Type LFDC
Digital Directional Comparison Protection Relay

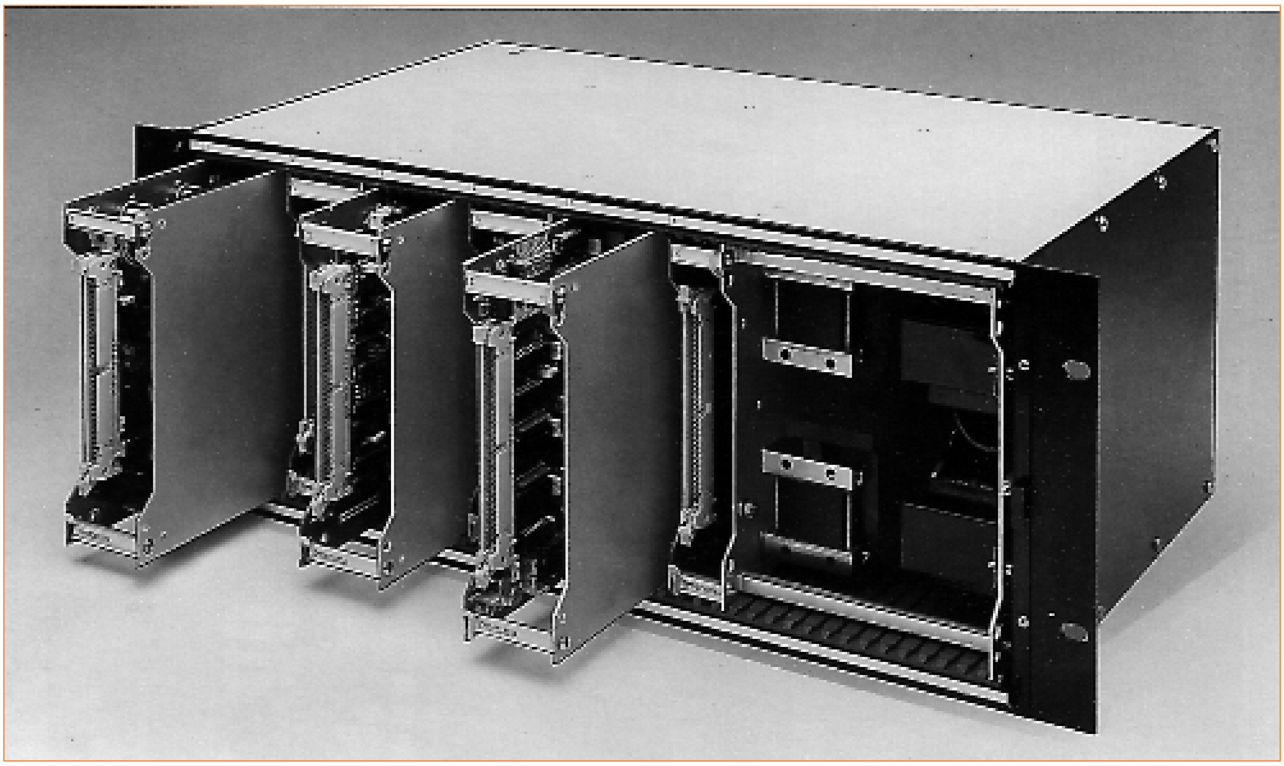


Figure 1: LFDC relay with hinged front cover removed to show the modular construction

Features

- Complete phase and ground fault protection for all types of ehv and uhv transmission lines
- Suitable for 3 pole or single pole tripping
- High speed directional comparison protection using a signalling channel. Operating time of ½ cycle plus the signalling delay
- Optional distance zone, for back-up in the event of signalling failure, provides either under-reaching instantaneous protection or over-reaching time delayed protection
- Alternative protection detects faults occurring following manual or auto-reclose
- Optional directional earth fault protection
- Built-in voltage transformer supervision
- Integral operator interface for easy access to relay settings and fault/alarm records
- Continuous self-monitoring and diagnostic facilities
- Remote interrogation via RS232C serial link if required.

Benefits

The need for improved power line protection has led to the development of a directional comparison protection relay based on new operating principles. This new protection has a number of advantages, including:

- fast operating time
- correct operation during evolving, inter-circuit and cross-country faults
- ability to detect high resistance faults
- excellent performance in the presence of distorted waveforms
- ability to withstand heavy circuit loading without the load encroachment problems of distance protection
- synchronised input signal sampling allows high sensitivity directional measurements, and provides an inherent immunity to power swings
- insensitivity to CVT transients, and to the distortion caused by CT saturation.

