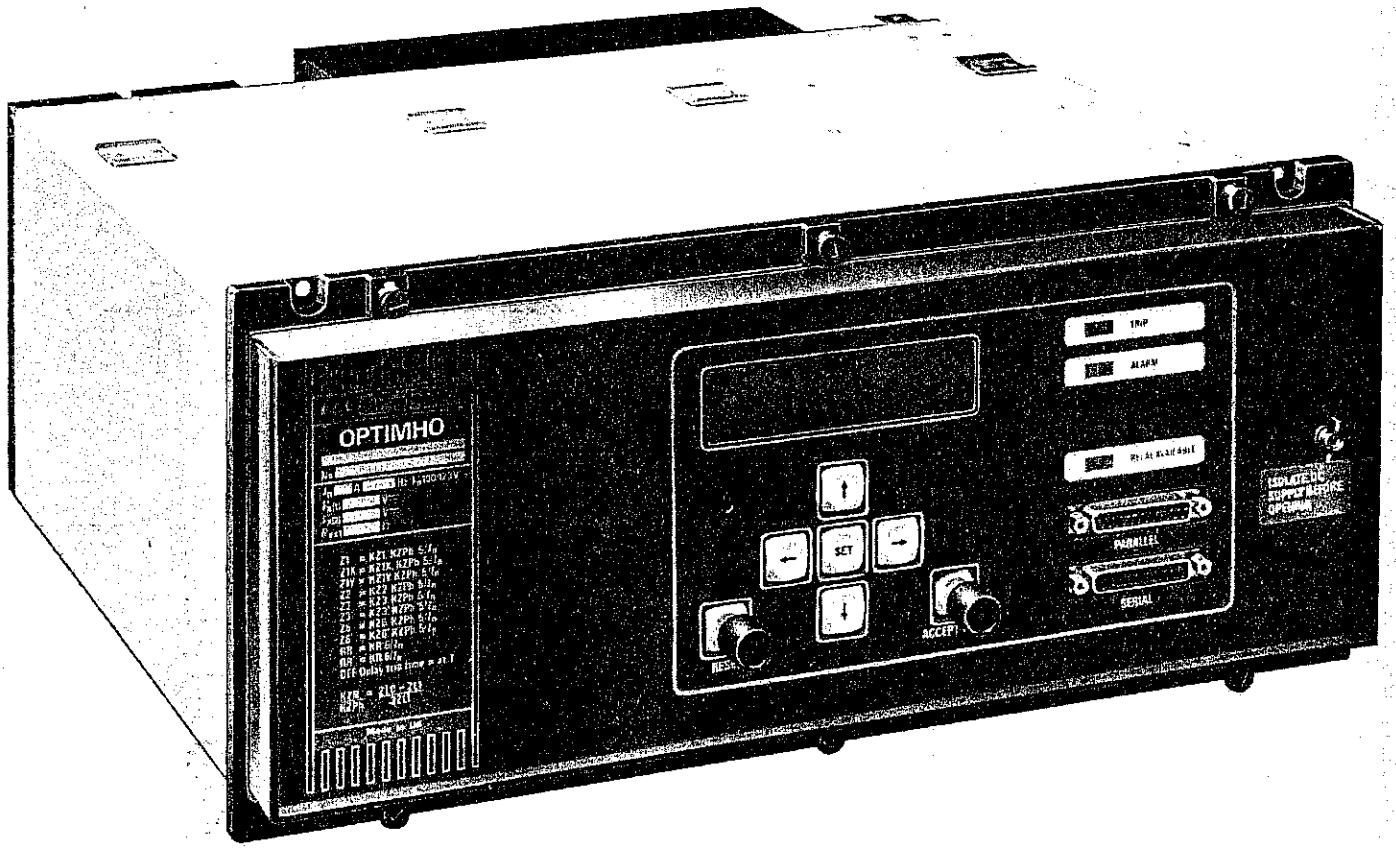
GEC Measurements

# OPTIMHO
# Static Distance Protection Relays



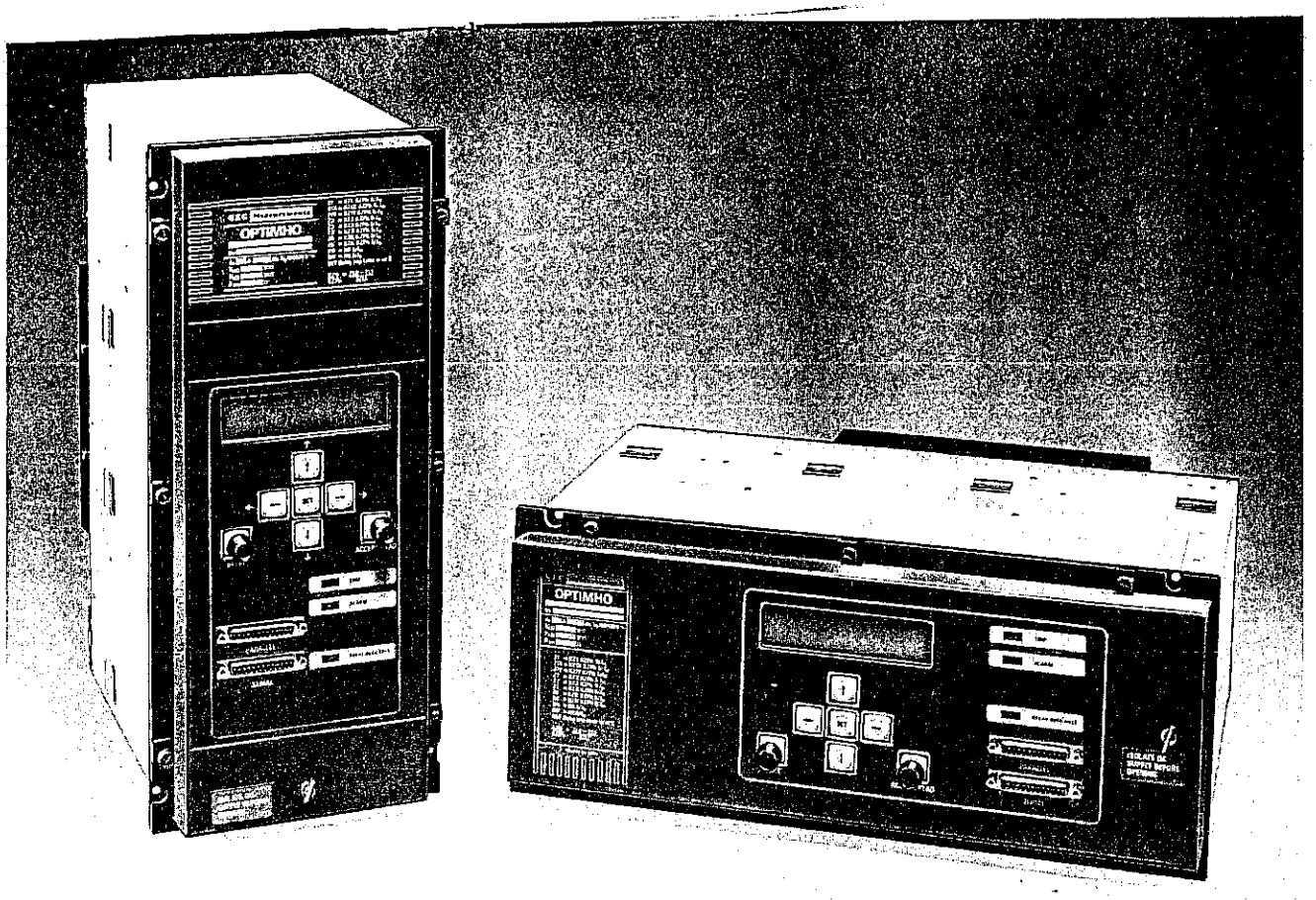



*Figure 1. Optimho (Type LFZP) relays*

# Type LFZP OPTIMHO Static Distance Protection Relays

## FEATURES

- Full scheme distance relays with 18, 12, 9 or 6 measuring units.
- Phase and ground distance, phase distance or single phase distance protection.
- Single or multiple zones.
- Optional directional earth fault protection.
- Typical operating time: one cycle for three phase faults.
- Optional fault location with data recording for post fault analysis and instrumentation functions.
- Integral user interface for easy access to relay setting and fault records.
- Remote communication if required.

## BENEFITS

- Wide model range for accurate matching to applications.
- Remote interrogation reduces need for site visits.
- Precise fault type / location data reduces outage time.
- Self diagnosis reduces maintenance costs.
- Vertical case option eases retrofit problems.
- Will interface with existing scheme logic.
- Fulfils basic SCADA role at no extra cost.

## APPLICATIONS OF OPTIMHO

Optimho is produced in several models, each suitable for a specific range of applications. The more sophisticated models have features and functional abilities which can fulfil the most exacting duties. These can include ehv applications depending on the fault clearance time required. The more basic models have reduced hardware and software to suit the simpler requirements of sub-transmission and distribution systems.

Optimho complements the well established Micromho and Quadramho, enhancing the already outstanding family of distance protection available from GEC Measurements.

The range of applications includes:

– main and back-up protection of overhead lines and underground cables including transformer feeders

– back-up protection of transformers, auto-transformers and shunt reactors (LFZP151)

– protection of solid or resistance earthed systems.

– three-pole or single-and-three-pole tripping, with or without the aid of a signalling channel.

– single zone relays used in multiple zone schemes to provide ultra-high reliability by additional redundancy of protection (LFZP121, 122 or 132 with one zone enabled).

– on-site replacement of obsolescent electro-mechanical or switched static distance relays.

– protection of systems with open-delta line voltage transformers or 3-phase 3-limb line voltage transformers (LFZP131 or 132).

