# MICROMHO
# Static Distance Protection Relays

## Features

- Complete 3 zone static design including main tripping outputs
- Very fast operating speed
- Unique polarising system ensures fast operation even under close-up, three-phase fault conditions
- Stability unaffected by CVT transients
- High measurement accuracy with negligible transient overreach
- Eighteen separate measuring elements, six for each zone
- Five basic, in-built, scheme arrangements, selected by switch
- Integral microprocessor-based scheme logic
- Suitable for 3 phase or single phase tripping
- Very low voltage and current circuit burdens
- Mutual compensation provided
- Optional built-in earth fault directional comparison scheme to cover high resistance faults
- Built-in voltage transformer supervision
- Built-in power-swing blocking
- Full range of test features for commissioning and routine testing. Interfacing enables automatic field test equipment to be used, if required
- Retention of trip indication in the event of any interruption of the dc supply

## Application

### SHNB 102

MICROMHO is a static distance protection scheme, specially designed for comprehensive, ultra high speed protection of hv and ehv power transmission systems.

Three zones of protection are included, each employing separate measuring elements covering each type of phase and earth fault. When used with a suitable signalling channel, MICROMHO will ensure very rapid clearance of any type of fault within the complete transmission line section.

A selection of alternative tripping schemes, in-built as standard, provides great versatility of operation, simply by the flick of a switch.

MICROMHO is the ideal choice for the first main protection system complemented by both the OPTIMHO relay, described in publication R4056 and the QUADRAMHO relay, described in publication R5580. This relay has been designed for system voltages up to 220kV and as a second main or back-up protection for higher voltage systems.

### SHNB 103

This version is specially designed for more difficult applications such as series compensated lines, lines adjacent to dc converter stations, and hybrid systems - a combination of overhead lines and underground cables.

The relay has additional filtering in the current circuits to work with the higher level of waveform distortion associated with these applications.

The relay operating times are slightly longer than SHNB 102 (3-5ms) due to the additional filtering and comparator 'count' strategy. The relay also has a higher level of memory, or synchronous polarising than the standard 102 model, with 80% memory polarising.

## Facilities

MICROMHO has many facilities available as customer options. The modular system enables most of the options to be provided simply by substituting or by adding extra modules selected from a standard range. These facilities include:

- Blocking of Zones 1 and/or 2 and/or 3 under power swing conditions
- Voltage transformer supply supervision to give an alarm and, if required, to block tripping
- Directional earth fault protection providing coverage of high resistance earth faults which may not be detected by the distance elements.
- Mutual zero sequence compensation for Zone 1 and/or extended Zone 1 and/or Zone 2 when used to protect double circuit lines. This has a novel feature to prevent the healthy line relays maloperating for faults in the adjacent feeder.