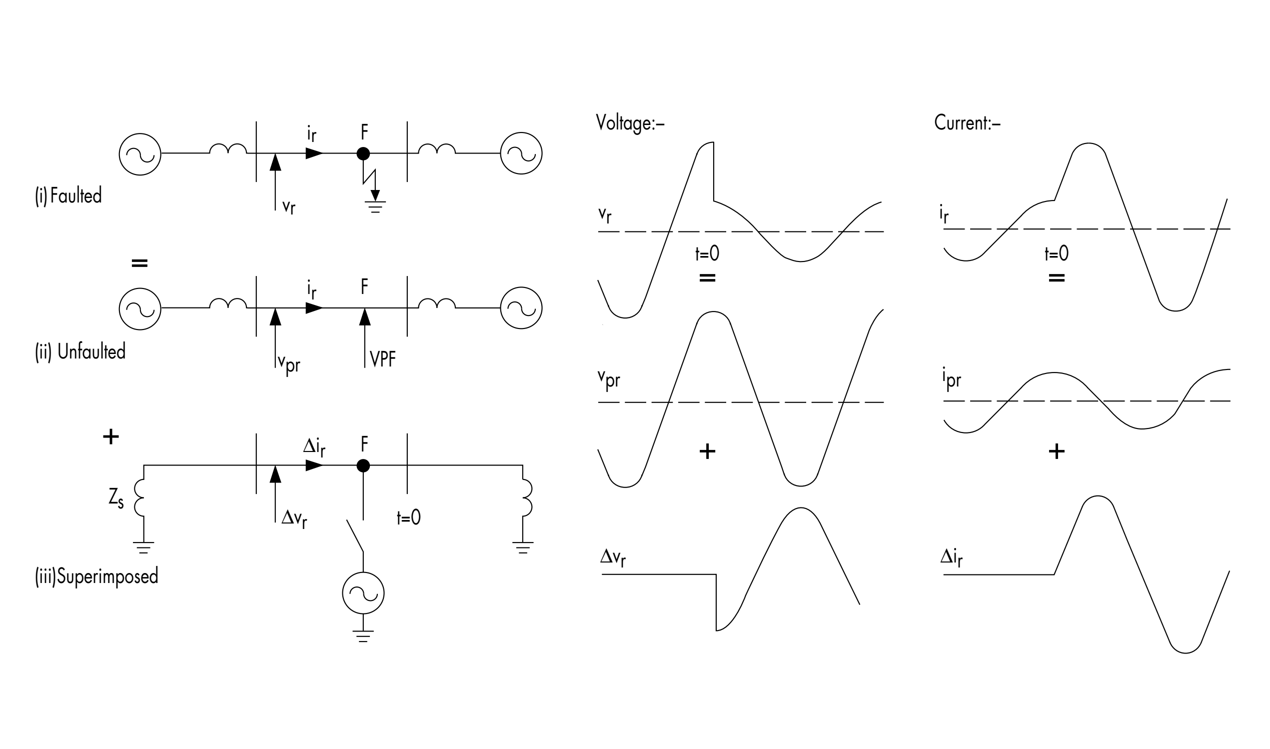


Figure 2: Relationship between the superimposed and the faulted power system

Application

The directional comparison protection relay, type LFDC, is designed to provide complete phase and ground fault protection for all types of of ehv and uhv transmission lines. Since the LFDC is based on an operating principle significantly different from conventional distanced protection, it is an ideal partner for Micromho, Quadramho or Optimho distance relays when two independent protection systems are required.

The directional comparison protection consists of an LFDC relay at each line end, communication between the relays being provided by a signalling channel and signalling equipment. Conventional on/off signalling equipment can be used (eg. power line carrier, microwave, fibre optics), since the channel is only required to transmit a single command. The protection operates as a blocking or permissive overreach scheme with an optional weak infeed feature available for the permissive overreach schemes, and provides three pole or single and three pole tripping.

The range of applications includes:

- lines with or without series compensation
- uncompensated line adjacent to series compensated lines
- shunt compensated lines
- lines requiring high sensitivity for ground faults
- parallel lines with high mutual coupling
- lines with mixed overhead and underground conductors

Operating Principle - Directional Comparison Protection

High speed directional elements within each relay determine the fault direction and produce either a forward or reverse decision. These decisions are combined using either a blocking or permissive overreach scheme to generate the required trip signals.

The directional elements use the fault-generated changes in the voltage and current signals at the relay location, referred to as the superimposed signals, to determine the direction of a fault. During a fault the voltage signal changes by Δv_r and the current signal changes by Δi_r.

Figure 2 illustrates that the faulted power system can be considered to consist of two parts: the unfaulted system and the superimposed system. The superimposed system defines the changes caused by the fault.

The directional elements process the signals Δv_r and Δi_r obtained from the superimposed system (see Figure 2(iii). For a fault in the forward direction the superimposed current (Δi_r) is related to the superimposed voltage (Δv_r) by the source impedance behind the relaying point ($Z_s = |Z_s| \angle \phi_s$) i.e.:

$$\Delta i_r = \frac{-\Delta v_r \angle -\phi_s}{|Z_s|}$$

Similarly, for a fault in the reverse direction:

$$\Delta i_r = \frac{+\Delta v_r \angle -\phi_{ls}}{|Z_{ls}|}$$

where $Z_{ls} = |Z_{ls}| \angle \phi_{ls}$ is the effective source impedance corresponding to the protected line plus the source at the remote in-feed.

The directional elements evaluate the direction of the fault by comparing the polarity of the phase delayed superimposed voltage ($\Delta v_r \angle -\phi$) with the polarity of the superimposed current (Δi_r). The superimposed voltage is phase delayed by 78°; which approximates to the power system source angle for most system configurations.

A definite relationship exists between the superimposed voltage and current:

- for a forward fault $\Delta v_r \angle -\phi$ and Δi_r are of opposite polarity and