– phase selection to allow, for example, a power line carrier phase comparison scheme (such as P10) to carry out single pole tripping (LFZP114).

## INTEGRAL USER INTERFACE

All relay settings and records are accessible from the integral user interface shown in Figure 4.

The liquid crystal display (LCD) indicates how the relay initiated the latest trip. The faulty phase and zone are indicated for trips initiated by the distance elements. The latest alarm condition is also indicated. If indications are present when the supply is lost, they are automatically reinstated when the supply is restored.

The date and time of the fault, location (if available), and more, are summoned by pressing READ. After the indications have been read, they can be cleared by pressing RESET, and the READ key can then be used to step through all the relay settings displayed in sequence.

The cursor and SET keys, and the two test sockets, are only accessible after removing the transparent front cover. The keys are used to select from a menu of options displayed on the LCD in English, and to enter new settings into temporary memory. The menu has a simple structure, allowing rapid familiarisation.

The SET key is used to transfer temporary entries to the permanent memory which determines relay action. Accidental changes are prevented by allowing SET to be operative only at certain points in the menu after appropriate warnings have been displayed.

## MENU OPTIONS

The menu holds an extensive range of options, including:

- viewing records of the LCD indications from the last four faults
- printing records or settings on a portable printer plugged into either the SERIAL or PARALLEL test socket
- entering a relay identification code for use on printouts
- comprehensive test options such as : monitoring test points on the PARALLEL socket; blocking output contacts (the relay inoperative alarm contact closes when the output contacts are blocked); simplified on-load directional testing; and closing selected output contacts (for instance to carry out a circuit breaker test)
- setting up the baud rate and protocol for the serial communications.

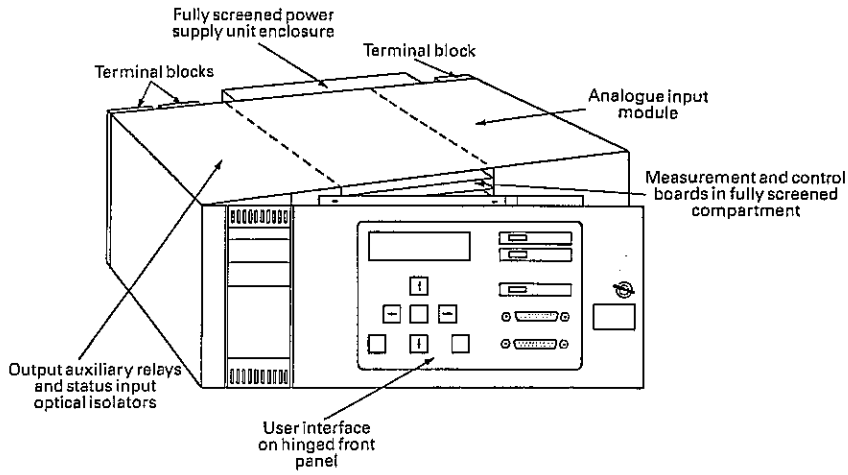



*Figure 3. Mechanical layout of LFZP.*

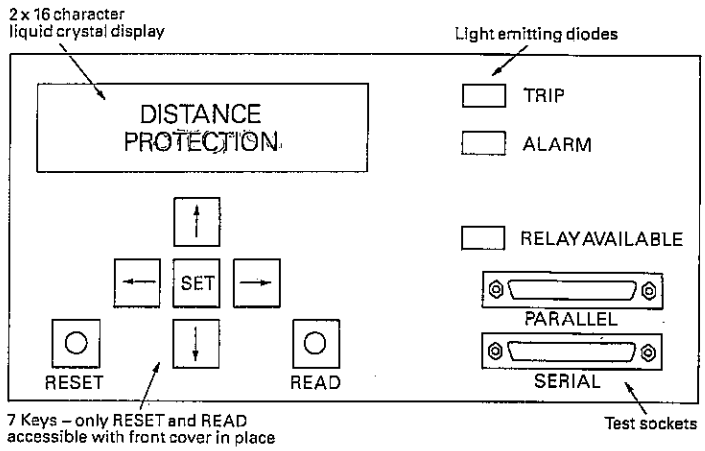



*Figure 4. User interface on front panel.*

## SETTINGS

The setting options allow the user to select functions to suit each application. The available options depend upon the model of Optimho, but usually include:

- scheme type
- which distance zones are enabled (up to 5 zones)
- whether ground fault time delayed zones (if fitted) are enabled
- direction of reach-stepped zones or of Zone 3 (if fitted)
- whether START indications are required for remote faults which do not result in a trip.

The menu is adaptive; for example, if Zone 2 is not required and has been disabled, its time setting is automatically removed from the menu.

## SCHEMES AVAILABLE

The scheme selection varies with the model of Optimho. Most models have basic distance with up to 3 independent zones available, designated Z1, Z2 and Z3. Additional zones 1X and 1Y are obtained, if required, by stepping the reach of the Zone 1 elements after time delays started by the Zone 2 and/or Zone 3 elements. On some models Zone 2 is obtained by stepping the reach of Zone 1, while on some other models, Zone 3 is omitted.

Zone 1 extension and Zone 2 acceleration schemes are provided in all models except the back-up protection LFZP 151. Models with independent Zone 1 and Zone 2 elements also have selectable permissive underreach, permissive overreach and unblocking schemes. The latter two schemes are complete with current reversal guard logic and open breaker echo logic.

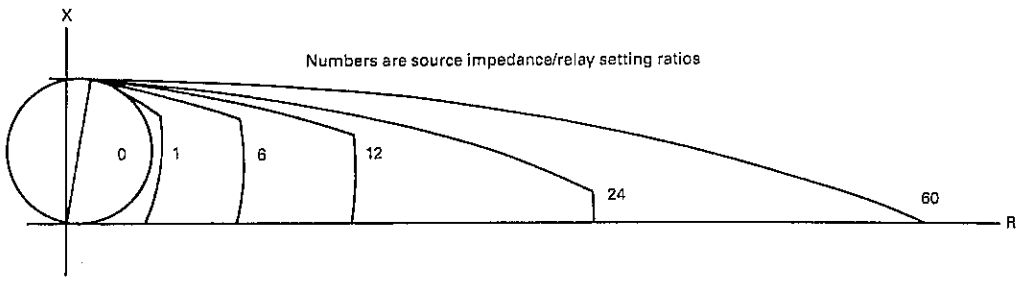



*Figure 5. Resistive expansion of partially cross-polarised mho under fault conditions for solidly grounded systems.*

Models having independent Zone 1, Zone 2 and Zone 3 have additional permissive overreach and unblocking schemes with weak infeed logic, also the blocking scheme. These schemes require Zone 3 to be set reverse looking.

Single pole tripping logic is available in some models.

## REMOTE COMMUNICATIONS

All the options available on the menu are also available from a local or remote terminal via an RS232C serial communication port. Sockets are provided on both the front and the rear of the relay for temporary or permanent connection respectively. The socket on the rear can also interface with a modem for communication over a suitable link, for instance a telephone line.

## DISTANCE CHARACTERISTICS

The phase comparator is arranged to produce several types of distance characteristics for the different models of Optimho. For further information see Table 2, Page 19.

| Characteristic type | Description |
|---|---|
| m | Partially cross polarised shaped mho with partial synchronous polarising for 3-phase faults. Expansion under fault conditions is more than adequate to cover arc and tower footing resistance for most systems, with excellent phase selection. See Figure 5. |
| f | Fully cross polarised (or quadrature polarised) mho with partial synchronous polarising for 3-phase faults. Similar to Type m above but used where only phase fault protection is required. |
| c | Self polarised mho, with a small proportion of cross polarising: used for ground fault protection of underground cables at high and medium voltages. |
| q | Quadrilateral with adaptive reactance measurement to avoid overreach or underreach for resistive faults with prefault load. The directional measurement is partially cross polarised. The resistive reach setting is variable up to 150 ohms (1A relay) or 30 ohms (5A relay). The quadrilateral is used instead of Type m above to cover ground fault resistance on overhead lines shorter than 15km, on resistance neutral systems, or on systems with high ground resistivity. See Figure 6. |
| D | Offset quadrilateral: as Type q but with reverse reach for busbar back-up protection in Zone 3 time. |
| N | Offset lenticular with a variable aspect ratio set to avoid load encroachment on long lines. A circular offset setting for shorter lines is included. The reverse reach is used for busbar back-up protection in Zone 3 time. Reach stepped zones whose timers are started by Zone 3 automatically avoid load encroachment if Zone 3 is shaped to avoid the load impedance. See Figure 7. |
| Q | Selectable between Type D and reverse Type q. |
| L | Selectable between Type N and reverse Type m. |
| P | Selectable between Type N and reverse Type f. |

## POLARISING

The partial cross polarising signal used in various distance characteristics is a square wave derived from a healthy phase reference, and 16% of the amplitude of the prefault voltage. This wave is added to the faulty phase voltage, and dominates it for close-up unbalanced fault conditions. This provides a clear directional reference even in the presence of capacitor voltage transformer transients.

The partial synchronous polarising is similar to partial cross polarising but is effective for 3-phase faults. Synchronous polarising is derived from prefault voltage and is available for 16 cycles after fault incidence to cover breaker failure protection time. Several cycles must elapse from system energisation before synchronous polarising is available, so switch-on-to-fault logic is arranged to provide protection for close-up 3-phase faults during this initial period.

## DIRECTIONAL EARTH FAULT PROTECTION

(not available in all models)

The directional earth fault protection (DEF) has these features selectable via the user interface:

– time delayed tripping, either definite time or inverse definite minimum time using a selection of built-in IEC or American curves. See Figure 8.

– instantaneous high-set tripping, available if the model of Optimho has no Zone 1 instantaneous ground fault elements fitted.

