POWER AND WATER AUTHORITY

STANDARDS BRANCH
– Power Division

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SUBJECT: HV FEEDER PROTECTION, MINOR POWER STATIONS

There is an inherent difficulty in protecting HV feeders from Minor Power Stations because of the following reasons:

1. Very low fault levels available on the HV system.

2. High earthing resistances often prevailing in remote communities.

These conditions result in unreliability in HV fuse protection for phase to earth faults in HV systems.

To overcome this problem, the use of a sensitive earth fault relay, in combination with a current transformer in step-up transformer HV neutral to earth connection is recommended. The C.T. should be fitted in an enclosure mounted at the step-up substation, with 1 pair of cables leading back to the protection relay which is fitted in the main switchboard.

Auxiliary power supply for the sensitive earth fault relay will be the 24V DC station supply. When the relay operates, it will activate the shunt trip mechanism on the appropriate feeder moulded case circuit breaker, thus de-energising the HV feeder.

Technical details ofthe relay and C.T. are as follows:

Protection Relay (manufacturer's literature attached)

Make:	G.E.C. 'Midos'
Type:	MCBB11 (1 pole)
Current Range:	10% - 200% of 1 Amp
Auxiliary Power Supply	30 volts DC (will work at 24V DC)
Recommended Setting:	50%

Current Transformer

Make:	Warburton Franki
Ratio:	1 : 1
Class:	0.1 PL 200 R 2.5
Type:	Epoxy Encapsulated

C.T. to Protection Relay Wiring.

Max Allowable circuit resistance: 1 ohm				
Cable Size (sq mm):	4	6	10	16
Max Route Length (meters):	111	166	279	442

Each step-up substation earth will be connected back to teh power station main switchboard earth bar with a minimum 19/2/14 copper cable. Total earth resistance should be less than 1 ohm.

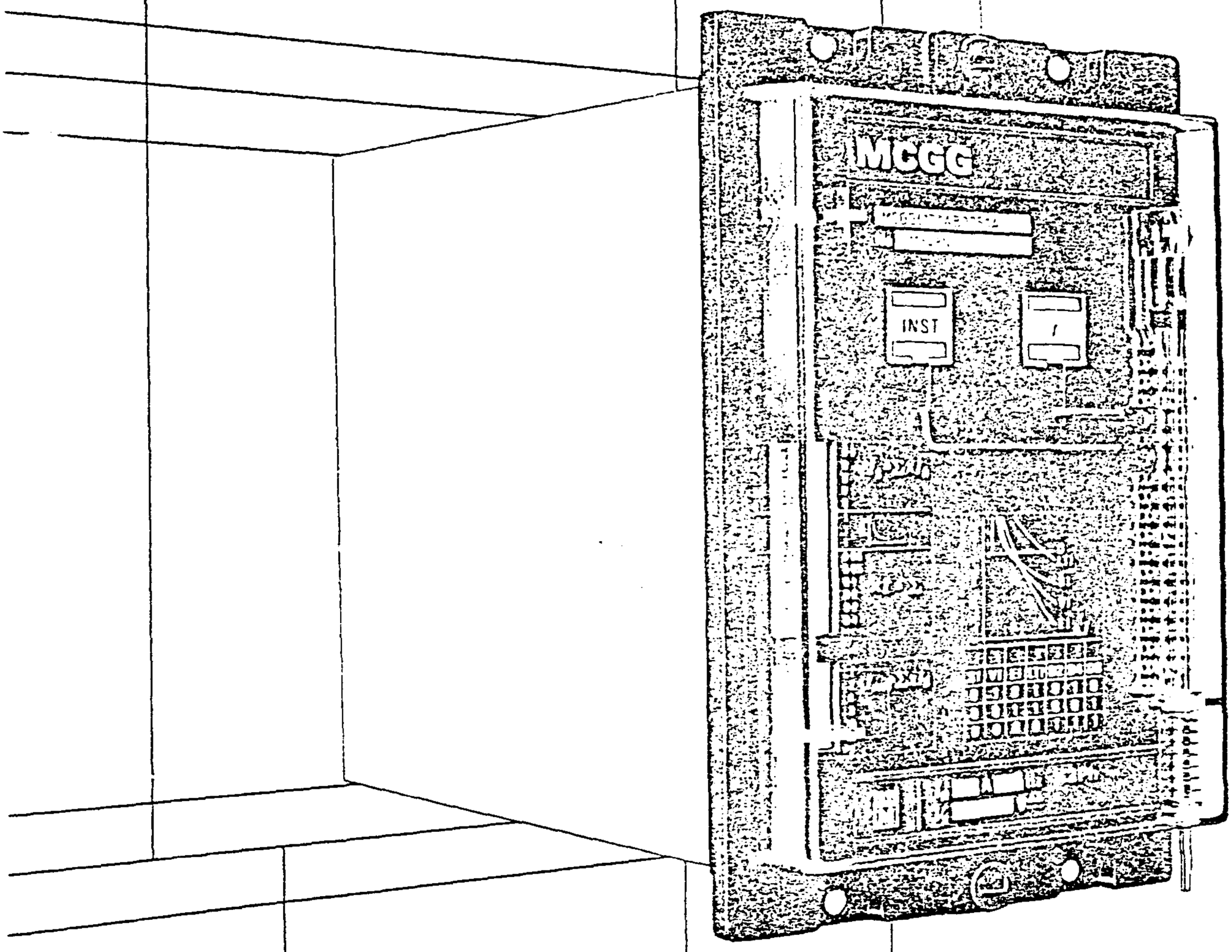
A sketch of recommended protection system for Minor Power Stations is attached, however a detailed technical standard on this subject will be published in a separate Standard's Volume on Minor Power Stations.