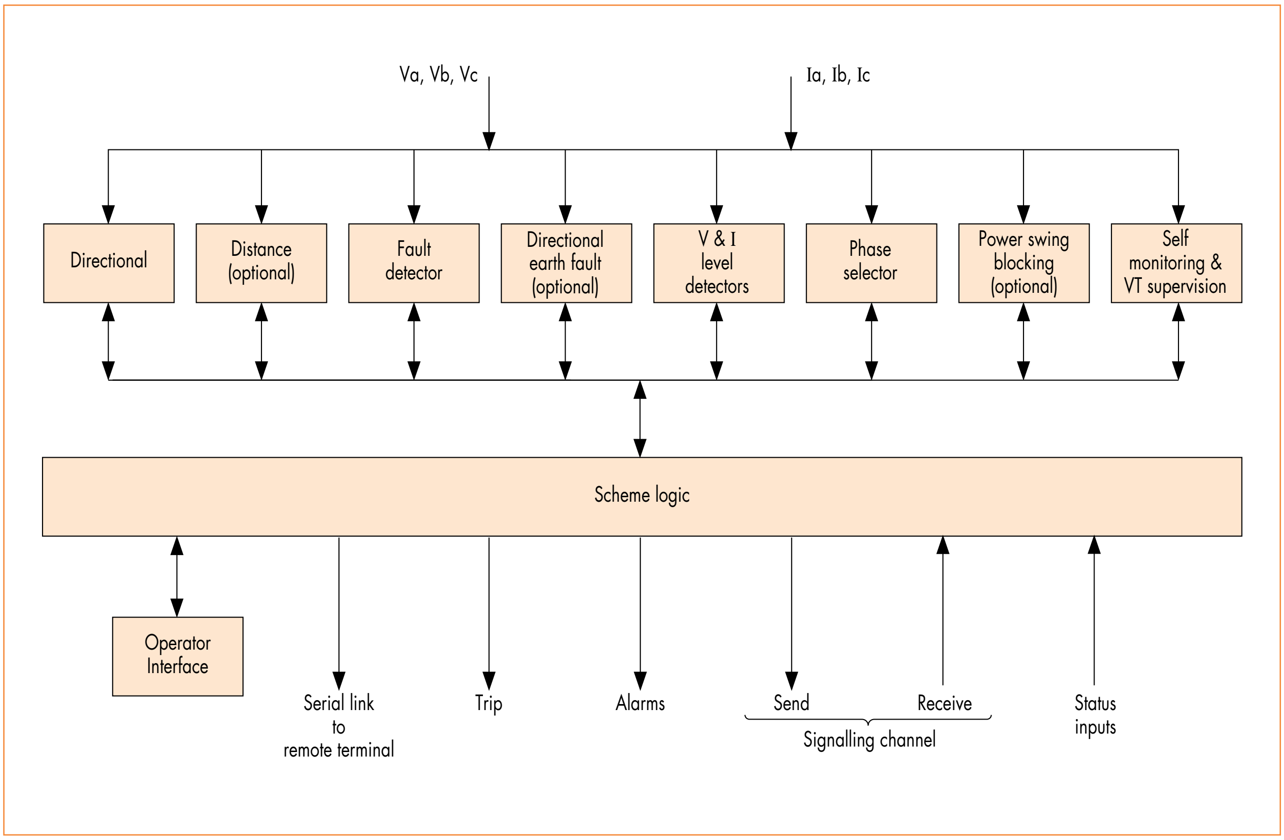


Figure 3: Functional block diagram

- for a reverse fault $\Delta v_r \angle -\varnothing$ and Δi_r are of the same polarity.

The comparison is performed by mixing $\Delta v_r \angle -\varnothing$ and Δi_r in accordance with the equation.

$$D_{op} = |\Delta v_r \angle -\varnothing - \Delta i_r| - |\Delta v_r \angle -\varnothing + \Delta i_r|$$

For a forward fault, since the magnitude of $\Delta v_r \angle -\varnothing - \Delta i_r$ is greater than the magnitude of $\Delta v_r \angle -\varnothing + \Delta i_r$, the directional operating signal, D_{op}, is positive.

Conversely for a reverse fault, since the magnitude of $\Delta v_r \angle -\varnothing + \Delta i_r$ is greater than the magnitude of $\Delta v_r \angle -\varnothing - \Delta i_r$, D_{op} is negative.

The directional elements evaluate the polarity of D_{op} and compare its value against operating thresholds to determine fault direction. All faults causing a current change of greater than 0.2In and a voltage change of greater than the voltage setting, are detected. The directional elements will change their directional decision if required, for example during cross-country faults. For security, and change in decision is supervised by a distance fault detector.

Operating Principle - Distance & Fault Detectors

The LFDC incorporates one complete zone of distance protection and a separate distance fault detector as shown in Figure 3.

The optional menu-selectable distance protection does not rely on the signalling channel for its operation, but is supervised by the forward directional decision. It is intended to give back-up protection in the event of signalling failure, by acting as either an under-reaching instantaneous protection, or a time delayed over-reaching protection providing back-up to the entire protected section. The distance zone is implemented using six forward-looking, memory polarised mho distance elements (A-N, B-N, C-N, A-B, B-C, C-A).

The fault detector, (comprising six forward-looking and six reverse-looking, memory polarised mho distance elements A-N, B-N, C-N, A-B, B-C, C-A) supervises the superimposed directional elements during inter-circuit or cross-country faults. The forward fault detector also provides protection following manual or auto-reclosure, when it is polarised by sound phase voltages since no memory voltage is available.

Each distance element is implemented using a digital version of a conventional memory polarised mho amplitude comparator. The comparator detects the fault as being within its operating zone when:

$$|IZ + V_{pol}| > |V - IZ + V_{pol}|$$

where V_{pol} is the polarising voltage and Z is half the reach setting.

Protection Following Breaker Closure

The switch-on-to-fault feature offers instantaneous protection following manual closure on to a fault. Tripping is normally initiated by the fault detectors, except during 3 phase close-up faults, when the detection of an over-current, under-voltage condition instigates tripping. An optional channel-dependent directional earth fault protection detects closure on to high resistance faults. A similar technique is used following auto-reclosure on to a fault, but in this case switch-on-to-fault is not indicated.

Optional Directional Earth Fault Protection

Most high resistance ground faults will be detected by the superimposed direction elements, but in some applications additional directional earth fault (DEF) protection is required. This is provided by a zero sequence DEF element which is usually polarised from the sound phase voltages and derives its signals from the existing phase voltage and current inputs. This element may operate as a channel-aided protection, sharing the same scheme and signalling channel as the directional comparison protection. Optional single pole tripping is available. A time delayed DEF protection, independent of the signalling channel, is also provided and can be used as an alternative or in addition to the channel-aided type.

Both forms of DEF protection are menu-selectable.

Optional Power Swing Blocking

Power swing and pole slip conditions present the relay with continuously changing currents and voltages, which generate superimposed signals. The superimposed signals produced by a power swing are generally too small to cause operation of the directional elements. However, an optional, menu-selectable power swing blocking feature is provided to prevent operation during pole slip, or near pole slip conditions. Blocking occurs if, while the system is balanced, a directional element attempts to operate forward following a gradual increase in the superimposed current signal.

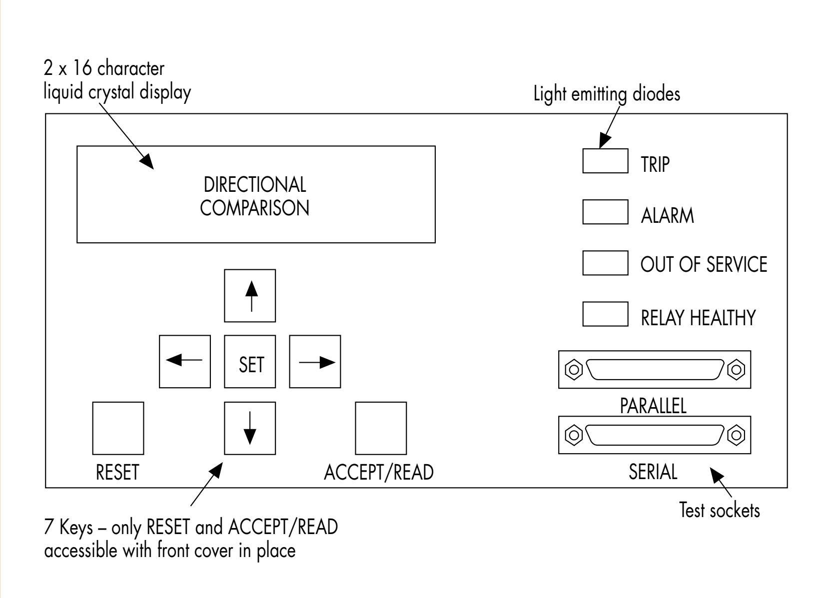


Figure 4: Operator interface on front panel

Hardware

The LFDC relay is housed in a 4U (178mm) high case suitable for either rack or panel mounting. The relay comprises 6 plug-in modules plus an operator interface (GM0025). The modules are classified as:

- power supply (GM0026)
- 8 element relay output module (GM0032)
- 14 element relay output module (GM0032)
- status input module (GM0022)
- microcomputer module (GM0024)
- analogue input/digital signal processor (DSP) module (GM0023)

Each of these modules is individually tested and calibrated in the factory, consequently any module can be exchanged without the need to recalibrate the relay.