– aided tripping via permissive overreach, unblocking, or blocking schemes (depending on the model), which work in conjunction with the distance scheme, sharing the same signalling channel.

– choice of polarising for the directional element :

negative sequence voltage derived from internal filters (compared against negative sequence current).

zero sequence current from a separate current input

zero sequence voltage (in some models) derived internally from $V_A$ $V_B$ and $V_C$.

dual zero-sequence current and voltage (some models only).

The overcurrent elements use zero sequence current as the operating quantity irrespective of the type of polarising used for the directional element.

The negative sequence filters are self-adaptive to system frequency, allowing greater sensitivity than is possible with fixed filters tuned to the nominal system frequency.

A magnetising inrush current detector is provided to prevent maloperation when energising in-zone transformers. The circuit uses the principle of detecting zeros in the current lasting for a quarter-cycle or more. This method is inherently unaffected by current transformer saturation, unlike second harmonic restraint.

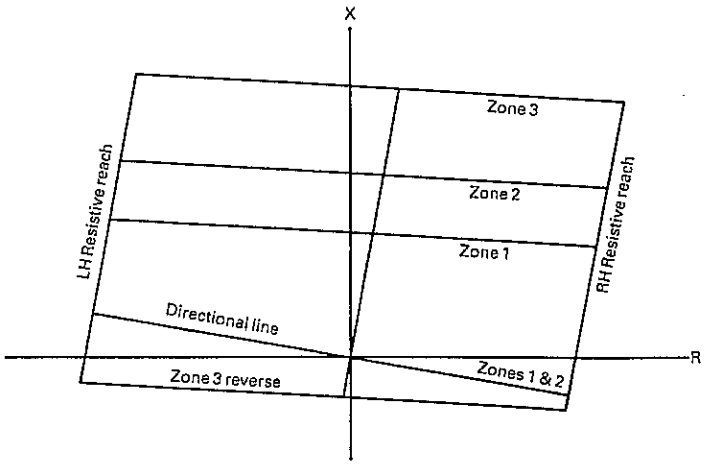



*Figure 6. Quadrilateral ground fault characteristics.*

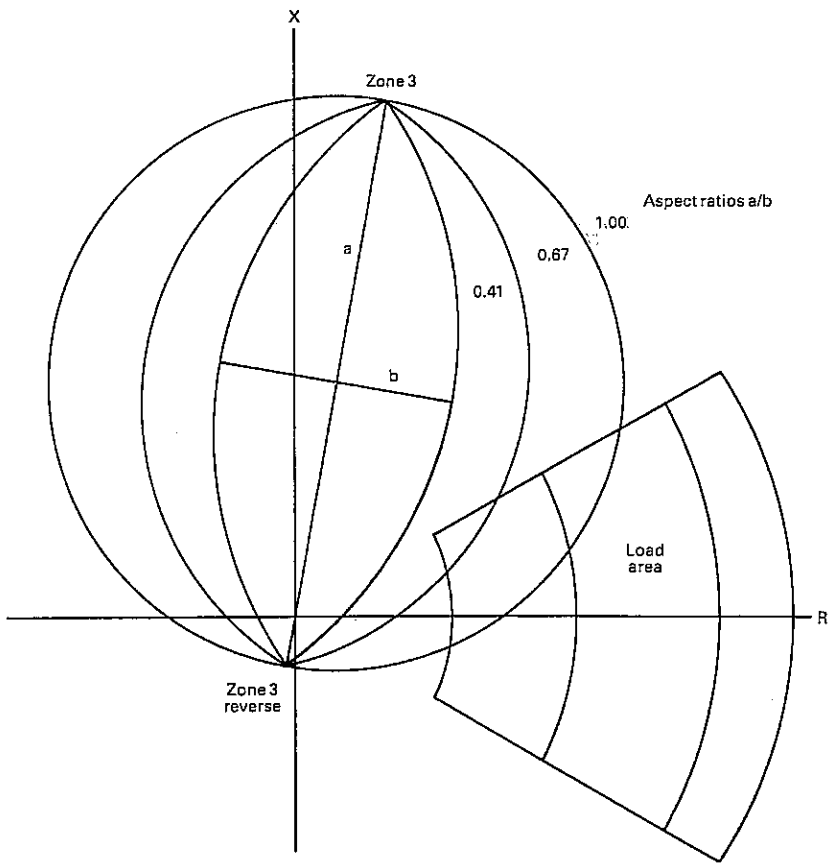



*Figure 7. Lenticular Zone 3.*

## FAULT LOCATION, FAULT DATA RECORDING AND INSTRUMENTATION

(not available in all models)

The fault location algorithm includes compensation for infeed into a resistive fault from a remote source with prefault load flow. Readout of the fault location can be selected to be in kilometres, miles or percent of line length.

The fault location board also computes prefault and fault voltages and currents phase-by-phase. These values, together with negative and zero sequence current and voltage can be read out to allow analysis of the power system network as it was at the time of fault. The duration of the fault is also determined.

At any time under healthy live line conditions, the line voltages, currents, watts and VArs can be calculated on demand. These values can be compared with other instrumentation for accuracy. As the fault location hardware is largely separate from that of the distance measuring elements, protection accuracy can be cross-checked with fault location accuracy during secondary injection tests.

All voltages and currents are given with phase angle relative to prefault $V_A$, and rms amplitudes in primary or secondary terms.

## SELF-MONITORING AND VOLTAGE TRANSFORMER FUSE/MCB SUPERVISION

Optimho has comprehensive continuous self-monitoring. If a failure occurs, an alarm is issued by closing the relay inoperative alarm contact and extinguishing the relay available LED. Diagnostic information is automatically displayed if the failure is such that it does not disable the main processor and LCD.

Monitoring of the analogue circuits includes (i) the dc supply and all internal dc power supply rails, and (ii) the ac supplies and internal analogue voltage and current circuits (the latter only if the model of Optimho has voltage transformer supervision).

The VT supervision logic can be set to block relay operation in the event of failure of a VT fuse. All models have an optically coupled isolator to monitor the auxiliary contact of a miniature circuit breaker if the VT supplies are protected by an MCB instead of fuses. Energising the optical isolator blocks relay operation.

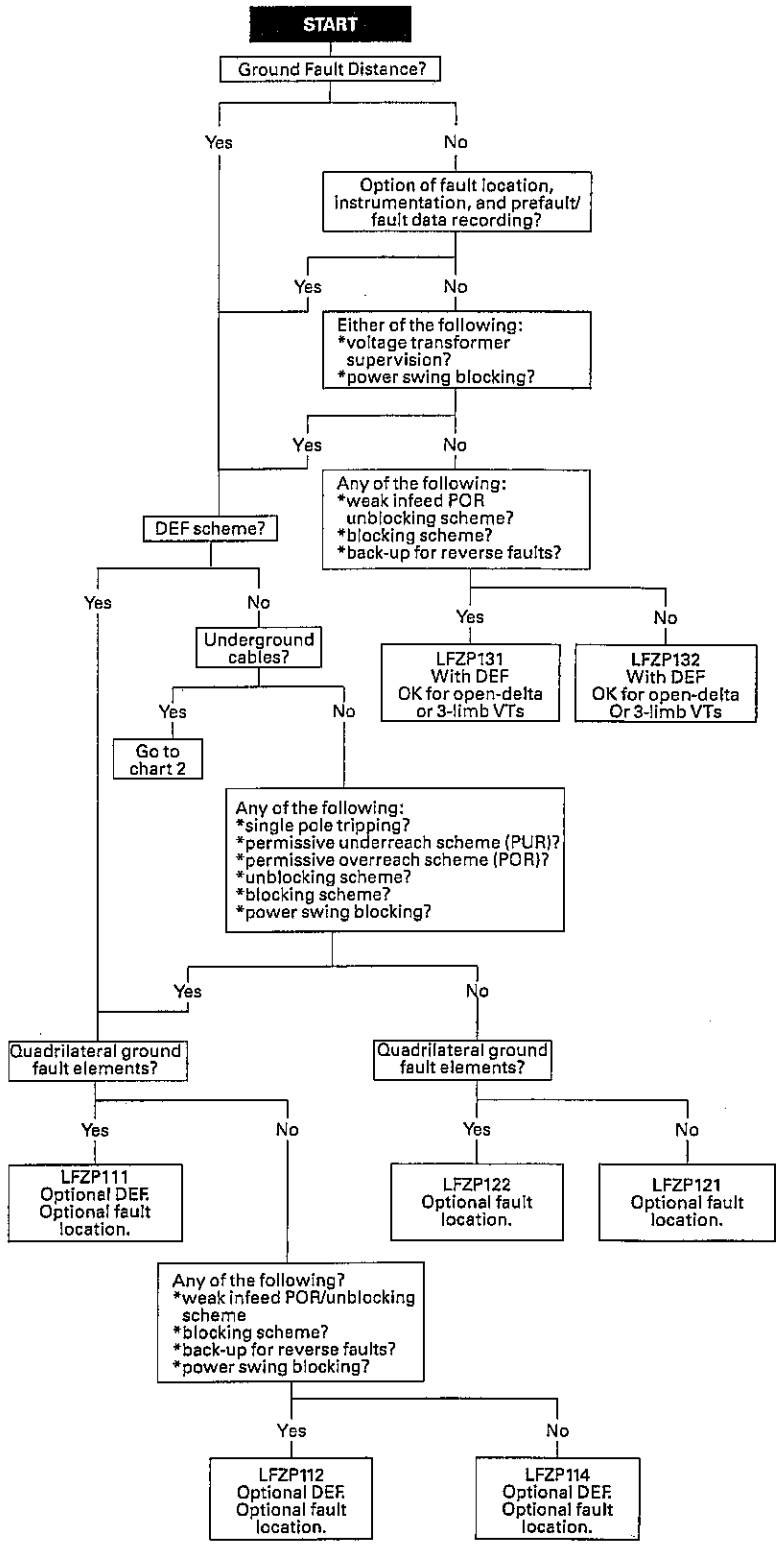
Monitoring of the digital circuits includes (i) bus communications (ii) check sum of all non-volatile memory data (EPROM and EEPROM) and (iii) watchdog circuits for every microcontroller. In the event of failure, trip signals originating from the affected part of the relay are blocked.