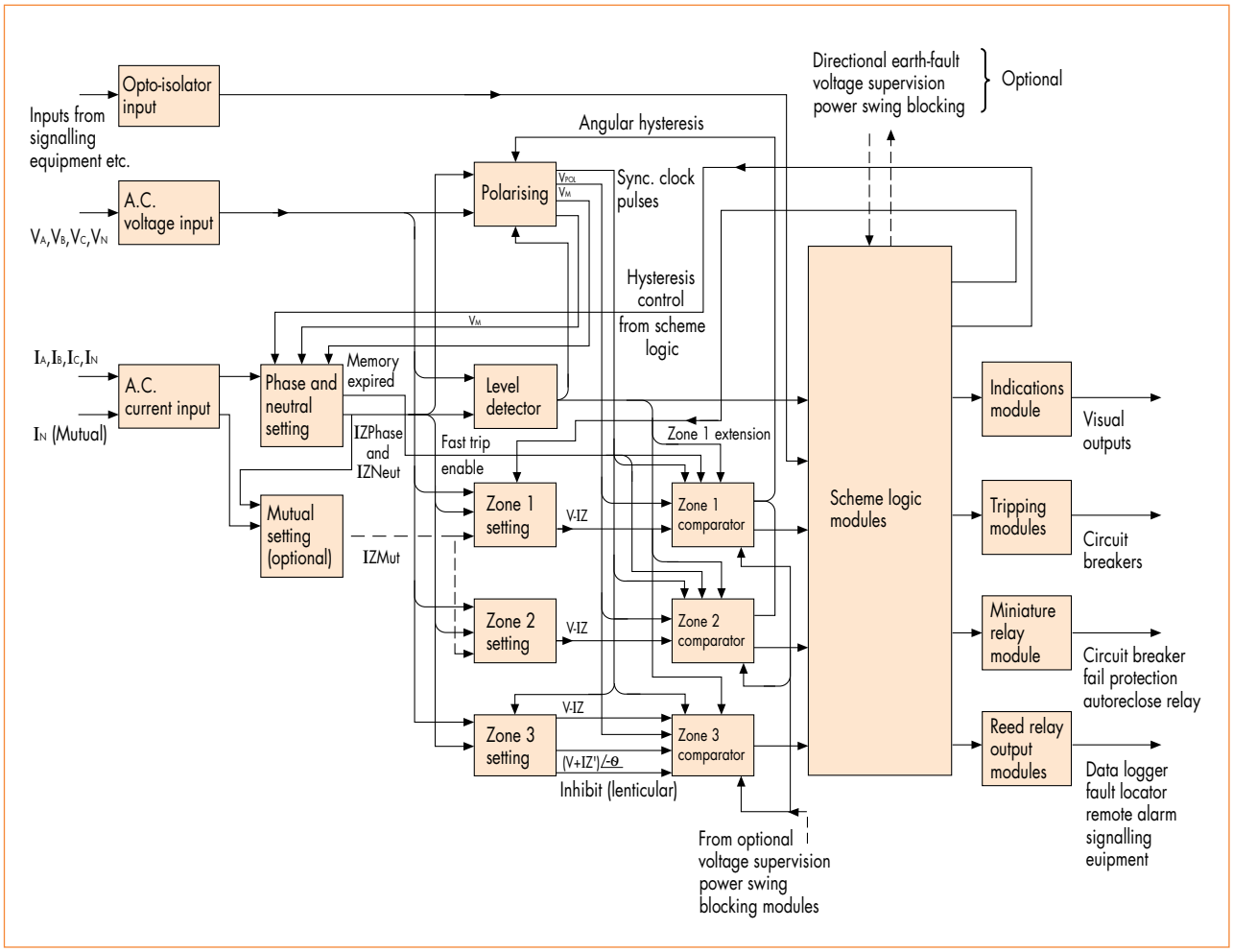


*Figure 1: Block diagram of complete relay*

## Operation

A block schematic diagram of the complete relay is shown in Figure 1. Typical external connections, and a key to the relay modules, are illustrated in Figures 9 and 10.

The relay has three independent zones of protection, having circular (mho) characteristics on the R, X plane, as shown in Figure 2. Separate comparators are provided for each type of phase and earth fault.

An alternative lenticular (lens-shaped) Zone 3 characteristic is available, with variable aspect ratio, to avoid the problem of load impedance encroaching into the operation zone. This characteristic, shown in Figure 3, is particularly useful where long reach is required to provide remote back-up.

The scheme has very fast Zone 1 operating speed, with operation times typically half a cycle including tripping element time. This high speed is couples with negligible overreach even in the presence of CVT transients.

The relay measurement accuracy is extremely high. For Zone 1 the accuracy is better than ±5% for system impedance ratios of up to 30, that is, faults down to 2.05V and 21% of rated current, $I_n$. For system impedance ratios of 30 to 60 the accuracy is ±10%.

### Synchronous polarising system

A unique synchronous polarising circuit, shown in Figure 4, ensures that the Zone 1 and Zone 2 elements operate down to zero voltage. Specially developed for MICROMHO, this circuit combines the advantages of partial sound-phase polarising for unbalanced faults and memory polarising for 3 phase faults.
The partial cross-polarising provides a limited expansion of the resistive coverage of the relay for low voltage faults. If greater expansion is required for the Zone 1 earth fault elements, 100% cross-polarising is available as an option. For low voltage 3 phase faults the synchronous polarising remains in step with the system frequency and ceases after 11 cycles.

### Current level detectors

Integral current units act as a check to prevent any possibility of the comparators maloperating during line de-energisation. The current units also ensure correct resetting of the faulty phase comparators during single phase auto-reclose dead times, when current in the residual current compensation circuit is present due to load current flow in the two healthy phases.

**Alternative tripping schemes**

MICROMHO is equipped with integral microprocessor-based scheme logic which provides five basic tripping schemes, selectable by pushbutton switches.

These are:

- Basic 3-zone distance
- Zone 1 extension
- Permission underreach*
- Permissive overreach*
- Blocking scheme*

*Requires signalling channel

Each scheme also provides the choice of 3 phase tripping or single and three-phase tripping.

The scheme logic contains the timers for Zone 2 and Zone 3 time delayed tripping, with separate settings for phase and earth faults, as well as the necessary timers for the individual tripping schemes.

The scheme logic also provides instantaneous clearance of 3 phase close-up solid faults arising when the circuit breaker is closed. This feature is available for power systems having busbar VT's, provided that an auxiliary contact is available on the circuit breaker.

The relay has integral tripping elements for either 3 phase tripping or single and 3 phase tripping of one or two breakers, and has repeat contacts available for interfacing with external communications channels or auto-reclose equipment, alarms, fault recorders and fault locators.

**Fault indication**

Indications are given by light-emitting diodes which may be reset by a push button on the relay.

**Power supply**

The power supply for the relay is a fully isolated dc/ac/dc unit operating from the station battery supply. It is continuously rated at maximum output and draws 28W from the station battery supply under normal healthy conditions.

An electro-mechanical indicator is provided to give indication that the output from the power supply is healthy, while an alarm contact gives remote warning of the failure of the supply.

**Reach setting**

Setting the distance reach of the relay is carried out by means of switches on the front panel. For Zone 1 there are separate settings for phase fault and earth fault elements, the total range of setting of a 1A relay being from 0.2 to 240Ω in 2% steps. For a 5A relay the range is 0.04 to 48 Ω.

Separate characteristic angle settings are provided for phase setting, residual compensation and (where fitted) mutual compensation, each with a range of 85° to 60° in 5° steps.

**Tripping**

The standard MICROMHO uses thyristors to provide the trip output. These are used because of their high operating speed and are ideal for most applications.

High speed tripping relays may be provided as an option. Using these outputs will add approximately 2.5ms to 3ms to the operating time of the MICROMHO when compared with the thyristor tripping version but, otherwise there is no effect on the relay's performance.

**Monitoring facility**

For ease of commissioning, the scheme logic module has pushbutton switch positions which enable the state of the various internal signals in the scheme to be monitored by means of the light emitting diodes of the indications module.

Other switch positions enable the tripping elements to be operated when a push button is pressed, to check the integrity of the tripping circuits.

Visual and remote alarms are given when the scheme logic is in a monitoring mode, to prevent the switches being left accidentally in any of the test positions.

The monitoring facility also aids fault finding should this ever be necessary, and in conjunction with a special extender card, enables a faulty module to be identified with the minimum of test equipment. No recalibration is required when a faulty module is replaced. A range of standard modules is available as spares for all the different ratings and options.

The relay has a self-monitoring feature which gives remote warning of failure of the output from the power supply.

The same alarm circuit monitors certain other critical internal signals in the relay and gives warning of failure by closing a reed relay contact.

