 10.2 Tests

(1) Characteristics control points
Refer to Chapter 3.

(2) Precautions in testing

a. Standard test conditions
Please keep to the following ambient conditions as far as possible. Note that if the tests are conducted under conditions fairly different from those mentioned below, it is sometimes difficult to obtain proper results of measurements.

| | |
|---|---|
| Ambient temperature | 20 ℃ ± 10 ℃ |
| Frequency | Rated frequency ± 1% |
| Waveform (AC) | 5% or less distortion rate |
| Power supply voltage | Rated voltage ± 5% |

b. Operation check
Check for operation values with operation/detection displays.

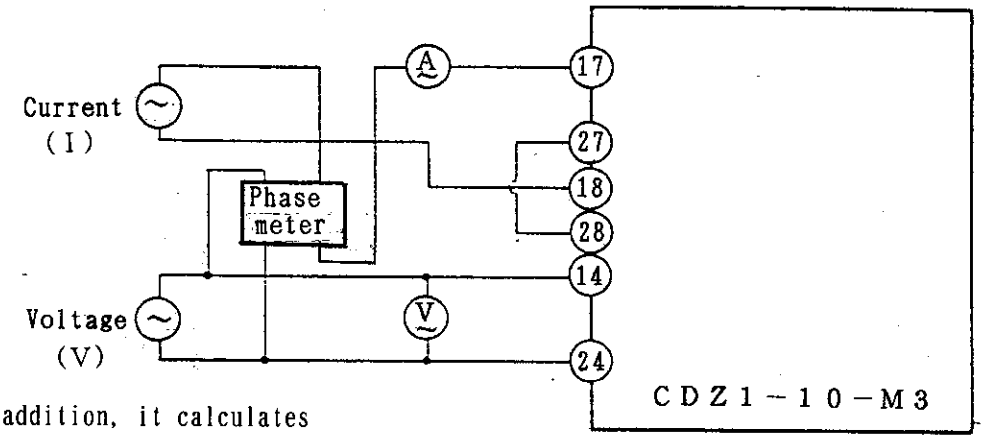
c. Measurement of operation time and reset time
Measure time using the output auxiliary relay contacts.

(3) Test circuit

Referring to the AC input circuits shown below, carry out the external connection of relay elements.

a. Phase fault distance element

An example of phase-AB is shown.



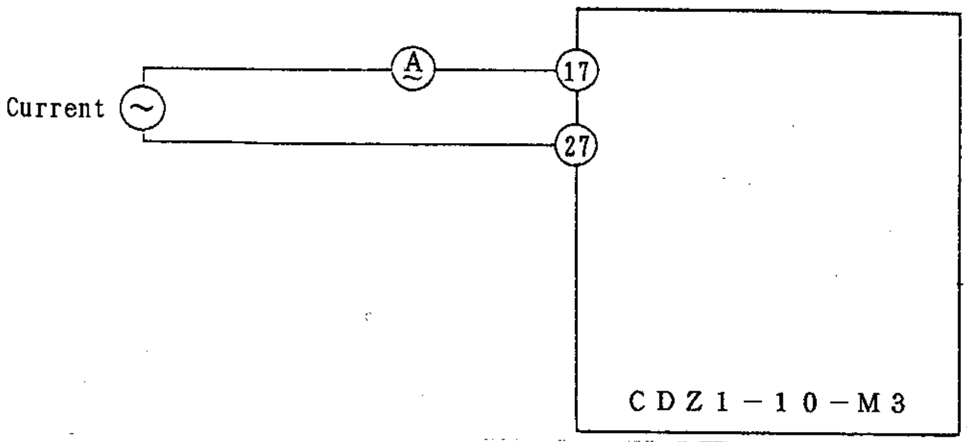

In addition, it calculates the Impedance(Z) measured in this circuit by the lower formula.

$$Z = \frac{V}{2 \cdot I}$$

| Test phase | Current terminal | Voltage terminal |
|---|---|---|
| Phase AB | 17-27-28-18 | 14-24 |
| Phase BC | 18-28-29-19 | 15-25 |
| Phase CA | 19-29-27-17 | 16-26 |

b. Over-current element

An example of phase-AB is shown.




| Test phase | Current terminal |
|---|---|
| Phase A | 17-27 |
| Phase B | 18-28 |
| Phase C | 19-29 |

(4) Tests

a. Test with forced operation switch
   Refer to 8-3-(2) Switch operations.

b. Operation value test
   Refer to Chapter 3, item of "Operation value" and "Reset value".

c. Operation time test
   Refer to Chapter 3, item of "Operation time".

d. Reset time test
   Refer to Chapter 3, item of "Reset time".

## 11. Maintenance

### 11.1 Daily inspection

Check the following points whenever occasion arises.

(1) The glass is not broken and is fully clamped.
(2) There is not dust, iron pieces, etc. in the unit.
(3) The glass cover is not abnormally clouded.
(4) There is no abnormal sound from the unit.

### 11.2 Periodical inspection

Periodical inspection is recommended to check the functions of relay elements. In this case, besides characteristics check conformed to the testing instructions please check the following points also.

Check Points

| Check Point | Description |
|---|---|
| Coil and Conductor | (1) Deformation and burnout due to overheat<br>(2) Loosening of soldered parts and screw-tightened parts, and other defects |
| PC card | (1) Discoloration of PC card due to overheat of parts<br>(2) Proper contact between PC card and connectors |
| Case | (1) Breakdown of cover glass<br>(2) Contamination of cover<br>(3) Slip-off of cover packings<br>(4) Deformation<br>(5) Cloudy condition of cover glass<br>(6) Breakdown of cover knob |
| Others | (1) Ingress of dust, iron pieces and other extraneous matters<br>(2) Rust and paint exfoliation<br>(3) Breakdown of structure |

12. Placing an order/Making contact

When you Place an order, please specify the folliwing:

(1) Type
(2) Rated current
(3) Rated frequency
(4) Power supply voltage
(5) Designation of Japanese nameplate or English nameplate

At the time of acceptance or maintenance inspection, if any fault is found in relay elements, contact the nearest service shop of our company.

**MITSUBISHI ELECTRIC CORPORATION**

HEAD OFFICE : 7-3 MARUNOUCHI 2-CHOME, CHIYODA-KU TOKYO, 100-8310, JAPAN

**Revised in Sep. 1999**