In models with quadrilateral ground fault characteristics, remedial action is performed if the quadrilateral measuring circuits fail. The alternative shaped mho ground fault measuring elements, located on a different board, are automatically brought into action to restore the ground fault protection. On power systems where most faults are ground faults, this capability considerably increases the overall availability of the relay.

## CONTACT ARRANGEMENTS

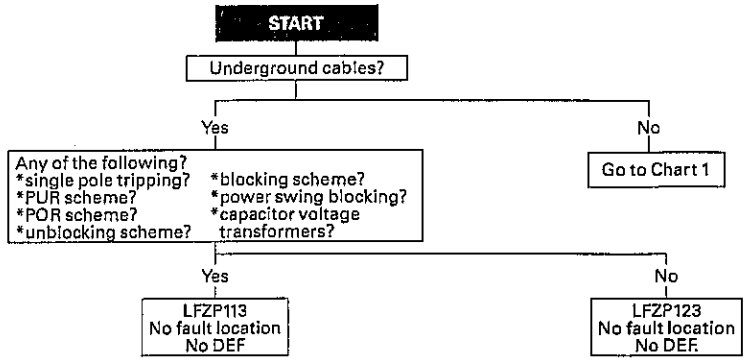
Most models are pre-programmed to give a choice of at least two output contact diagrams. One of these diagrams is arranged to give direct access to the relay's measuring units via the output relay contacts, so that a customer's existing protection scheme can be operated in conjunction with Optimho if required. The other diagrams take advantage of the Optimho's own integral scheme logic.

**Selection Chart 1**




In some of the models specified above, it will be necesary to disable unwanted zones and facilities with settings on the menu.

## Selection Chart 2

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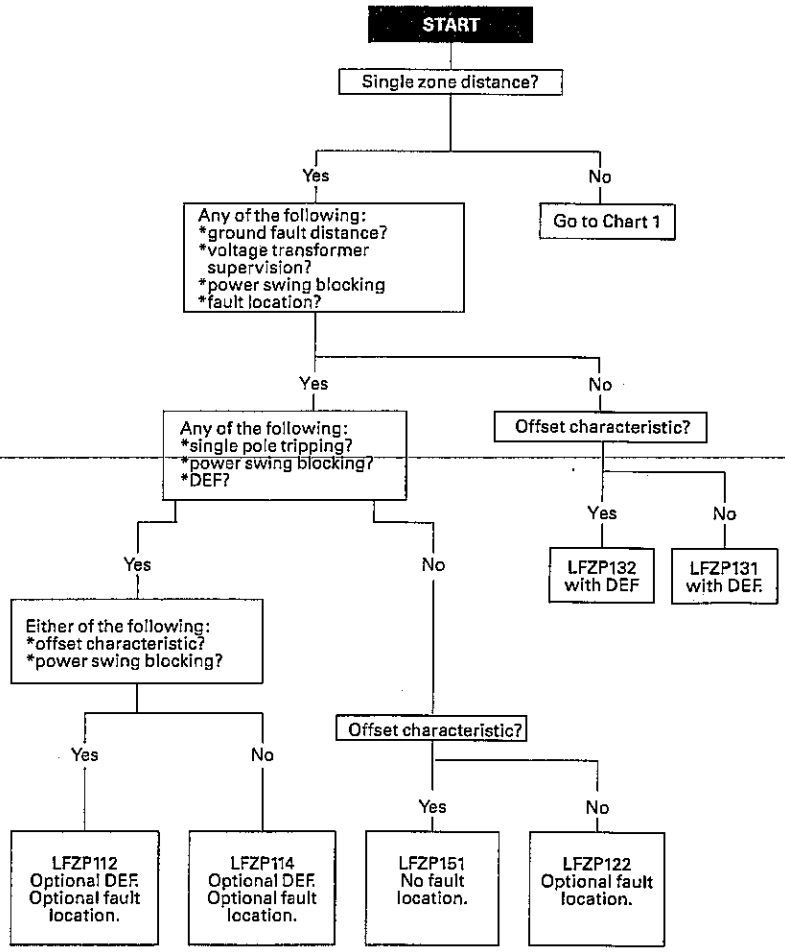
## Selection Chart 3

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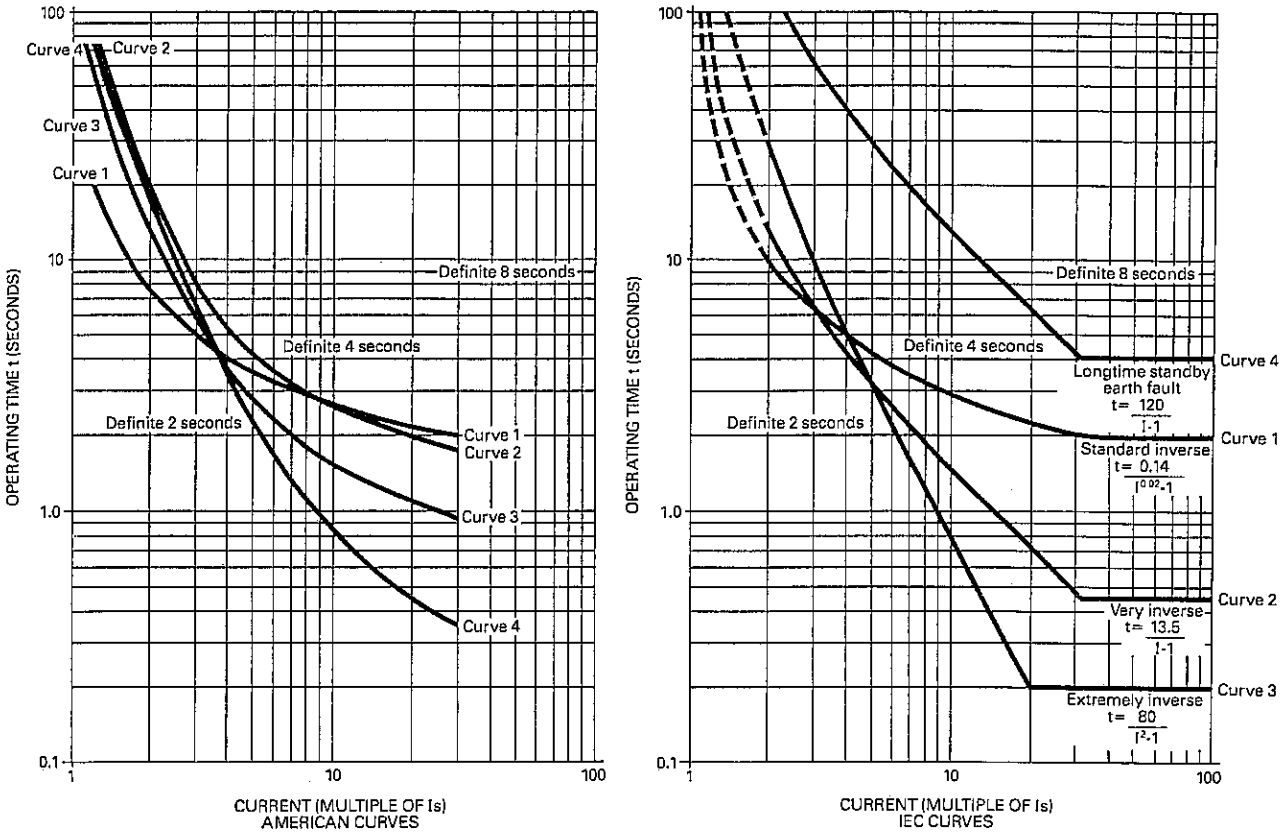