**Directional earth fault**

The optional Directional Earth Fault feature of the MICROMHO measures zero sequence current in order to detect high resistance earth faults occurring in the forward direction, which may not be detected by the distance protection measuring elements.

The unit utilises separate scheme logic to provide a directional comparison scheme, which uses an independent signalling channel to allow fast tripping of the line, with additional time-delayed tripping provided for back-up protection.

A push-button switch is provided which allows either a permissive or a blocking scheme to be selected for directional comparison and also provides a number of test options to be used to monitor the state of internal signals during commissioning or testing of the relay.

**Test facilities**

An additional 9-way test socket is included on module 14 which allows the selector switches to be overridden electrically. This, together with facilities to mount detection equipment on the indications module, allows the use of a programmable secondary injection test set.

External trip links must be provided to isolate the trip circuit for commissioning and on-load directional tests.

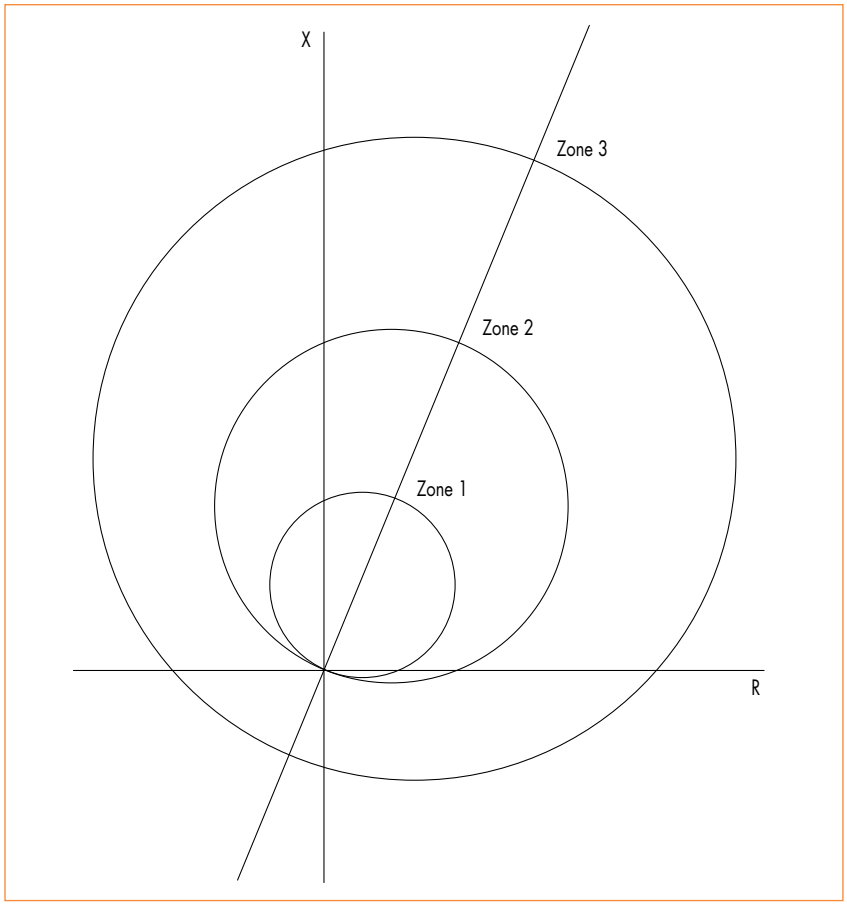


*Figure 2: Operation zones with circular Zone 3 characteristic*

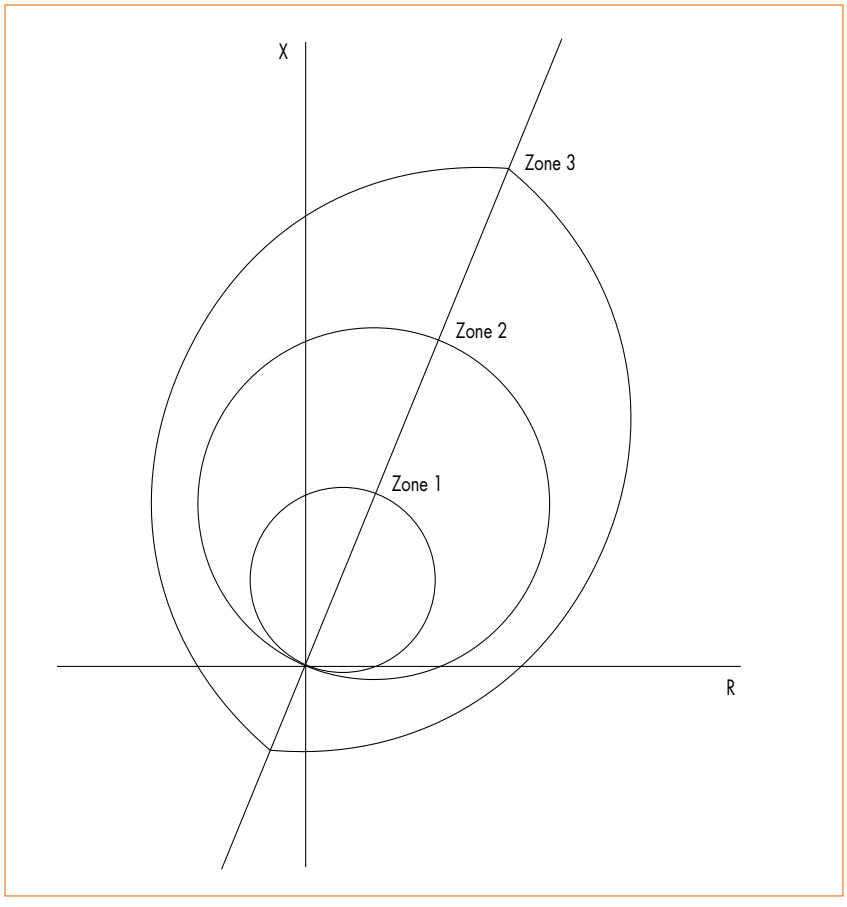


*Figure 3: Operation zones with lenticular Zone 3 characteristic*

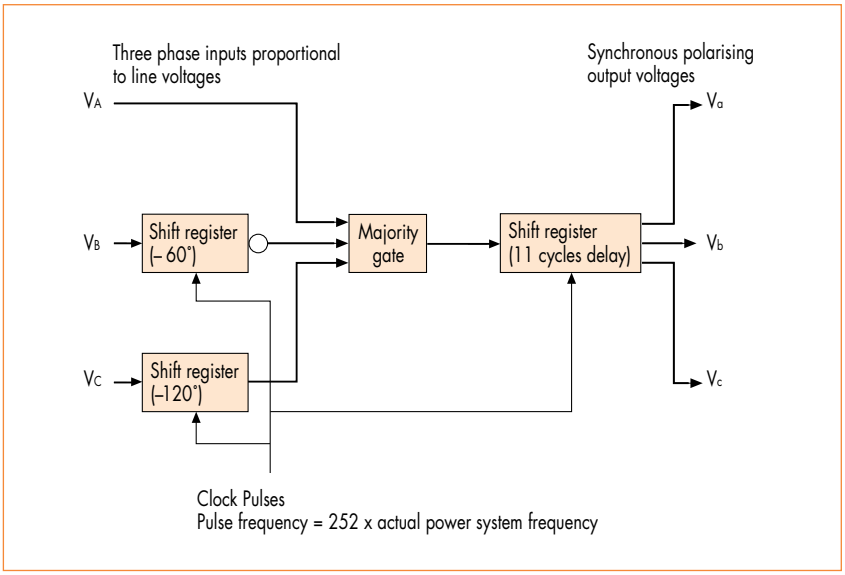


*Figure 4: Block diagram of synchronous polarising system*

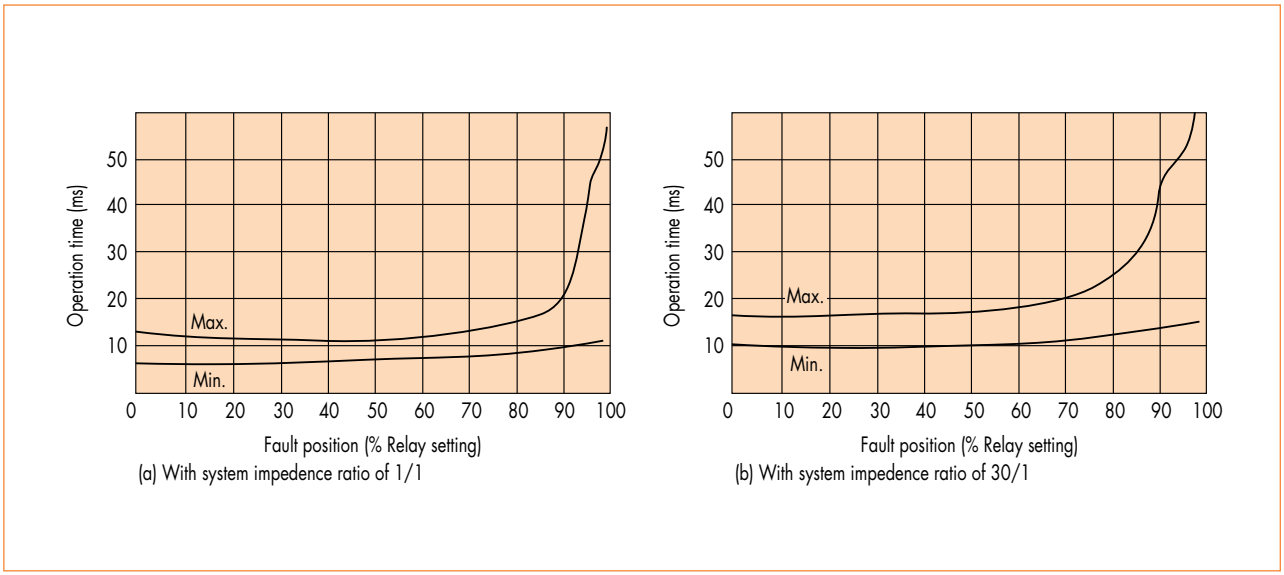


*Figure 5: Typical operating time characteristics: Zone 1 phase-earth faults*

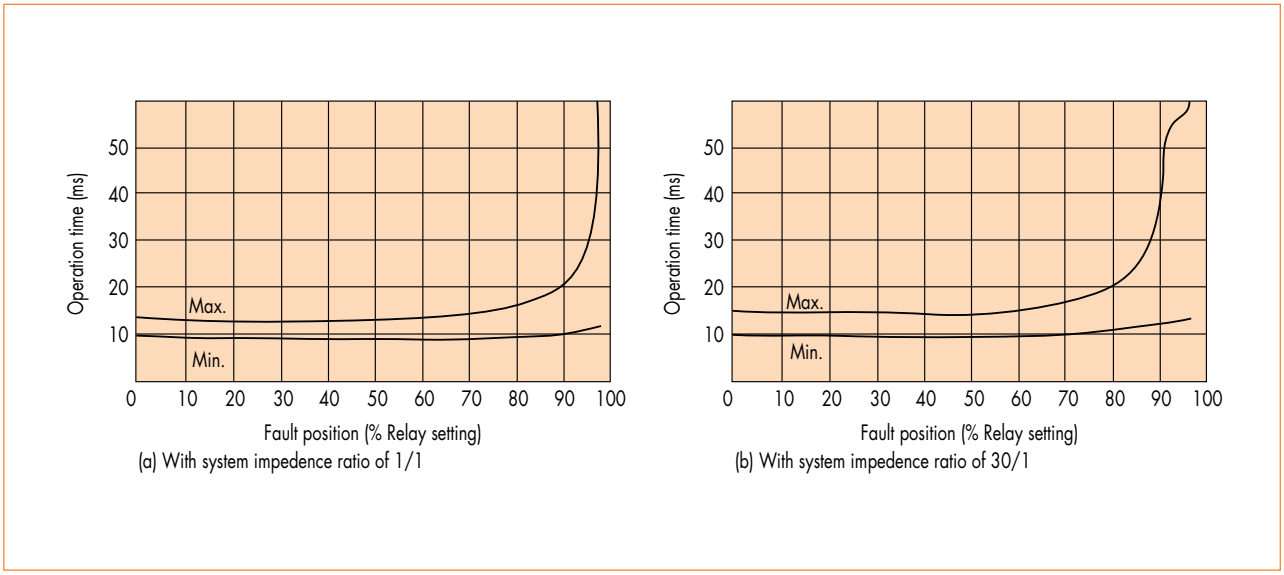


*Figure 6: Typical operating time characteristics: Zone 1 phase-phase faults*