The analogue input/digital signal processor module transforms the input voltage and current signals into a form suitable for digital processing, samples the signals, converts each sample into an equivalent digital number and processes the digitised samples in accordance with the protection algorithm. The resulting output decision is then transferred to the microcomputer module.

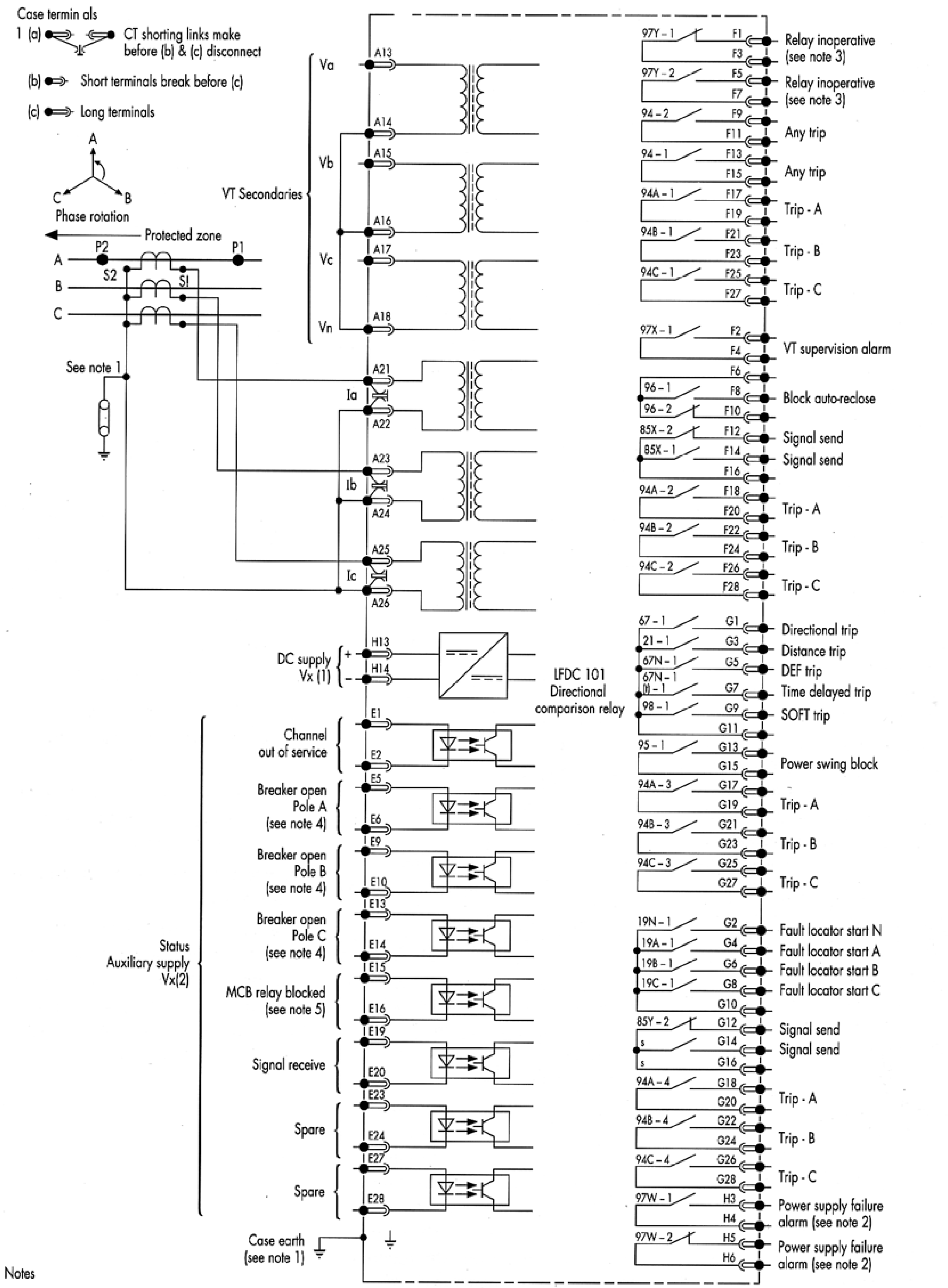
The microcomputer module reads the output decision, processing this and data from the status input module in accordance with the protection scheme logic. If necessary, the microcomputer then activates the appropriate elements in the relay output modules.

Two relay output modules, provide 34 trip and alarm contacts. Twelve of these, arranged as four sets of trip A, trip B, trip C contacts, are used for breaker tripping, breaker fail initiation, alarm annunciation and auto-reclose control.

The status input module contains 8 optically isolated inputs each of which monitors the status of an external contact.

The operator interface described in the next section provides a simple method of interfacing with the relay.

The power supply module converts the auxiliary dc voltage into the regulated dc voltage rails required by the LFDC relay. High efficiency and isolation from the auxiliary supply are achieved by the use of a switching dc/dc converter. A power fail monitoring circuit with an alarm output contact is included.



Notes

1. Earthing connections as shown are typical only.
2. Under healthy operating conditions contact 97W-2 is held open and 97W-1 is held closed.
   The following conditions causes these contacts to change state:
   A. Loss of dc supply
   B. Loss of any internal dc rail volage.
3. Under normal operating conditions contact 97Y-1 is held open and 97Y-2 held closed.
   The following conditions cause them to change state:
   A. loss of dc supply
   B. Detection of hardware failure
   C. Selection of contacts blocked } Commission Test Option
   D. Selection of VTS DISABLED
4. Breaker open status inputs must be connected if busbar VT's are used or if the scheme is permissive overeaching
5. MCB relay blocked input must be energised when the MCB is open (required when a MCB is fitted instead of VT fuses)

Figure 5: External connection diagram: directional comparison relay type LFDC 101. Single breaker version

Operator Interface

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

Information about the relay is displayed on the liquid crystal display (lcd); the 7 keys drive the display and allow all the available information to be viewed. The cursor keys (↑, ↓, →, ←), the SET key and the two test sockets are only accessible after removing the transparent front cover.
These keys are used to select from a menu of operations which can be displayed on the lcd. One such option allows the relay settings to be altered. Any change which will affect relay operation does not become effective until the user has confirmed the change by pressing the SET key. Accidental changes are prevented by allowing SET to be operative only at certain points in the menu after appropriate warnings have been displayed. Valid changes are transferred to permanent memory, so that if the supply is lost, correct relay settings etc. are always reinstated when the supply is restored.