BRIAN KENT
STANDARDS MANAGER POWER

GEC Measurements

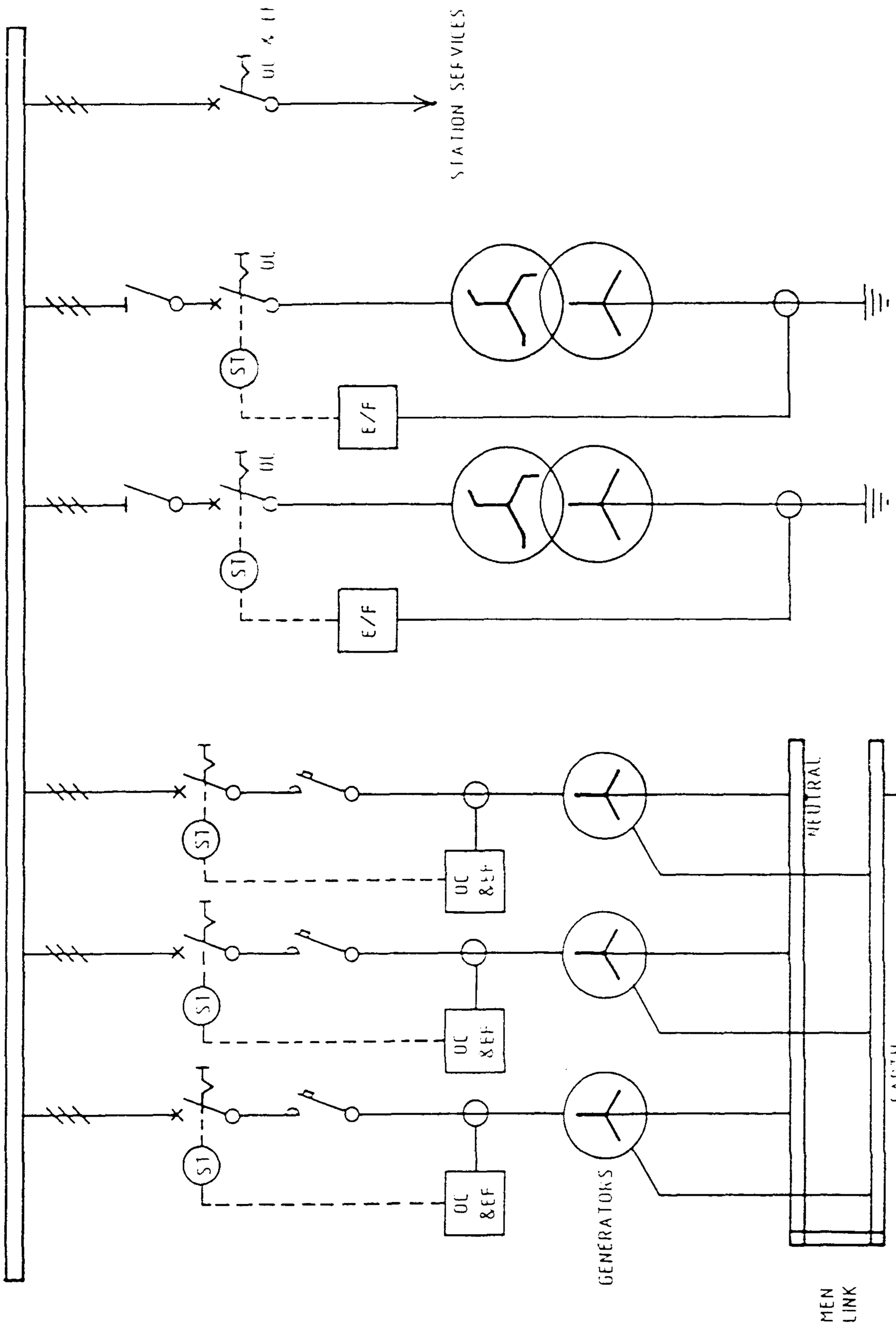
Type MCGG

Overcurrent Relay for Phase and Earth Faults



MiDOS

3RD ANGLE - DO NOT SCALE-- REPORT ANY ERRORS, OMMISSIONS TO DRAWING OFFICE.



N.T.E.C.	DES	N.T. ELECTRICITY COMMISSION		
	DRN	H.V.FEEDER PROTECTION MINOR POWER STATIONS SINGLE LINE DIAGRAM		
	CKD			
	APPD.			
	ISSUED			
	DRAFTING STANDARD TO AS 1100	A4	INDEX N°	DRG. N° P001
	ALL DIM IN mm	SCALE		SHEET

AMDT

The time given by each of the operating characteristics must be multiplied by the time multiplier to give the actual operating time of the relay. This control is marked xt = Σ where Σ is the sum of all the switch positions.

The range of multiplication is from 0.05x to 1.0x in steps of 0.025.

This acts as a conventional time multiplier on the current dependent characteristics and gives the following time ranges for the definite time characteristics.

Operating Characteristic Sec.	Time Range Sec.
2	0.1 to 2.0 in 0.05s steps
4	0.2 to 4.0 in 0.1s steps
8	0.4 to 8.0 in 0.2s steps

Current Setting – Time Delayed Element

The current setting control is marked $I_s = \Sigma \times I_n$ where I_s is the current setting in amps, Σ is the sum of all the switch positions and I_n is the relay rated current in amps.
Thus in the example of a single phase relay Σ provides a factor of 0.1X to 2.0X in steps of 0.1 (see Technical Data).

Current Setting – Instantaneous Element

The setting control of the instantaneous element is marked $I_{INST} = \Sigma \times I_s$, where Σ is the sum of the switch positions and I_s is the time delayed element setting.
When all switches are set to the left (at zero), or when the lower switch is set to infinity regardless of the positions of the other five switches, the instantaneous feature is rendered inoperable. The range of adjustment of finite settings is from 1x to 31x in unity steps.