*Figure 8. DEF Protection time delay trip times.*

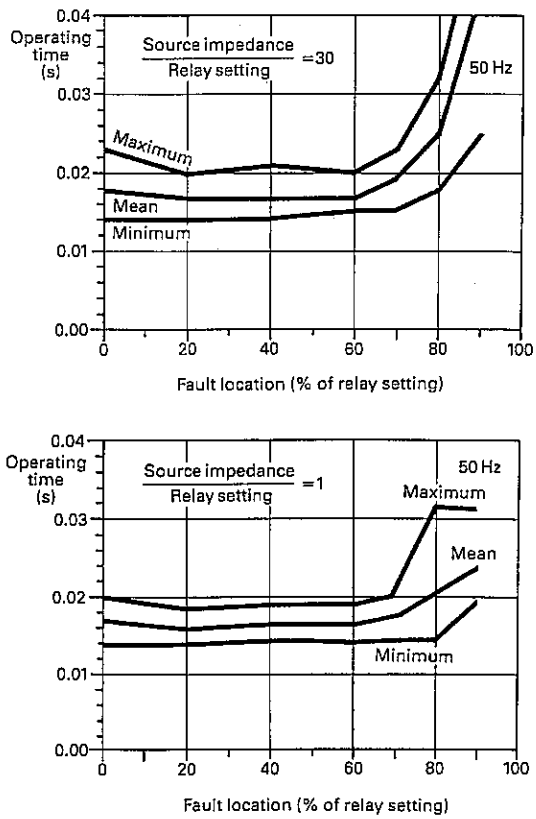



*Figure 9. 50Hz operating times (MHO characteristic).*

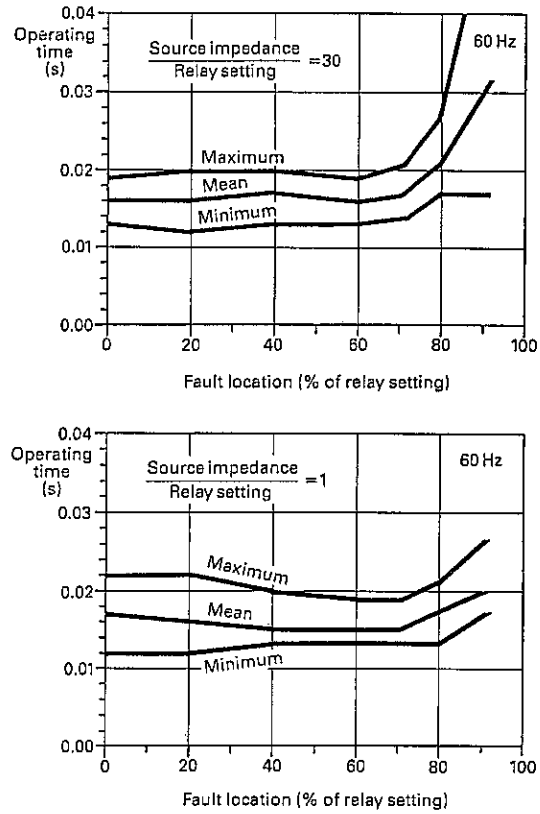



*Figure 10. 60Hz operating times (MHO characteristic).*

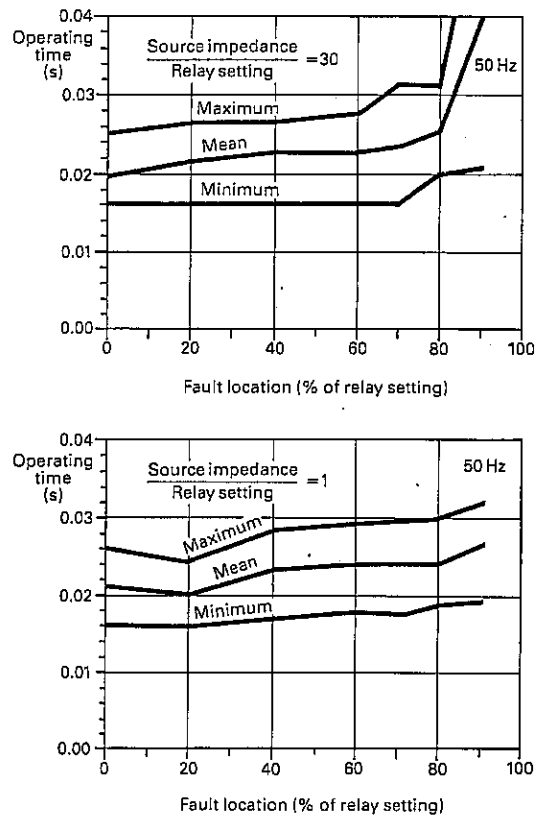



*Figure 11. 50Hz operating times (quadrilateral characteristic).*

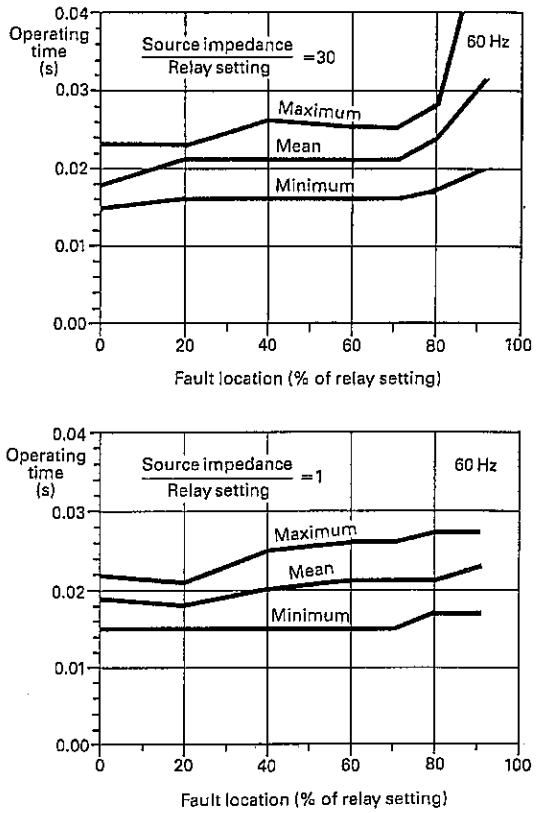
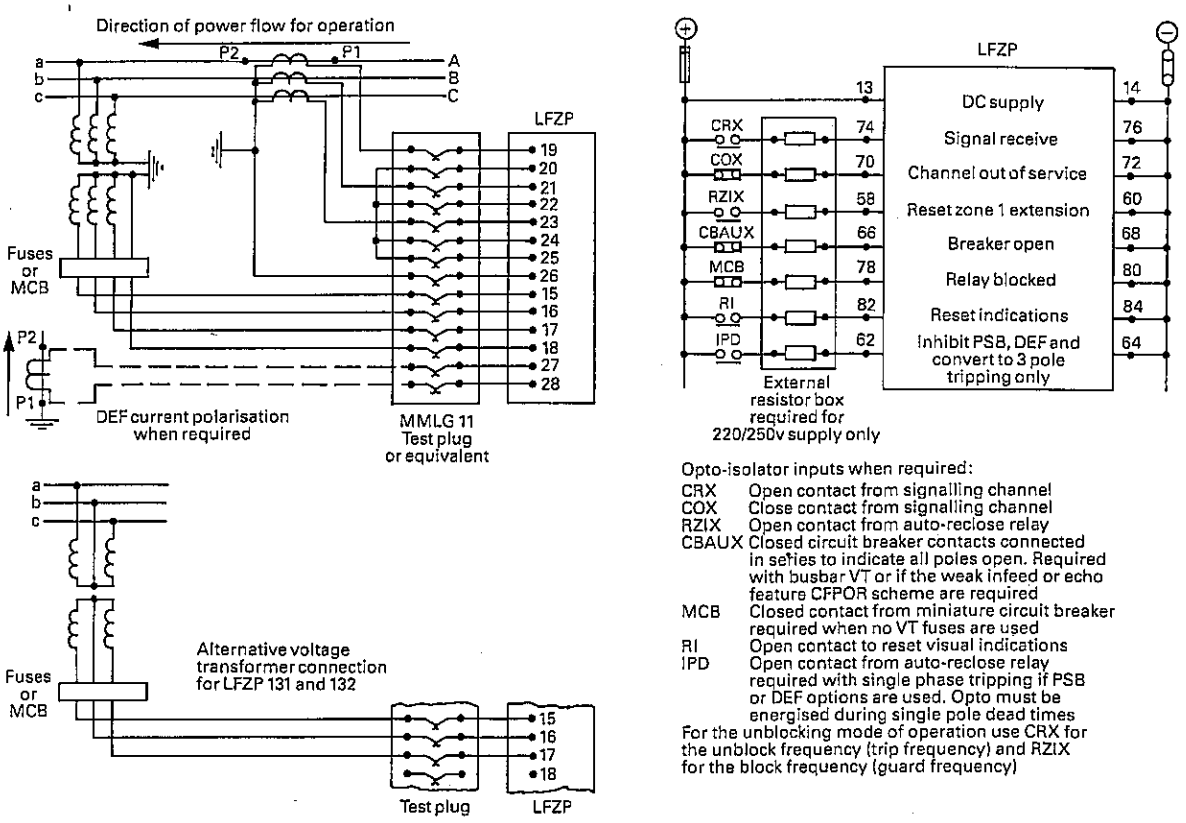



*Figure 12. 60Hz operating times (quadrilateral characteristic).*




Opto-isolator inputs when required:

CRX Open contact from signalling channel
COX Close contact from signalling channel
RZIX Open contact from auto-reclose relay
CBAUX Closed circuit breaker contacts connected in series to indicate all poles open. Required with busbar VT or if the weak infeed or echo feature CFPOR scheme are required
MCB Closed contact from miniature circuit breaker required when no VT fuses are used
RI Open contact to reset visual indications
IPD Open contact from auto-reclose relay required with single phase tripping if PSB or DEF options are used. Opto must be energised during single pole dead times

For the unblocking mode of operation use CRX for the unblock frequency (trip frequency) and RZIX for the block frequency (guard frequency)

*Figure 13. Case connection diagram for relay inputs.*

## TECHNICAL DATA

### Ratings

| | |
|---|---|
| AC voltage Vn: | 100 to 120V rms phase-phase |
| AC current In: | 1A or 5A rms per phase |
| Frequency fn: | 50Hz or 60Hz |
| Operative frequency range: | 47 to 51Hz or 56.4 to 61.2 Hz |

DC Supply Vx(1): For switched mode dc/ac/dc power supply unit, available in three versions:

| Nominal | Operative range | Maximum withstand |
|---|---|---|
| 48/54V | 37.5 to 60V | 64.8V |
| 110/125V | 87.5 to 137.5V | 150V |
| 220/250V | 175 to 275V | 300V |

There is negligible change of accuracy with change of voltage within the operative range of the relay.

DC supply Vx(2): For optically coupled isolators. Supply options are the same as Vx(1). External resistor box provided for 220/250V version (see Figure 15).