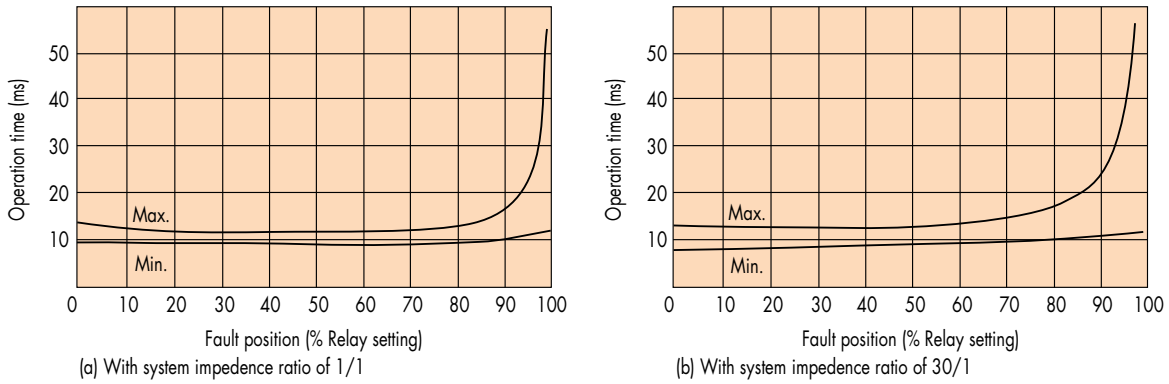


*Figure 7: Typical operating time characteristics: Zone 1 three phase-earth faults*

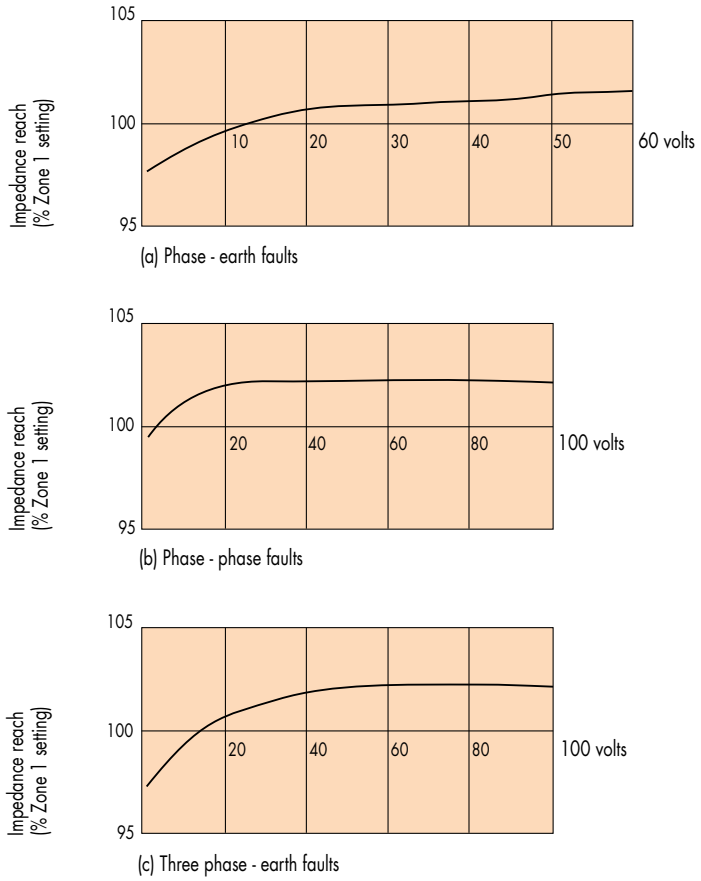


*Figure 8: Typical impedance reach accuracy characteristics for Zone 1*

## Technical Data

**Ratings**

| | |
|---|---|
| AC Voltage(V) | 100V to 120V rms phase-phase |
| AC Current (I) | 1A or 5A rms per phase |
| Frequency | 50Hz or 60Hz |
| DC Supply (V) | 48/54V, 110/125V or 220/250V<br>Tolerance +10% –20% of rated value |

**Burdens**

| | |
|---|---|
| AC voltage circuits | Less than 0.1VA, 0.4pf per phase at 63.5V phase to neutral |
| AC current circuits | 1A relay: 0.27VA per phase<br>5A relay: 1.1VA per phase<br>(with balanced three phase rated current) |
| DC supply | 60W under tripping conditions<br>28W under standby conditions |