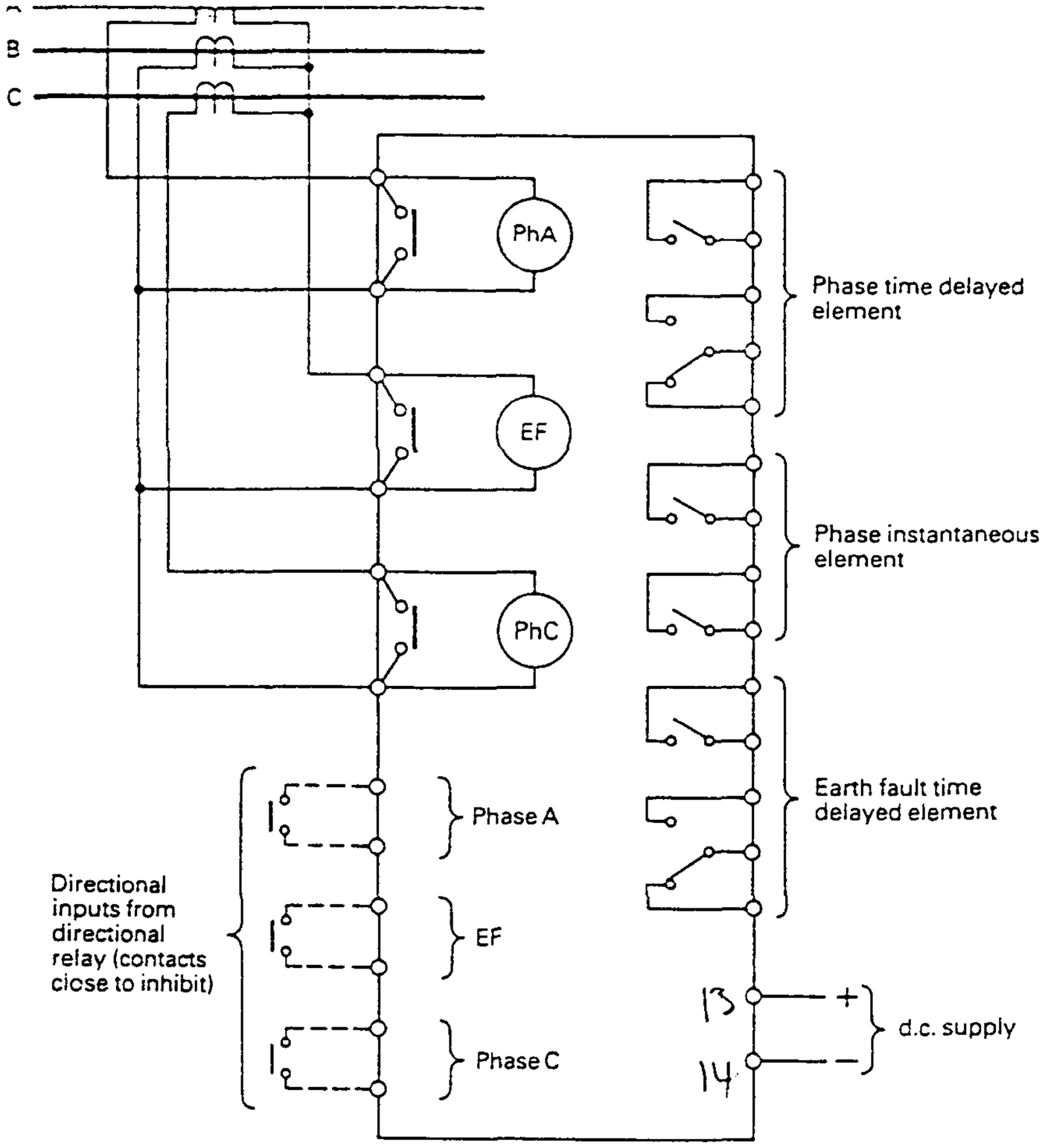


Figure 4. Typical connection diagram for a two phase and earth fault relay with phase instantaneous protection and showing connections for a directional relay.