### Maximum overload ratings

| | |
|---|---|
| AC voltage: | 1.2Vn for measuring accuracy<br>1.5Vn continuous withstand<br>2.5Vn withstand for 10s. |
| AC current: | 2.4In continuous withstand<br>25In for fault location and instrumentation accuracy (when fault locator fitted)<br>56In for distance measuring accuracy<br>100In withstand for 1s (In = 1A)<br>80In withstand for 1s (In = 5A) |

### Burdens

| | |
|---|---|
| AC voltage circuits: | 0.1 VA per phase at Vn |
| AC current circuits: | 0.08 VA per phase (In = 1A)<br>0.5 VA per phase (In = 5A) |
| DC supply (1): | 18W under healthy live line conditions at Vx(1)<br>28W maximum |
| DC supply (2): | 10mA per energised optically coupled isolator at Vx(2). |

### Distance elements

Range of positive sequence settings referred to line VT and CT secondaries:

| | |
|---|---|
| All employed zones except reverse Zone 3: | 0.2 to 250 ohms (In = 1A)) Overhead line models<br>0.04 to 50 ohms (In = 5A))<br><br>0.1 to 125 ohms (In = 1A)) Underground cable models<br>0.02 to 25 ohms (In = 5A)) |
| Reverse Zone 3: | 0.04 to 250 ohms (In = 1A)) Overhead line models<br>0.008 to 50 ohms (In = 5A))<br><br>0.02 to 125 ohms (In = 1A)) Underground cable models<br>0.004 to 25 ohms (In = 5A)) |

Reach setting method is by digitally controlled analogue attenuators. Attenuation factors KZPh and KZN operate on current signals and are common to all zones. Attenuation factors KZ1, KZ1X, KZ1Y, KZ2, KZ3 and KZ3' operate on voltage signals and are specific to Zone 1, Zone 1X, Zone 1Y, Zone 2, Zone 3 forward and Zone 3 reverse respectively. The positive sequence reach for Zone 1 is given by:

Zone 1 = KZ1. KZPh.5/In for overhead line models.

Zone 1 = KZ1. KZPh.5/2In for underground cable models.

Either KZ1 or KZPh is set to 1.000. To obtain the formula for each of the other zones employed, replace KZ1 by the appropriate attenuation factor for the zone.

Extra settings for ground fault distance:

Residual compensation factor:

$$\frac{KZN}{KZPh} = \left| \frac{Z_{L0} - Z_{L1}}{3Z_{L1}} \right|$$

Where $Z_{L0}$ and $Z_{L1}$ are the phasor values of zero and positive sequence impedance of the protected line.

Quadrilateral resistive reach settings:

Right-hand reach = KR.5/In
Left-hand reach = KR.6/In (LFZP 111)
Left-hand reach = KR.5/In (LFZP 121)

| | | |
|---|---|---|
| Range of factors: | KZPh | 0.040 to 1.000 in steps of 0.001 |
| | KZN | 0.000 to 1.360 in steps of 0.001 |
| | KZ1, KZ1X, KZ1Y, KZ2, KZ3 | 1.00 to 49.98 in steps of 0.02 |
| | KZ3' | 0.2 to 49.9 in steps of 0.1 |
| | KR | 1 to 30 in steps of 1 |

Range of setting of Zone 3 lenticular aspect ratio:
a/b = 1.00, 0.67 or 0.41

Characteristic angle settings:
θ Ph = arg $Z_{L1}$ to nearest available setting.
θ Ph = 45° to 80° in 5° steps.
or θ Ph = 20°, 25°, 30°, 35°, 40°, 50°, 60° or 70° (LZFP123 only)

Vectorial residual compensation for ground fault distance:
θ N = arg $(Z_{L0} - Z_{L1})$ to nearest available setting
θ N = 45° to 80° in 5° steps for overhead line models
θ N = −45°, −35° and −25° to + 80° in 5° steps for underground cable models.

Note: LFZP113 is not designed to be used with a ground fault loop setting $(2Z_{L1} + Z_{L0})/3$ with an argument less than 30°.

Minimum operating values of the distance measuring elements for all types of fault:
Voltage: zero
Current: 0.05In/KZPh.

Accuracy:
Reach: ±5% at 2In and 20°C
Characteristic angle: ±2°

Resetting ratio:
105%

Timer ranges:
Zone 1X timer, Zone 1Y timer, Zone 2 timer, Zone 3 timer — each timer 0.10s to 9.98s in steps of 0.02s

Scheme co-ordination timers used in permissive overreach, unblocking and blocking schemes:
TP, TD, TDW — 0 to 98ms in steps of 2ms

Timer accuracy:
±1% of setting and ±3ms.

Operating time:
Typical relay operating times for Zone 1 are shown in Figures 9 to 12.

| | | |
|---|---|---|
| Mho characteristic (type m, f or c) | 50Hz | minimum: 14 ms, typical: 18 ms |
| | 60Hz | minimum: 12 ms, typical: 16 ms |
| Quadrilateral characteristic (type q) | 50Hz | minimum: 16 ms, typical: 23 ms |
| | 60Hz | minimum: 15 ms, typical: 20 ms |

Reset time:
The trip contacts are sealed in for 60ms following the initial contact closure. Thereafter, the maximum reset time is 35 ms.

## Power swing blocking

Power swing detected by transit time of impedance between Zone 6 and either Zone 2 or Zone 3 as selected. Zone 6 is offset mho or offset lenticular, with the same range of forward and reverse reach settings and aspect ratios as Zone 3.

Zone 6 timer range: 20ms to 90ms in steps of 5ms

Power swing detection regimes:
(i) detection disabled.
(ii) detection indicated only.
(iii) indication plus blocking of any one or more selected zones.

Blocking disabled if a ground fault or (if DEF fitted) a phase fault occurs during a power swing.

## Directional earth fault

Directional measuring elements: one forward-looking, one reverse-looking:

Current sensitivity determined by current level detector: 0.05 In to 0.80In in steps of 0.05In

Characteristic angle $\theta$ G = 10° to 80° in 10° steps.

Instantaneous trip (available only if no Zone 1 ground fault distance elements fitted):

Setting range: 0.2In to 30In in steps of 0.05In

Accuracy: ±5% at fn, 20°C.

Aided tripping scheme:

Scheme co-ordination timers:
TPG, TDG } 0 to 98ms in steps of 2ms
High set current level detector 0.05 In to 0.80In in steps of 0.05In

Time delay trip:

Setting $I_S$ = 0.05In to 1.20In in steps of 0.05In

Time curves: four curves and three definite time ranges shown in Figure 8.

Time multiplier: *t = 0.025 to 1.000 in steps of 0.025

Accuracy at fn, 20°C, *t = 1, Is = 0.05In to 0.80in:

Current: +10% −0%

Operating time: definite time ±3% over 1.3Is to 31Is
curve 1, curve 2, curve 3 } ±5% over 2Is to 31Is
curve 4 ±7.5% over 2Is to 20Is

## Fault location and instrumentation

Fault location positive sequence settings referred to line VT and CT secondaries:

Range: 0.2 ohms to 200 ohms (In = 1A)
0.04 ohms to 40 ohms (In = 5A)

Setting: Zone F = KZF. KZPh. 5/In

KZPh and residual compensation are common to the distance measuring elements.

KZF range: 1.00 to 40.00 in steps of 0.01.

Line length setting (in miles or km or %):

0.00 to 99.99 in steps of 0.01
100.0 to 999.9 in steps of 0.1

Accuracy ±2% at 2In, fn, 20°C.

Settings to allow for transformer ratios for instrumentation functions:

CT ratio: 1:1 or 100 to 2000:1 in 100:1 steps

VT ratio: 1:1 or 100 to 5000:1 in 100:1 steps

## Block or enable auto-reclose logic

A normally-open or normally-closed contact is supplied on most models to block or enable autoreclose respectively.

The menu allows the following choices of logic:

Auto-reclose blocked or enabled on:

Zone 1 or aided trip caused by 2 or 3 phase fault
Zone 1 or aided trip caused by 3 phase fault
Zone 1X and/or Zone 1Y and/or Zone 2 time delayed trip
Channel out of service
DEF instantaneous and/or aided trip.

### Switch-on to fault logic

Menu choices allow instantaneous trip and alarm and indication for faults occurring on line energisation, whether busbar or line voltage transformers are used:

SOTF enabled either 0.2s or 110s after line de-energised (110s prevents SOTF action on auto-reclosure).

SOTF trip via measuring elements.

SOTF trip via current and voltage level detectors.

### Output contacts

Some of the available diagrams are shown in Table 1.

Ratings: Make and carry 7500VA for 0.2s, maxima 30A, 300V, ac or dc.

Carry continuously 5A ac or dc.

Break ac: 1250VA
dc: 50W resistive
25W L/R = 0.04s
} maxima 5A, 300V

### Environmental withstand

Environmental classification: for storage only:
IEC68
BS2011
} 25/070/56.

| | |
|---|---|
| Temperature: | Operative range −25°C to +55°C.<br>Storage and transport −25°C to +70°C. |
| Humidity: | Long term damp heat:<br>IEC 68-2-3<br>BS2011 part 2.1 Ca<br>56 days at 93% RH and +40°C. |
| Salt mist: | BS 2011 part 2.1Kb. |
| Enclosure protection: | IP50 (dust protected).<br>IEC 529<br>BS 5490 |
| Vibration: | IEC255-21 part 1<br>BS 142 1982 section 2.2 category S2.<br>0.5g between 10 and 300Hz. |

### Mechanical durability

The relay will perform more than $10^4$ operations.