**Setting ranges**

| | |
|---|---|
| Distance measurement: | |
| Overall range, all zones | 1A relay: 0.2Ω to 240Ω<br>5A relay: 0.04Ω to 48Ω |
| Coarse settings, all zones | 1A relay: 0.2Ω to 4.8Ω in 0.2Ω steps<br>5A relay: 0.04Ω to 0.96Ω in 0.04Ω steps |
| Fine settings<br>(multiples of coarse settings) | Zone 1: 1 to 9.98 in 0.02 steps<br>Zone 2: 1 to 9.98 in 0.02 steps<br>Zone 3: 1 to 9.9 in 0.1 steps<br>Zone 3 offset: zero, 0.25, 0.5, 1,2<br>Note: These settings can be further adjusted by an additional multiplier with 1x and 5x settings<br>Extended Zone 1: 1x to 2x normal Zone 1 in 0.02 steps |
| Power swing blocking characteristics (multiples of coarse distance setting) | Forward reach: 1 to 9.9 in 0.1 steps<br>Reverse reach: 1 to 9.9 in 0.1 steps<br>Note: These settings can be further adjusted by an additional multiplier with 1x, 2x, 5x and 10x settings |
| Directional earth fault current level detectors | 10, 20 or 30% of neutral rated current |
| Directional earth fault time delay | 0.5-7.5s in 0.5s steps |
| Residual compensation | 1A relay: 0.02Ω to 5.98Ω in 0.02Ω steps<br>5A relay: 0.004 Ω ohms to 1.196 Ω ohms in 0.004 Ω ohm steps |

| | |
|---|---|
| Mutual compensation | Where fitted the ranges are as quoted above for residual compensation but with maxima of 3.98Ω (1A) and 0.796Ω (5A). |
| Characteristic angle | Phase: 85° to 60° in 5° steps<br>Residual: 85° to 60° in 5° steps<br>Mutual: 85° to 60° in 5° steps (where fitted) |
| Lenticular aspect ratio | For Zone 3 and power swing blocking:<br>0.47, 0.58, 0.70, 0.84 and 1.0 (setting of 1.0 gives circular characteristic) |
| Time delays | Zone 2: 0 to 2.55s in 10ms steps<br>Zone 3: 0 to 5.1s in 20ms steps<br>Both zone times separately adjustable for phase and earth faults |
| **Operating time** | Typical operating time characteristics are shown in Figures 5, 6 and 7 |
| **Polarising** | |
| Zone 1 earth fault units | Choice of full or partial (16%) sound phase cross-polarising |
| Zone 1 phase fault units and Zone 2 units | Partial (16%) sound phase cross–polarising |
| Synchronous polarising | Effective on Zone 1 and Zone 2 elements, for 11 cycles, for 3 phase close-up faults |
| Directional sensitivity without synchronous polarising | 1% of nominal voltage for 3 phase faults |
| Synchronous polarising tracks | With rate of change of up to 6Hz/s over range<br>42Hz to 56Hz (50Hz nominal) or 52Hz to 66Hz (60Hz nominal) |
| **Accuracy** | |
| Zone 1 reach | ±5% up to a system impedance ratio of 30, as shown in Figure 8.<br>±10% up to an S.I.R. of 60 with the relay set up to 4.8Ω (1A relay) or 0.96Ω (5A relay) |
| Zone 2 reach | ±10% up to an S.I.R. of 60 |
| Zone 3 forward reach | ±10% up to an S.I.R. of 60 |
| **Ambient temperature range** | |
| Operative range | –20°C to +55°C |
| **Overload ratings** | |
| AC voltage | Withstands 1.5Vn continuously<br>2.5Vn for 10s |
| AC current | Withstands 3 In continuously<br>100 In for 1s |

**Contacts** Shown in Figure 9

**Contact ratings**

| | |
|---|---|
| Thyristor trip outputs | Make and carry 30A for 0.5s with maximum 300V dc |
| | Carry 2A dc continuously (with thyristor gate pulses removed) |
| | Break - not applicable |
| Reed relay alarms (normally open) | Make, carry and break 35VA with maxima of 2A and 300V, ac or dc |
| Reed relay alarms (normally closed) | Make, carry and break 20VA with maxima of 1.5A and 300V, ac or dc |
| Electro mechanical relay outputs and high speed electro mechanical tripping relay output (if fitted) | Make and carry 7500VA for 0.2s with maxima of 30A and 300V, ac or dc<br>Carry continuously 5A ac or dc |
| | Break 1250VA ac or 50W dc resistive or 25W dc indictive, with maxima of 5A and 300V |

**Insulation**

IEC 255–5, series C — 2kV 50/60Hz for one minute

**Impulse test withstand**

IEC 255-4,Appendix E, Class III — 1MHz, 1kV peak transverse mode,

**High frequency disturbance**

IEC 255-6, Class III — 1MHz, 1kV peak transverse mode, 2.5kV peak longitudinal mode, decaying to half value in 3 to 6 cycles Repetition rate: 400 per second

**CT requirements**

The CT's should have a minimum knee point output voltage Vk defined as

$$V_K = I_F\left(1 + \frac{X}{R}\right)(Z_R + R_{CT} + R_L)$$

Where $I_F$ = The maximum fault current at the relay zone 1 reach point in secondary terms

$\frac{X}{R}$ = primary system ratio

$Z_R$ = relay burden impedance

$R_{CT}$ = CT internal resistance in secondary terms

$R_L$= lead resistance from CT's to relay (lead and return for earth faults, lead only for phase faults)

The following table gives the value of $Z_R$

| | | | |
|---|---|---|---|
| 1A relay | earth faults | $Z_R = 0.58\Omega$ | $\angle -8°$ |
| | phase faults | $Z_R = 0.27\Omega$ | $\angle -8°$ |
| 5A relay | earth faults | $Z_R = 0.089\Omega$ | $\angle -8°$ |
| | phase faults | $Z_R = 0.043\Omega$ | $\angle -8°$ |