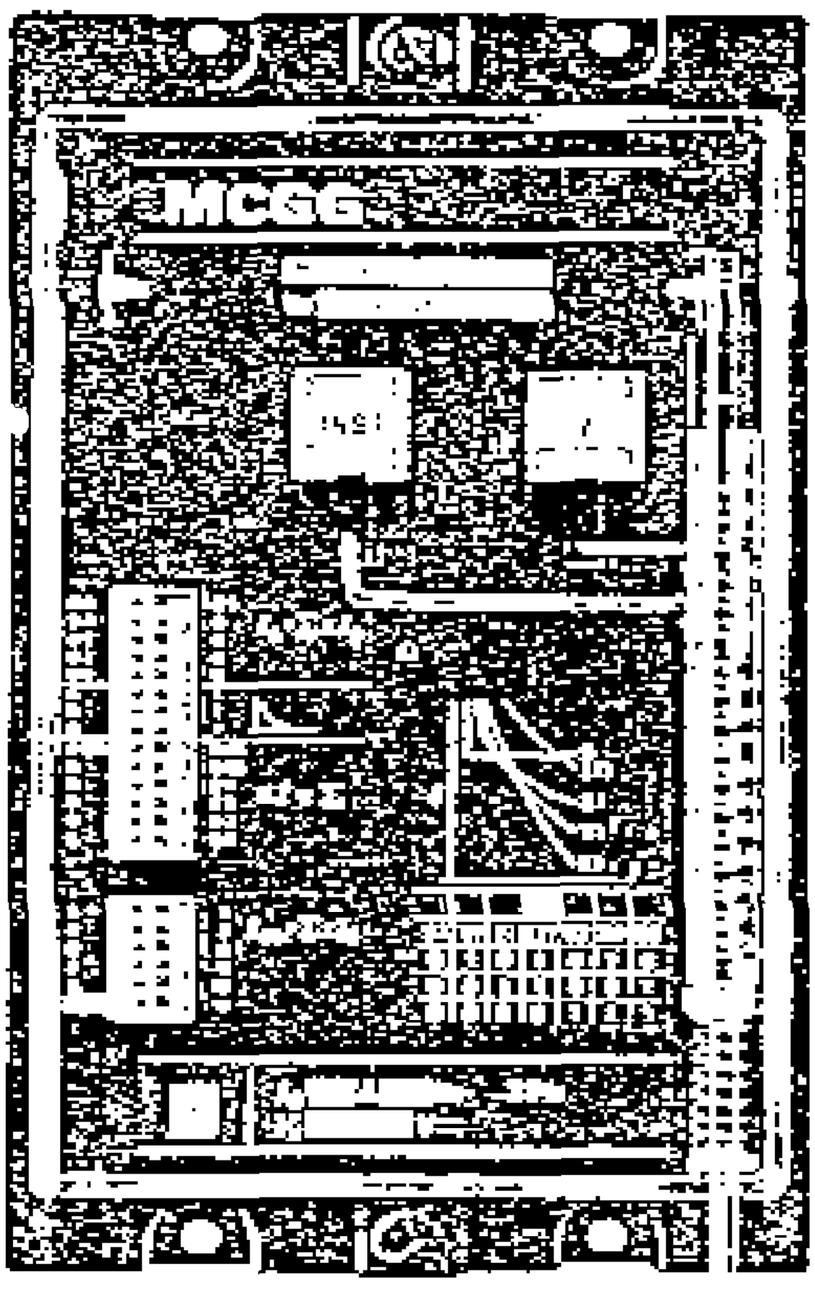