The test sockets can be used to send information about the relay to either a parallel or serial printer. In addition, test points within the relay can be monitored on the PARALLEL socket.

When the relay trips, the date and time of the fault, the element which initiated the trip and the faulty phases, are indicated on the lcd. If another trip occurs, the display is automatically updated to show details of the new fault. The latest alarm conditions are also indicated. If fault or alarm indications are present when the supply is lost, they are reinstated when the supply is restored.

Each fault/alarm indication occupies a single page (ie. 2 lines x 16 characters) of the lcd. When several different indications occur each one can be displayed by pressing the READ key. When all indications have been read, they can be cleared by pressing the RESET key. For security, when the front cover is in place the user has restricted access and cannot change any parameters which affect relay performance. However, the indications can still be read and reset since the READ and RESET keys remain accessible. An additional feature is provided to allow the user to view (but not change) each relay setting by repeated presses of the READ key.

The colour coded light emitting diodes (leds) show if any unusual conditions have arisen. The red TRIP led is illuminated when the relay initiates break tripping and is not extinguished until the fault indication is reset. The yellow ALARM led flashes when a fault or alarm indication occurs and stays flashing until all indications have been read. It then remains lit (but not flashing) and only goes out when all indications are reset. The yellow OUT OF SERVICE led is illuminated when the relay is inhibited from operating as a protection. The green RELAY HEALTHY led is always on when the relay is functioning correctly, but is switched off if the relay becomes faulty.

The relay incorporates self testing including a continuous check of the permanent memory which holds the relay settings. If an error is detected, a warning is displayed on the lcd.

Menu Options

The menu provides an extensive range of options, which allow the user to:

- view and change the relay settings
- change the configuration (baud rate, etc.) of the RS232C serial port
- view time-tagged records of the lcd indications for the last 10 alarms
- view time-tagged records of the lcd indications for the last 3 faults. (Separate storage of alarms and faults ensures that the last 3 faults are always available even in the event of multiple alarms)
- remove all past fault and alarm records from the memory
- view and change a calendar clock
- transmit information to a printer, to provide a print-out of relay settings, fault and alarm records. The user selects whether to transmit the information to the PARALLEL or SERIAL port
- view and change a relay identification name for use on print-outs
- implement a comprehensive range of test options, for example, a simple on-load directional test.

Settings

The setting option allows the relay to be set to suit each application.

The user can select:

- voltage sensitivity of the directional elements
- reach (set directly in secondary impedance) and residual compensation of the distance protection and fault detectors
- scheme type, for example: blocking, permissive over reach, or permissive over reach with weak infeed echo and tripping
- whether the distance protection is enabled and if so, whether it is instantaneous or time delayed
- whether the directional earth fault element is enabled and if so, whether it is channel-aided or time delayed or both
- value of scheme timers
- single or three pole tripping
- the conditions for which auto-reclosure is blocked
- whether the directional earth fault element is enabled during switch-on-to-fault conditions
- whether power swing blocking is enabled

The menu is adaptive and only displays the relevant settings; for example, if the distance protection has been disabled its reach setting is not required and is automatically removed from the menu.

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.

Self-Monitoring and Voltage Transformer Fuse/MCB Supervision

The LFDC has comprehensive continuous self-monitoring. If a failure occurs, an alarm, is issued by closing the relay inoperative alarm contact and extinguishing the RELAY HEALTHY led. Diagnostic information is automatically displayed if the failure is such that it does not disable the main processor and lcd. In the event of failure of a VT fuse, the VT supervision logic disables the affected directional elements, thereby blocking relay operation. An optically coupled isolator monitors the auxiliary contact of a miniature circuit breaker (mcb) if the VT supplies are protected by an mcb instead of fuses. Energising the optical isolator blocks relay operation. When a VT supply is lost, an alarm is issued by closing the VT supervision alarm contact.

Contact Arrangements

The output contact arrangement for single breaker applications is shown in Figure 5. A version providing 6 sets of trip A, trip B and trip C contacts is also available for double breaker applications.

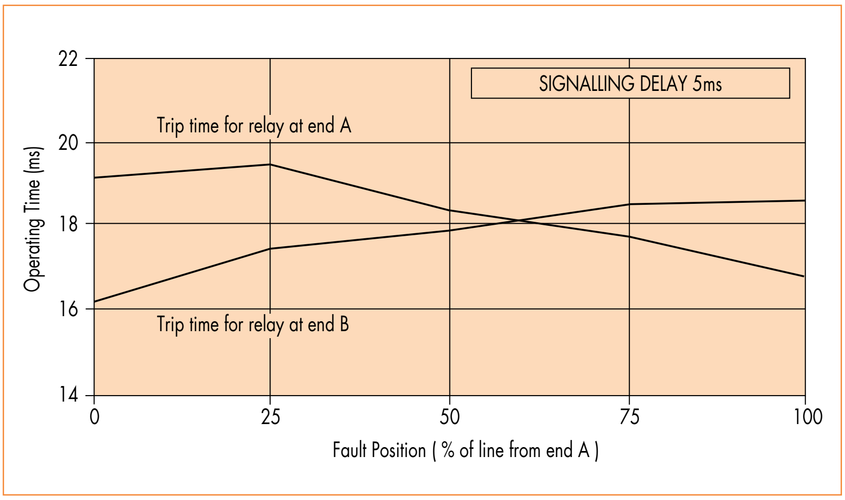


Figure 6: Directional comparison protection typical 50Hz operating times for a permissive overreach scheme