$Z_R$ of mutual compensation circuit

| | | | |
|---|---|---|---|
| 1A relay | earth faults | $Z_R = 0.27\Omega$ | $\angle -8°$ |
| 5A relay | earth faults | $Z_R = 0.043\Omega$ | $\angle -8°$ |

ZR of directional earth fault polarisation circuit

| | | | |
|---|---|---|---|
| 1A relay | earth faults | $Z_R = 0.027\Omega$ | $\angle -8°$ |
| 5A relay | earth faults | $Z_R = 0.005\Omega$ | $\angle -8°$ |

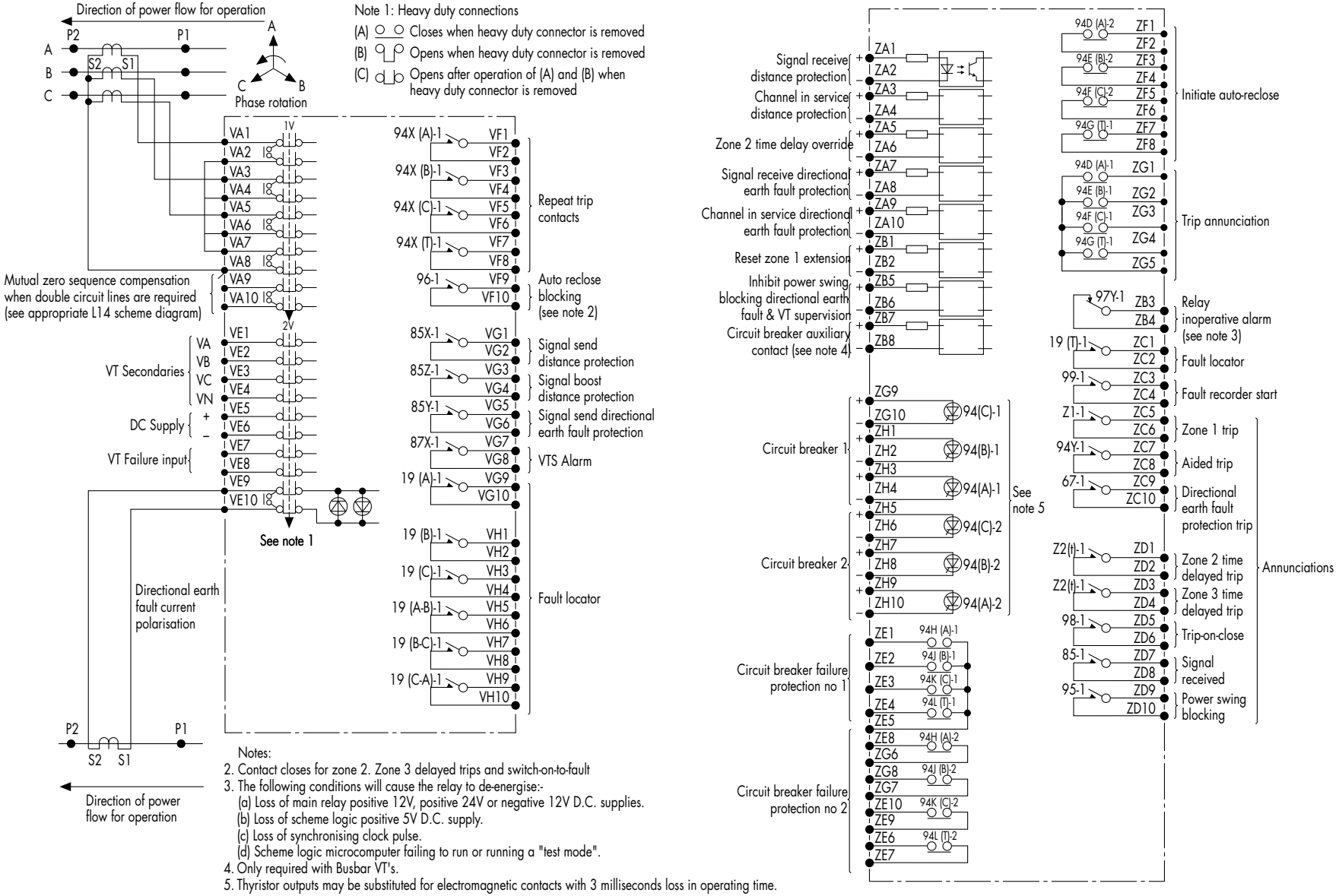


*Figure 9: Typical diagram of external connections and contact arrangements*

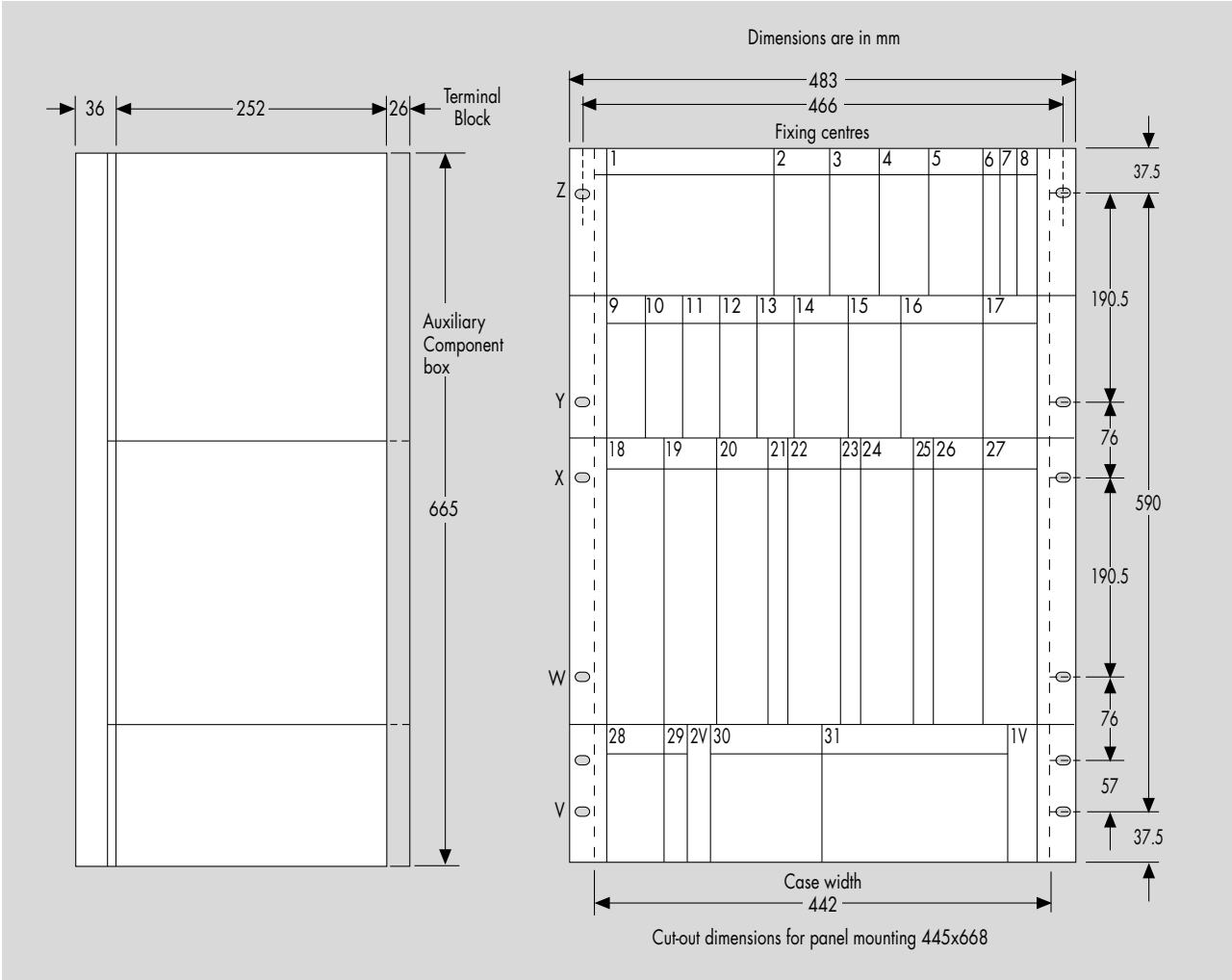


*Figure 10(a): Outline drawing and module layout - rack mounting*

| Module Position | Module Reference | Module Function |
|---|---|---|
| 1 | RPA06 | Power supply |
| 2 | ZBB06 | Blank |
| 3 | RVS02 or RVC55 | Static tripping *E/M tripping |
| 2 3 | RVS02 or RVC54 | Static tripping High speed *E/M tripping |
| 4 | RVC51 | *E/M output |
| 5 | RVH03 | Reed relay output |
| 6 | RFJ01 | Optical isolator input |
| 7 | RFJ01 | Optical isolator input |
| 8 | RFJ01 | Optical isolator input |
| 9 | RMV02 | Level detector |
| 10 | RMV02 | Level detector |
| 11 | RMV02 | Level detector |
| 12 | RMV02 | Level detector |
| 13 | RMU01 | Voltage supervision |
| 14 | RCL07 | Input/output expander 1 |
| 15 | RCL04 | Input/output expander 2 |
| 16 | RCL08 | Microprocessor |
| 17 | RVV06 | Indications |
| 18 | RRZ01 | Phase and neutral impedance setting |
| 19 | RRZ02 | Mutual impedance setting and directional earth fault |
| 20 | RRM01 | Zone 1 setting |
| 21 | RMS02 | Comparator |
| 22 | RRM01 | Zone 2 setting |
| 23 | RMS02 | Comparator |
| 24 | RRM02 | Zone 3 setting (circular) or RRM05 Zone 3 setting (lenticular) |
| 25 | RMS02 | Comparator |
| 26 | RCB02 | Power swing blocking |