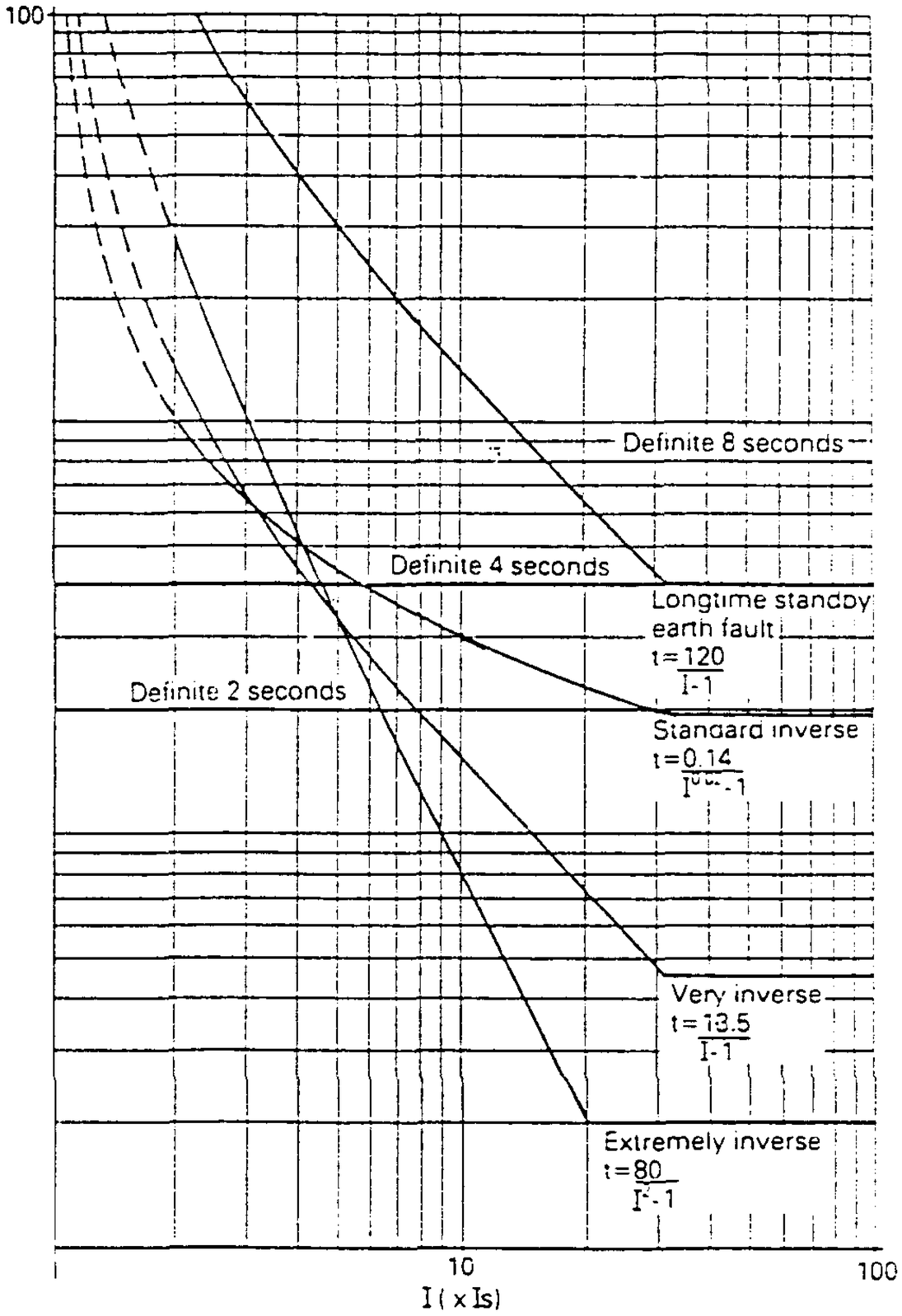