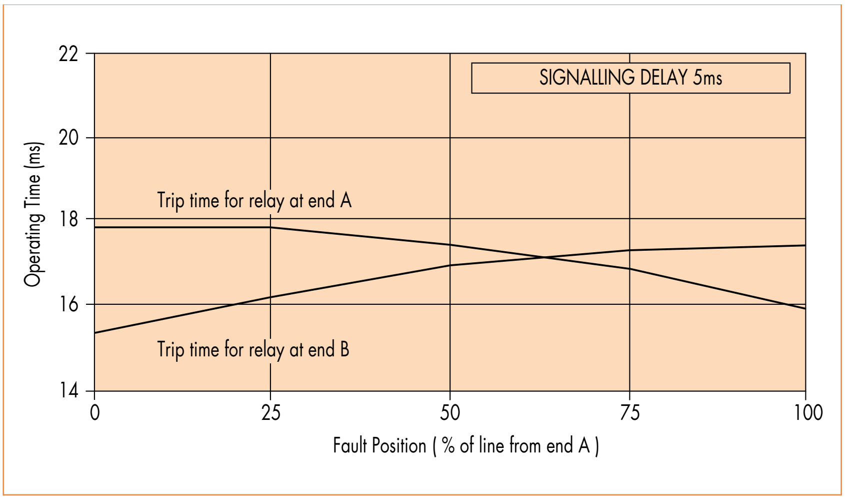


Figure 7: Directional comparison protection typical 60Hz operating times for a permissive overreach scheme

Technical Data

Ratings

AC voltage (V_n)	100 to 120V rms phase-phase	
AC current (I_n)	1A or 5A rms per phase	
Frequency (f_n)	Nominal: 50 Hz or 60 Hz	
	Operative range:	47.0 to 51.0 Hz or 57.0 to 62.0 Hz
Auxiliary dc voltage	Nominal (V)	Operative range (V)
($V_x(1)$)	24/27	19 – 32
	30/34	24 – 41
(Power supply)	48/54	37.5 – 65
	110/125	87.5 – 150
	220/250	175 – 300
Auxiliary dc voltage	Nominal (V)	Operative range (V)
($V_x(2)$)	24/27	19 – 32
	30/34	24 – 41
(Status inputs)	48/54	37.5 – 65
	110/125	87.5 – 150
	220/250	175 – 300

Note: $V_x(2)$ may be different from $V_x(1)$

Dynamic Range/Maximum overoad ratings

Dynamic Range Ratings	
AC voltage	$1.7V_n$ for measuring accuracy
AC current	$35I_n$ for Directional measuring accuracy $25I_n$ for Distance measuring accuracy
Maximum Overlead Ratigs	
AC voltage	$2.2V_n$ continuous withstand $2.5V_n$ withstand for 10s
AC current	$4I_n$ continuous withstand $100I_n$ withstand for 1s (I_n=1A) $80I_n$ withstand for 1s (I_n=5A)

Burdens

AC voltage circuits	<0.1VA per phase at V_n
AC current circuits	<0.1VA per phase at I_n(I_n=1A) <0.2VA per phase at I_n(I_n=5A)
DC supply (V_x(1))	< 12W under healthy live line conditions 35W maximum (during tripping)
DC supply (V_x(2))	20mA maximum per energised status input at rated volts <10mA average per energised status input (status inputs are strobed)

Note: all subsequent settings are referred to line VT and CT secondaries

Directional comparison protection

Features:	Forward and reverse directional decisions are used to provide blocking or permissive overreach protection schemes
Voltage setting (V_s)	1.0V to 60V (rms phase-phase) in 0.25V steps
Current setting (I_s)(fixed)	$0.2I_n$ (rms phase-phase (I_n = 1A or 5A)
Forward sensitivity	Superimposed current $\geq 0.2I_n$ and Superimposed voltage $\geq V_s$
Reverse sensitivity	Superimposed current $\geq \frac{2}{3} \times 0.2I_n$ and Superimposed voltage $\geq \frac{2}{3} \times V_s$
Timer ranges:	
Trip co-ordination delay timer	TP) 1 ms to 100ms in steps of 1ms TD)
Timer accuracy	TP) –1ms, +2ms TD)

Operating time	
Permissive overreach scheme	Closure of the signal send contact (forward fault):
50Hz	minimum 6ms typical 9ms
60Hz	minimum 5ms typical 8ms
	Closure of the trip contact:
50Hz	minimum 10ms + signalling delay typical 13ms + signalling delay
60Hz	minimum 9ms + signalling delay typical 12ms + signalling delay
Blocking scheme	Closure of the signal send contact (reverse fault);
50Hz	minimum 7ms typical 9ms
60Hz	minimum 6ms typical 8ms
	Closure of the trip contact:
50Hz	minimum 5ms + TP typical 8ms + TP
60Hz	minimum 4ms + TP typical 7ms + TP
	(TP = maximum signalling delay + 6ms)
Reset time	The trip contacts are sealed in until the relay detects a pole dead (minimum 64ms)
Fault detector	
Features	Forward and reverse distance fault detectors which control the directional elements during cross-country faults and provide instantaneous protection following breaker closure
Reach of the forward fault detector (FD) (positive sequence)	0.200Ω to 250Ω (I_n = 1A) 0.040Ω to 50.0Ω (I_n = 5A)
	Note: settings are to 3 significant digits with a minimum step size of 0.001Ω
Reach of the reverse fault	120% of forward fault detector reach
Residual compensation factor (KN)	0 to 400% in 5% steps
	where: $KN = \frac{1}{3} \cdot \left(\frac{Z_{L0}}{Z_{L1}} - 1\right)$. 100%
	and Z_{L0} and Z_{L1} are the phasor values of zero and positive sequence impedances of the protected line.
Characteristic angle	$Ø_{ph} = Ø_N$ = 78% (fixed).

Current sensitivity	The minimum operating current (I min) is: $0.134I_n$ if $z \geq \frac{3.2\Omega}{I_n}$. or $0.134I_n \times \frac{3.2}{I_n \times z}$ if $z < \frac{3.2\Omega}{I_n}$. If the distance protection is enabled, z is the distance reach setting (Z). If the distance protection is disabled, z is the forward fault detector reach setting (FD).
Voltage sensitivity	The minimum operating voltage is zero.
Accuracy	At fn and 20°C: Reach: ±10% up to SIR =60.
Operating time	Switch-on-to-fault: closure of trip contact:
50Hz	minimum 26ms typical 41ms
60Hz	minimum 26ms typical 38ms
	Fault evolving from an external to an internal location: operating time of the fault detector following the internal fault:
50Hz	minimum 17ms typical 38ms
60Hz	minimum 12ms typical 31ms

Channel independent distance protection (optional)

Features	One zone of distance protection intended as a back-up in the event of signalling failure. Provides either under-reaching instantaneous protection or over-reaching time delayed protection.
Reach of the distance zone (Z) (positive sequence)	0.2Ω to 250Ω (I_n =1A) 0.04Ω to 50Ω (I_n = 5A)
	Note: settings are to 3 significant digits with a minimum step size of 0.001Ω.
Residual compensation factor (KN)	0 to 400% in 5% steps where: $KN = \frac{1}{3} \cdot \left(\frac{Z_{L0}}{Z_{L1}} - 1\right).100\%$ and Z_{L0} and Z_{L1} are the phasor values of zero and positive sequence impedances of the protected line.
Characteristic angle	$\varnothing_{ph} = \varnothing_N = 78°$ (fixed).
Current sensitivity	The minimum operating current is I min. See section: fault detector
Voltage sensitivity	The minimum operating voltage is zero.