### Voltage withstand

| | |
|---|---|
| Insulation: | IEC 255-5<br>BS 142 1982 section 1.3<br>ANSI C37.90-1978<br>2kV rms for 1 minute from circuits to case earth.<br>2kV rms for 1 minute between circuits.<br>1.5kV rms for 1 minute across normally open contacts. |
| High voltage impulse withstand: | IEC 255-5<br>BS 142 1982 section 1.3<br>5kV peak, 1.2/50μs, 0.5J<br>from circuits to case earth and between circuits. |
| High frequency disturbance test: | IEC 255-22-1 class 3<br>BS 142 1982 section 1.4<br>ANSI C37.90.1-1974.<br>2.5kV peak between circuits and case earth.<br>1.0kV peak across input circuits.<br>1MHz bursts. |
| Fast transient test: | Proposed ANSI C37.90a.<br>4kV 5/50ns repetitive. |
| Electrostatic discharge test: | IEC 801-2 class 3.<br>8kV discharge. |
| Electromagnetic interference test: | IEC 801-3 level 3.<br>Draft ANSI C37.90.2.<br>25MHz – 1GHz 10V/m. |
| Dimensions: | Size: see Figure 14<br>Weight: 15 kg |

**Table 1. Standard output contact case terminal connections**

| Terminal | LFZP 111, 112, 113, 114 (Note 1) | LFZP 121, 122, 123 | LFZP 131, 132 | LFZP 151 |
|---|---|---|---|---|
| 29-31 | 97Y | 97Y | 97Y | 97Y |
| 29-33 | 97X | 97X | 67N | 97X |
| 29-35 | 21 (Note 2) | Z1 | 21 | 94T |
| 37-39 | 94A | 94T | 94T | 94T |
| 41-43 | 94B | 94T | 94T | 94T |
| 45-47 | 94C | 94T | 94T | 94T |
| 49-51 | 85X | 85X | 85X | 94T |
| 53-55 | 98 | 98 | 98 | 99 |
| 30-32 | 21/67N(T) (Note 3) | Z1X/Z1Y(T) | Z1X/Z1Y/Z2(T) (Note 6) | |
| 30-34 | 67N (Note 4) | Z2(T) | Z3(T) (Note 7) | |
| 30-36 | 94Y | Z3(T) | 67N(T) | |
| 38-40 | 94A | 94Y | 94Y | |
| 42-44 | 94B | 94T | 94 | |
| 46-48 | 94C | 94 | 85Y | |
| 50-52 | 96 | 96 | 96 | |
| 54-56 | 99 | 99 | 99 | |
| 57-59 | 94A | | | |
| 57-61 | 94B | | | |
| 57-63 | 94C | | | |
| 65-67 | 94A | | | |
| 69-71 | 94B | | | |
| 73-75 | 94C | | | |
| 77-79 | 94 | | | |
| 81-83 | 95 (Note 5) | | | |

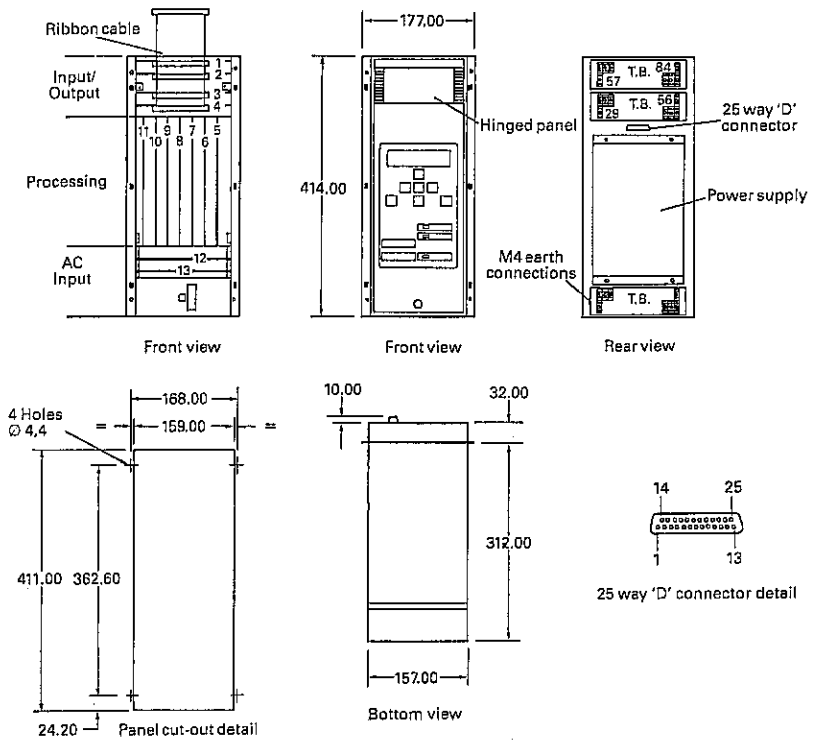
Notes
1. When 3 pole tripping scheme is used, 94A, 94B, 94C and 94 all respond as 94T.
2. Z1 in LFZP 113.
3. Z1X/Z1Y/Z2(T) in LFZP 113.
4. Z3(T) in LFZP 113.
5. 85Y in LFZP 114.
6. Z1X/Z1Y(T) in LFZP 132.
7. Z2(T) in LFZP 132.

Key to contact functions.

| | |
|---|---|
| 97Y | Relay inoperative alarm. |
| 97X | Voltage transformer supervision. |
| 95 | Power swing blocking. |
| 21 | Distance trip. |
| 67N | DEF trip. |
| 98 | Switch on to fault trip. |
| Z1 | Zone 1 trip. |
| Z1X(T) | Zone 1X time delay trip. |
| Z1Y(T) | Zone 1Y time delay trip. |
| Z2(T) | Zone 2 time delay trip. |
| Z3(T) | Zone 3 time delay trip. |
| 21/67N(T) | Any time delay trip. |
| 94Y | Aided trip. |
| 94 | Any trip. |
| 94A | Trip pole A of breaker. |
| 94B | Trip pole B of breaker. |
| 94C | Trip pole C of breaker. |
| 94T | Trip all poles of breaker. |
| 96 | Block autoreclose. |
| 85X | Signal send. |
| 85Y | Signal stop. |
| 99 | DEF element operated (forward or reverse) or any Zone 1, 2 or 3 element. |

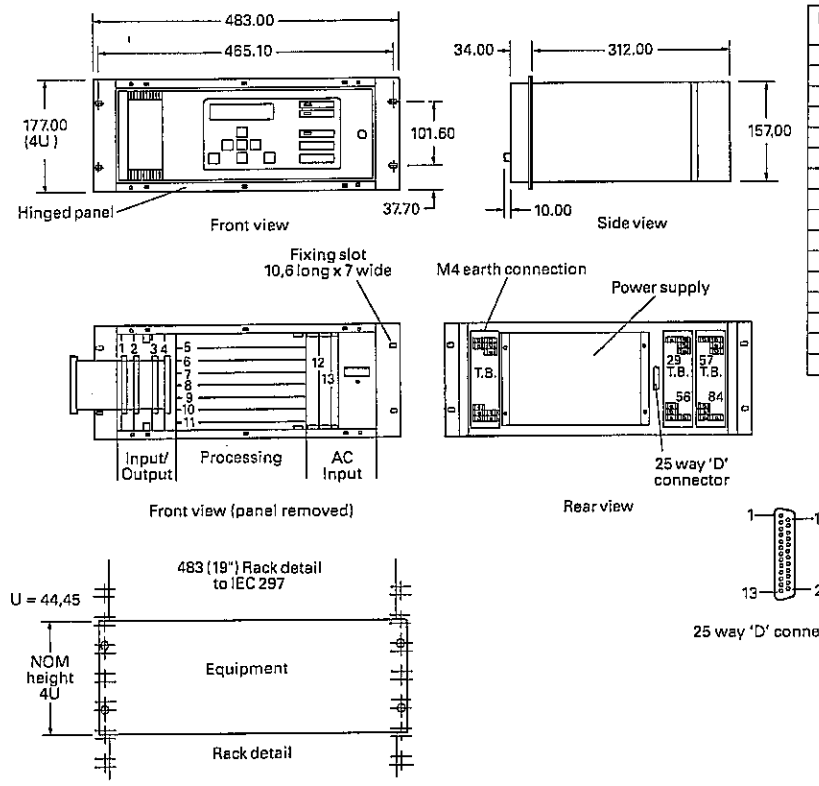
## INFORMATION REQUIRED WITH ORDER

LFZP model required (see Summary Chart).
Whether DEF required (if optional for model selected).
Whether IEC or American curves are required for DEF time overcurrent protection.
Whether fault location required (if optional for model selected).
Nominal current rating In: IA or 5A.
Frequency fn: 50Hz or 60Hz.
Voltage of dc supply Vx(1): 48/54V, 110/125V or 220/250V
Voltage of dc supply Vx(2): 48/54V, 110/125V or 220/250V
Mounting arrangements: rack, panel horizontal, panel vertical.
Whether the block auto-reclose contact 96-1 is to be a normally-open or normally-closed contact.
Whether the signal send contact 85X-I is to be a normally-open or normally-closed contact.
Advice is available when the information requested above is difficult to specify.
Requests for advice should include:
– current and voltage transformer ratios.
– positive and zero sequence impedances of the protected feeder or full details of the feeder lengths and construction.
– source impedances or fault levels for both minimum and maximum plant conditions.