Figure 5. Type MCGG board assembly.



STATIC MODULAR OVERCURRENT RELAY – IDMT CURVES

ed overcurrent element – operation time characteristics.

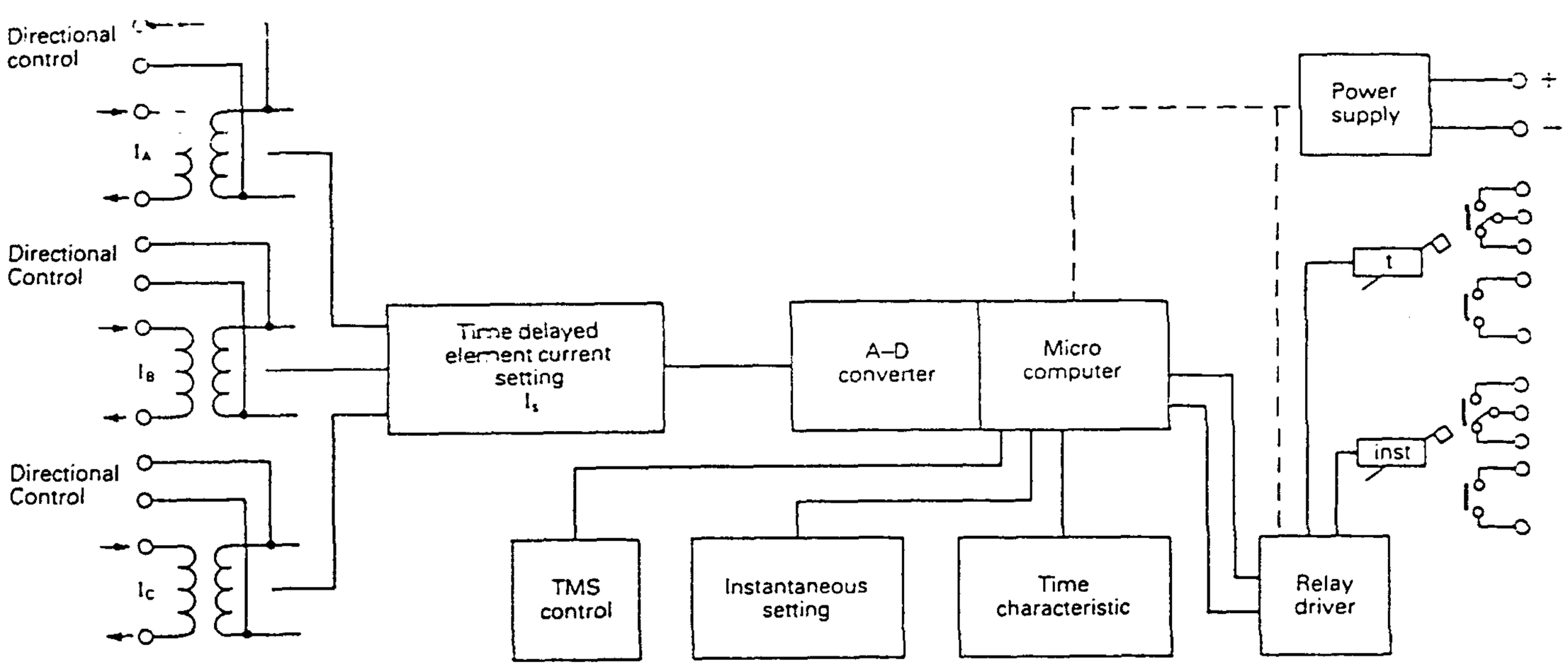


Figure 2. Block diagram of 3 phase relay with instantaneous element.