| 27 | RGC01 | Polarising |
| 28 | RVH03 | Reed relay output |
| 29 | RVH02 | Reed relay output |
| 30 | RFV02 | AC voltage input |
| 31 | RFC04 | AC current input |
| 32 | ZRB05 | Auxiliary component box (mounted on rear of relay) |

1V Heavy duty connector

2V Heavy duty connector

*Note E/M Electro-mechanical

*Figure 10(b): Key to modules*

## Cases

The relay can be housed in a case suitable for either rack mounting or panel mounting.

The relay cases, together with the module nameplates and the frames for the glazed front covers are finished in black.

## Information Required with Order

Nominal current rating: 1A or 5A

Nominal voltage rating: 100V, 110V, 115V or 120V

Frequency: 50Hz or 60Hz

Voltage of dc supply: 48/54V, 110/125V or 220/250V

Tripping: single/three phase or three phase

Zone 3 characteristic: circular or lenticular

Optional features required:

Blocking mode feature

Voltage transformer supervision

Power swing blocking

Mutual compensation

Directional earth fault

Mounting arrangement: rack, flush or panel

Tripping relays as an alternative to the standard thyristor tripping

Advice on applications is available when the information requested is difficult to specify. Requests for advice should include the following details:

Voltage transformer ratio

Current transformer ratio

Positive and zero sequence impedances of the protected feeder or full details of feeder length and construction.

Source impedances or fault levels for both minimum and maximum plant conditions.

Accessories to aid injection testing are available, Reference SHNB accessory kit 01 or 02. For more details consult the Relay Sales Department.

Injection testing information can be found in chapter 3 section 2.1 of the MICROMHO Service Manual.