Accuracy	At fn and 20°C: Reach: ±5% up to SIR = 15 Reach: ±10% up to SIR = 60 System Impedance Ratio (SIR) is defined as: Zs/Z for phase-phase faults Zs/(Z + KN.Z) for ground faults where Zs is the total source impedance per phase, Z is the distance setting and KN in the neutral compensation factor.
Timer ranges	Time delayed distance TZ(T) = 0.02s to 5.0s in 0.02s steps.
Timer accuracy	TZ(T): ±5ms
Operating time	Under-reaching instantaneous protection: Closure of the trip contact:
50Hz	minimum 24ms typical 45ms
60Hz	minimum 17ms typical 40ms

Directional earth fault (DEF) (optional)

Features	Zero sequence directional element provides forward or reverse decisions for high resistance phase-ground faults.
Residual current sensitivity (IA + IB + IC)	The operating current is proportional to the largest phase-phase current with minimum values of: $0.11I_n$ for forward decisions $0.073I_n$ for reverse decisions
Residual voltage sensitivity (VA + VB + VC)	The minimum operating voltage is zero for single phase-ground faults, but equal to the directional voltage setting, V_s, for faults occurring following breaker closure.
Characteristic angle	$Ø_{DEF}$ = 78° (fixed).
Channel-aided tripping (Option)	Scheme co-ordination timers: TP, TD. See section on directional comparison protection. Scheme initiation delay time: TDEF = 10ms to 200ms in 10ms steps (Accuracy = ±5ms).
Time delayed trip (option)	Definite time range: TDEF(T) = 0.5s to 10.0s in 0.1s steps. (Accuracy = ±10%).
Operating time - Channel-aided DEF trip (TDEF = 10ms)	
Permissive overreach scheme:	Closure of the trip contact:
50Hz	minimum 51ms + signalling delay typical 56ms + signalling delay
60Hz	minimum 49ms + signalling delay typical 52ms + signalling delay

Blocking scheme	Closure of the trip contact:
50Hz	minimum 45ms + TP typical 50ms + TP
60Hz	minimum 43ms + TP typical 48ms + TP
	(TP = maximum signalling delay + 6ms)

Protection following breaker closure

Application	Instantaneous tripping of the circuit breaker for faults occurring following line energisation. Manual closure of the breaker (SOTF protection) is assumed when all three poles have been open for 110s. All other conditions of breaker closure are assumed to be auto-reclose.
Fault detector	All faults except close-up 3 phase faults and high resistance faults are detected using the fault detector (FD). During line energisation the fault detector is sound phase polarised.
Level detectors	Close-up 3 phase faults are detected using overcurrent and undervoltage level detectors (> I < V).
Directional earth fault (option)	High resistance faults are detected by the channel-aided directional earth faults protection (DEF).

Auxiliary Functions

Trip type	
1 or 3 pole	Single pole tripping for single phase faults and three pole tripping for multiphase faults, or
3pole only	Three pole tripping for all faults.
Block auto-reclose	A normally open or normally closed contact is supplied to block or enable auto-reclose relays. The menu allows auto-reclose to be blocked or enabled for: ● 3 phase faults ● 2 and 3 phase faults ● channel-aided DEF trip ● channel out of service
Power swing blocking	Enabled or disabled.

Output contacts

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 inductive at L/R = 40ms (maxima 5A, 300V ac or dc).

Environmental withstand

Termperature	Operative range −25°C to +55°C Storage and transport −25°C to +70°C
Humidity IEC 68−2−3 Long term damp heat	56 days at 93% RH and +40°C.
Enclosure protection IEC 529	IP50 Category 2 (dust protected)
Vibration IEC 255−21−1 class 1	0.035mm displacement 10–59Hz 0.5g acceleration 59–150Hz

Voltage withstand

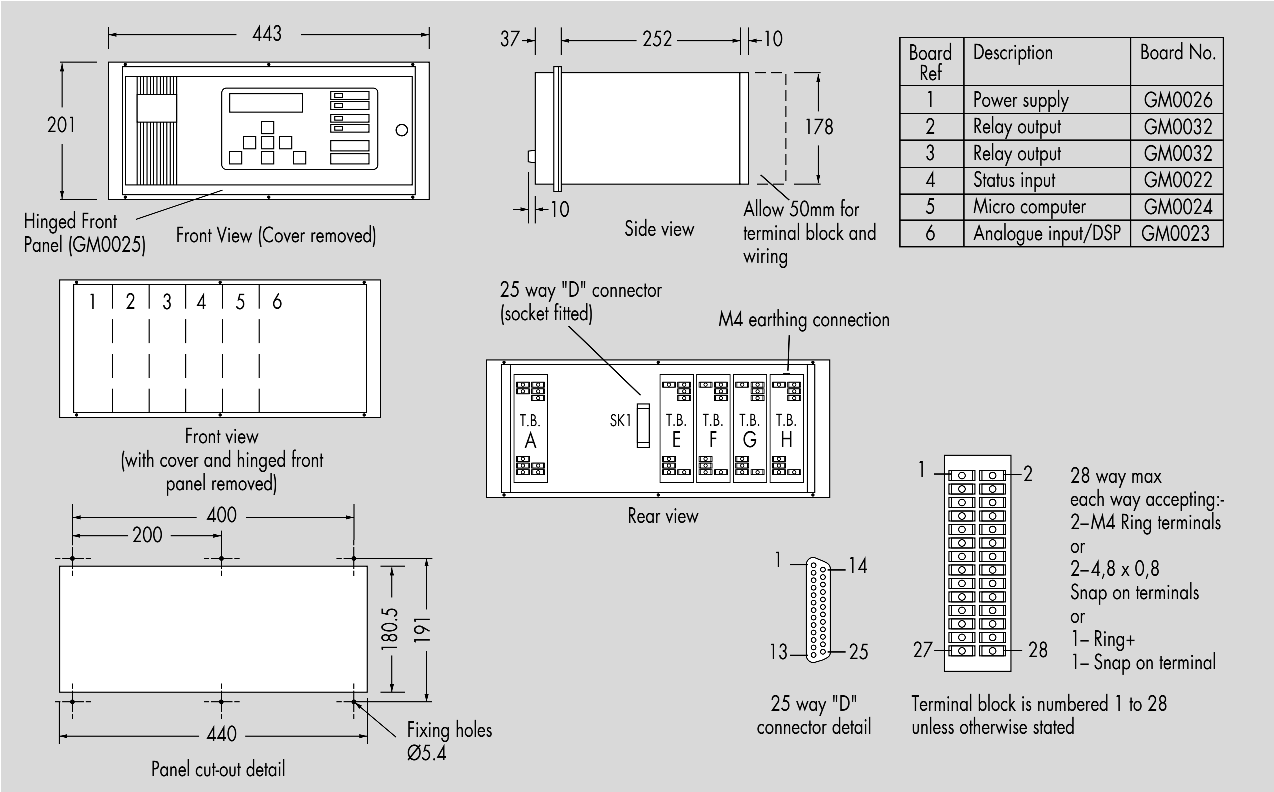
Insulation IEC 255−5 ANSI C37.90–1978	2kV rms for 1 minute between circuits and case earth. 2kV rms for 1 minute between independent circuits. 1.5kV rms for 1 minute across normally open contacts.
High voltage impulse IEC 255−5	5kV peak, 1.2/50μs, 0.5J between circuits and case earth, between independent circuits and across terminals of the same circuit
High frequency disturbance IEC 255−22−1 class III ANSI C37.90.1 - 1989	2.5kV peak between circuits and case earth. 2.5kV peak between each independent circuit and all other independent circuits 1.0kV peak cross terminals of the same circuit at 1MHz
Electrical fast transients IEC draft document 41B, 1990 ANSI C37.90.1–1989	4kV 5/50ns repetitive pulses
Electrostatic discharge IEC 255–22–2 class III	8kV discharge.
Radiated electromagnetic interference test IEC 255−22−3 class III	27-500MHz,10V/m
Draft ANSI C37.90.2	25MHz - 1GHz 10V/m