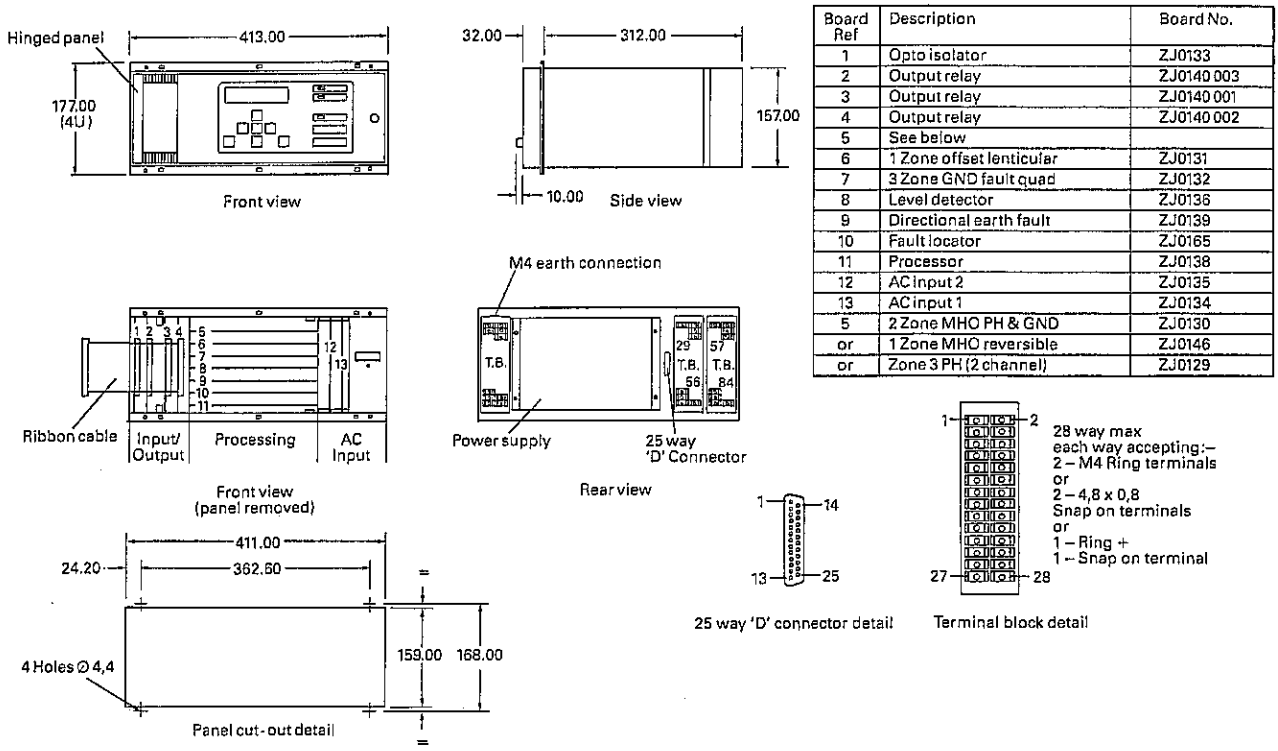

| Board Ref | Description | Board No. |
|---|---|---|
| 1 | Opto isolator | ZJ0133 |
| 2 | Output relay | ZJ0140 003 |
| 3 | Output relay | ZJ0140 001 |
| 4 | Output relay | ZJ0140 002 |
| 5 | See below | |
| 6 | 1 Zone offset lenticular | ZJ0131 |
| 7 | 3 Zone GND fault quad | ZJ0132 |
| 8 | Level detector | ZJ0136 |
| 9 | Directional earth fault | ZJ0139 |
| 10 | Fault locator | ZJ0165 |
| 11 | Processor | ZJ0138 |
| 12 | AC input 2 | ZJ0135 |
| 13 | AC input 1 | ZJ0134 |
| 5 | 2 Zone MHO PH & GND | ZJ0130 |
| or | 1 Zone MHO reversible | ZJ0146 |
| or | Zone 3 PH (2 channel) | ZJ0129 |

*Figure 14a. Arrangement and outline Optimho panel mounting vertical.*




| Board Ref | Description | Board No. |
|---|---|---|
| 1 | Opto isolator | ZJ0133 |
| 2 | Output relay | ZJ0140 003 |
| 3 | Output relay | ZJ0140 001 |
| 4 | Output relay | ZJ0140 002 |
| 5 | See below | |
| 6 | 1 Zone offset lenticular | ZJ0131 |
| 7 | 3 Zone gnd fault quad | ZJ0132 |
| 8 | Level detector | ZJ0136 |
| 9 | Directional earth fault | ZJ0139 |
| 10 | Fault locator | ZJ0165 |
| 11 | Processor | ZJ0138 |
| 12 | AC input 2 | ZJ0135 |
| 13 | AC input 1 | ZJ0134 |
| 5 | 2 Zone mho ph & gnd | ZJ0130 |
| or | 1 Zone mho reversible | ZJ0146 |
| or | Zone 3 ph (2 channel) | ZJ0129 |

*Figure 14b. Arrangement and outline: Optimho panel mounting horizontal.*




| Board Ref | Description | Board No. |
|---|---|---|
| 1 | Opto isolator | ZJ0133 |
| 2 | Output relay | ZJ0140 003 |
| 3 | Output relay | ZJ0140 001 |
| 4 | Output relay | ZJ0140 002 |
| 5 | See below | |
| 6 | 1 Zone offset lenticular | ZJ0131 |
| 7 | 3 Zone GND fault quad | ZJ0132 |
| 8 | Level detector | ZJ0136 |
| 9 | Directional earth fault | ZJ0139 |
| 10 | Fault locator | ZJ0165 |
| 11 | Processor | ZJ0138 |
| 12 | AC input 2 | ZJ0135 |
| 13 | AC input 1 | ZJ0134 |
| 5 | 2 Zone MHO PH & GND | ZJ0130 |
| or | 1 Zone MHO reversible | ZJ0146 |
| or | Zone 3 PH (2 channel) | ZJ0129 |

*Figure 14c. Arrangement and outline: Optimho rack mounting.*

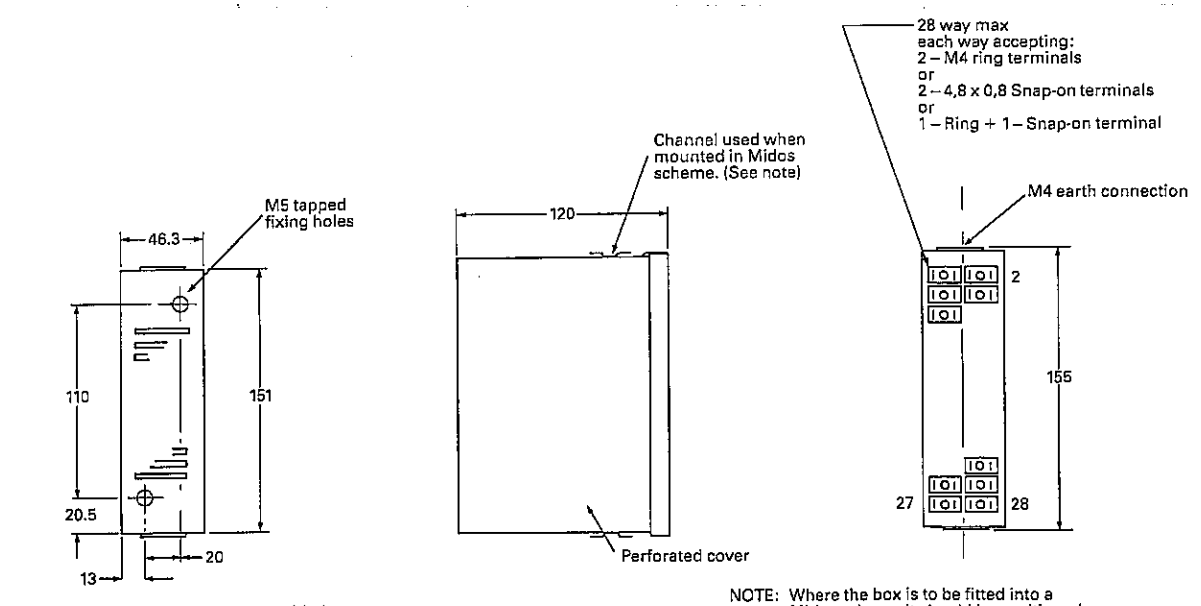



*Figure 15. Outline – external component box.*

Table 2. Hardware details

| | | Transmission and sub-transmission main protection | | | | Sub-transmission and distribution main protection | | | | | Back-up only |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LFZP Model | | 111 | 112 | 113 | 114 | 121 | 122 | 123 | 131 | 132 | 151 |
| Available independent zones | | Z1 | Z1 | Z1 | Z1 | Z1 | Z1 | Z1 | Z1 | Z1 | |
| | | Z2 | Z2 | Z2 | Z2 | | | | Z2 | Z2 | |
| | | Z3 | Z3 | Z3 | | Z3 | Z3 | Z3 | Z3 | | Z3 |
| Available reach-stepped zones | | Z1X | Z1X | Z1X | Z1X | Z1X | Z1X | Z1X | Z1X | Z1X | |
| | | Z1Y | Z1Y | Z1Y | Z1Y | Z1Y | Z1Y | Z1Y | Z1Y | Z1Y | |
| | | | | | | Z2 | Z2 | Z2 | | | |
| Reach-stepped zones reversible at time steps | | | | | | ● | ● | ● | | | |
| VT supervision | | ● | ● | ● | ● | ● | ● | ● | | | ● |
| Power swing blocking | | ● | ● | ● | | | | | | | |
| Number of output contacts | | 24 | 24 | 24 | 24 | 16 | 16 | 16 | 16 | 16 | 8 |
| Distance characteristics (Key page 5): | Z1, Z1X, Z1Y, Z2 Phase | m | m | m | m | m | m | m | f | f | |
| | Z1, Z1X, Z1Y, Z2 Ground | q/m | m | m | m | q/m | m | c | | | |
| | Z3 Phase | L | L | L | | N | N | N | P | | N |
| | Z3 Ground | Q/L | L | L | | D/N | N | N | | | N |
| DEF polarising: | Neg seq volts, Zero seq current | ● | ● | | ● | | | | ● | ● | |
| | Zero seq volts, Zero zeq volts + Current | ● | ● | | ● | | | | | | |

See also: distance characteristics, page 5