Auxiliary dc supply

Supply interruptions IEC 255–11	Duration of interrupt 10ms.
Supply ripple IEC 255–11	ac component in dc, 12% of rated dc value.

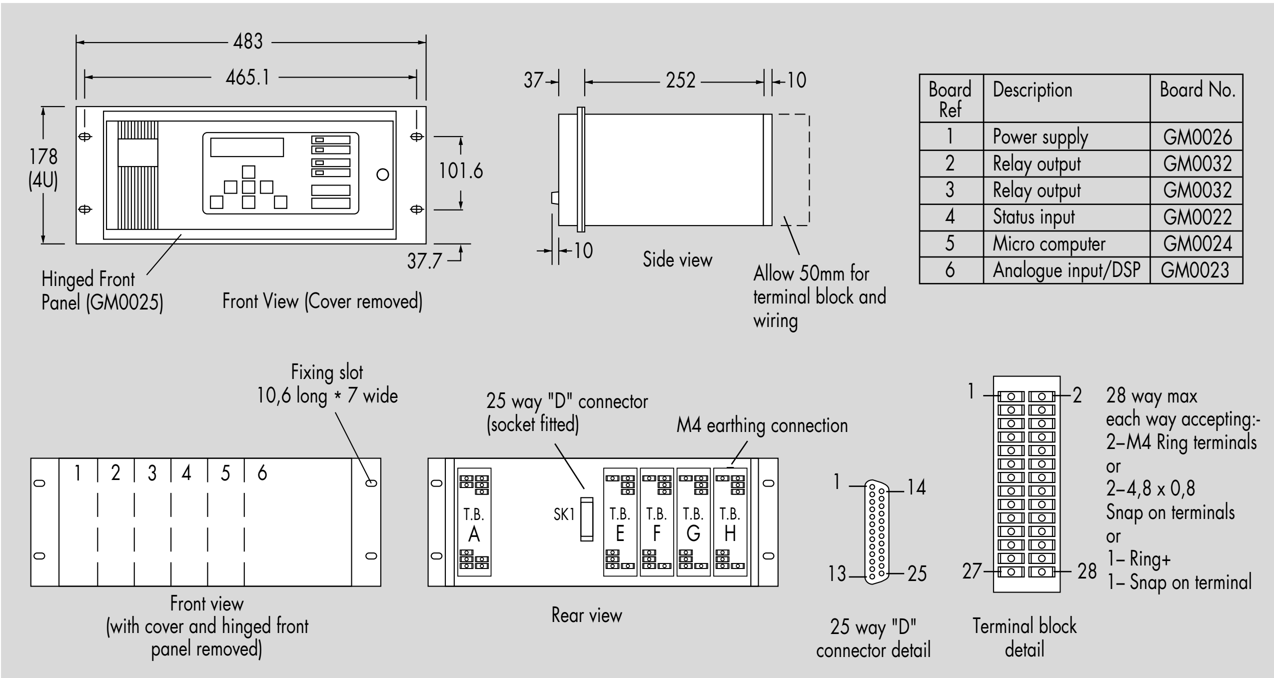
Mechanical construction

Mechanical durability Loaded contact Unloaded contact	 10,000 operations minimum 100,000 operations minimum
Case dimensions	Type LFDC relays are housed in multi-module MIDOS cases (see Figure 8).
Case weight	15kg.



Board Ref	Description	Board No.
1	Power supply	GM0026
2	Relay output	GM0032
3	Relay output	GM0032
4	Status input	GM0022
5	Micro computer	GM0024
6	Analogue input/DSP	GM0023

Figure 8a: Arrangement and outline: panel mounting



Board Ref	Description	Board No.
1	Power supply	GM0026
2	Relay output	GM0032
3	Relay output	GM0032
4	Status input	GM0022
5	Micro computer	GM0024
6	Analogue input/DSP	GM0023

Figure 8b: Arrangement and outline: rack mounting

Information Required with Order

Nominal current rating I_n:	1A or 5A
Auxiliary dc voltage $V_x(1)$	24/27V, 30/34V, 48/54V, 110/125V, 220/250V
Auxiliary dc voltage $V_x(2)$	24/27V, 30/34V, 48/54V, 110/125V, 220/250V
Mounting arrangements	rack or panel, horizontal
Nominal frequency	50Hz or 60Hz
Single or double breaker	Type LFDC101 (4 sets of trip contacts for single breaker applications) or type LFDC102 (6 sets of trip contacts for double breaker applications).