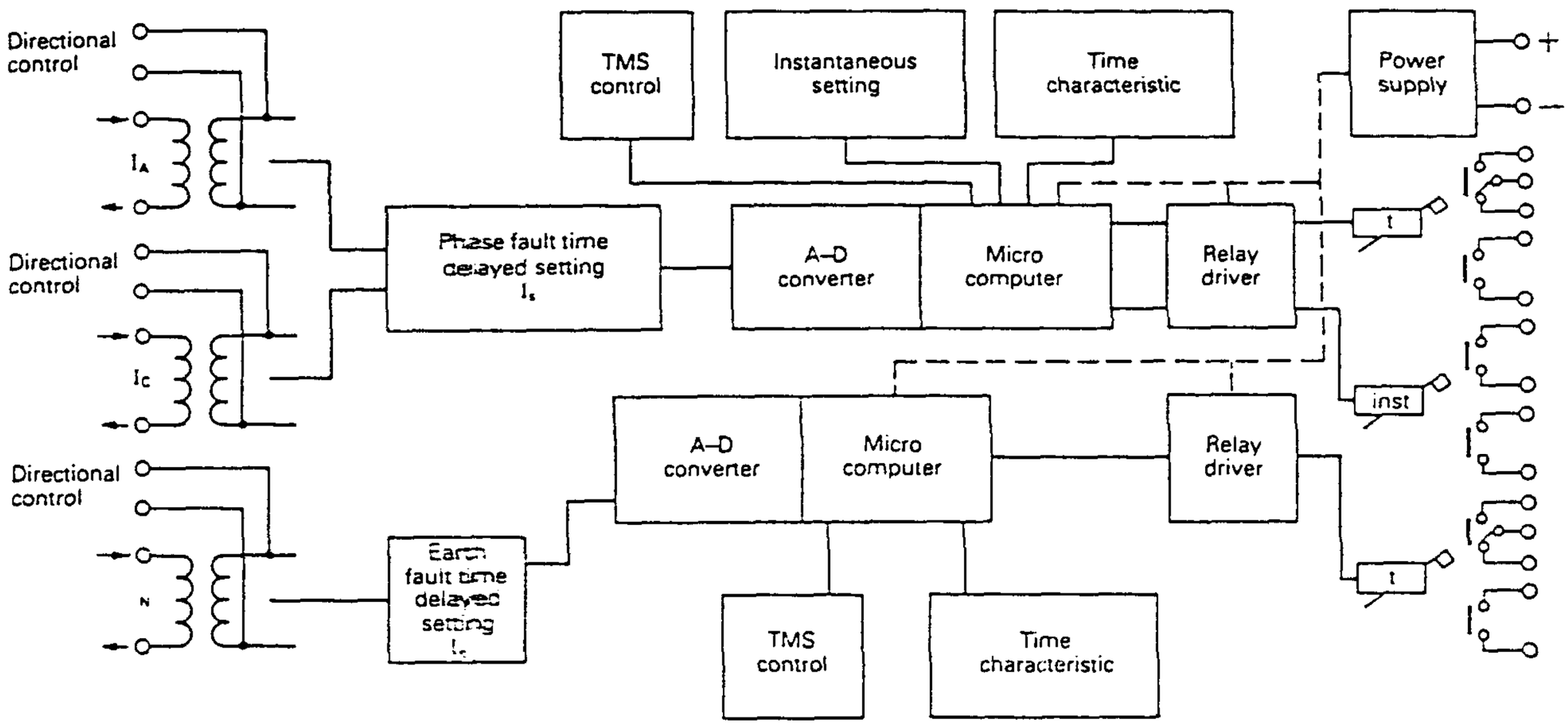


Figure 3. Block diagram of 2 phase and earth fault relay with phase instantaneous element.

RELAY SETTINGS

Relay settings are simply obtained:
Figure 5 shows the relay nameplate.

Selection of Time Characteristics

The current/time characteristic selection is carried out by means of three switches (identified by ⊥ symbol on the nameplate).
Table 1 gives the basic operating characteristics and the settings of the switches.

Switch Position (0) (1)	Operating Characteristic		
●	Standard inverse	$t = \frac{0.14}{(I^{0.02}-1)}$ sec	SI
●	Very inverse	$t = \frac{13.5}{(I-1)}$ sec	VI
●	Extremely inverse	$t = \frac{80}{(I^2-1)}$ sec	EI
●	Long time earth fault	$t = \frac{120}{(I-1)}$ sec	LT
●	Definite time 2 seconds		D2
●	Definite time 4 seconds		D4
●	Definite time 8 seconds		D8

Table 1. Operating time characteristics with corresponding switch positions

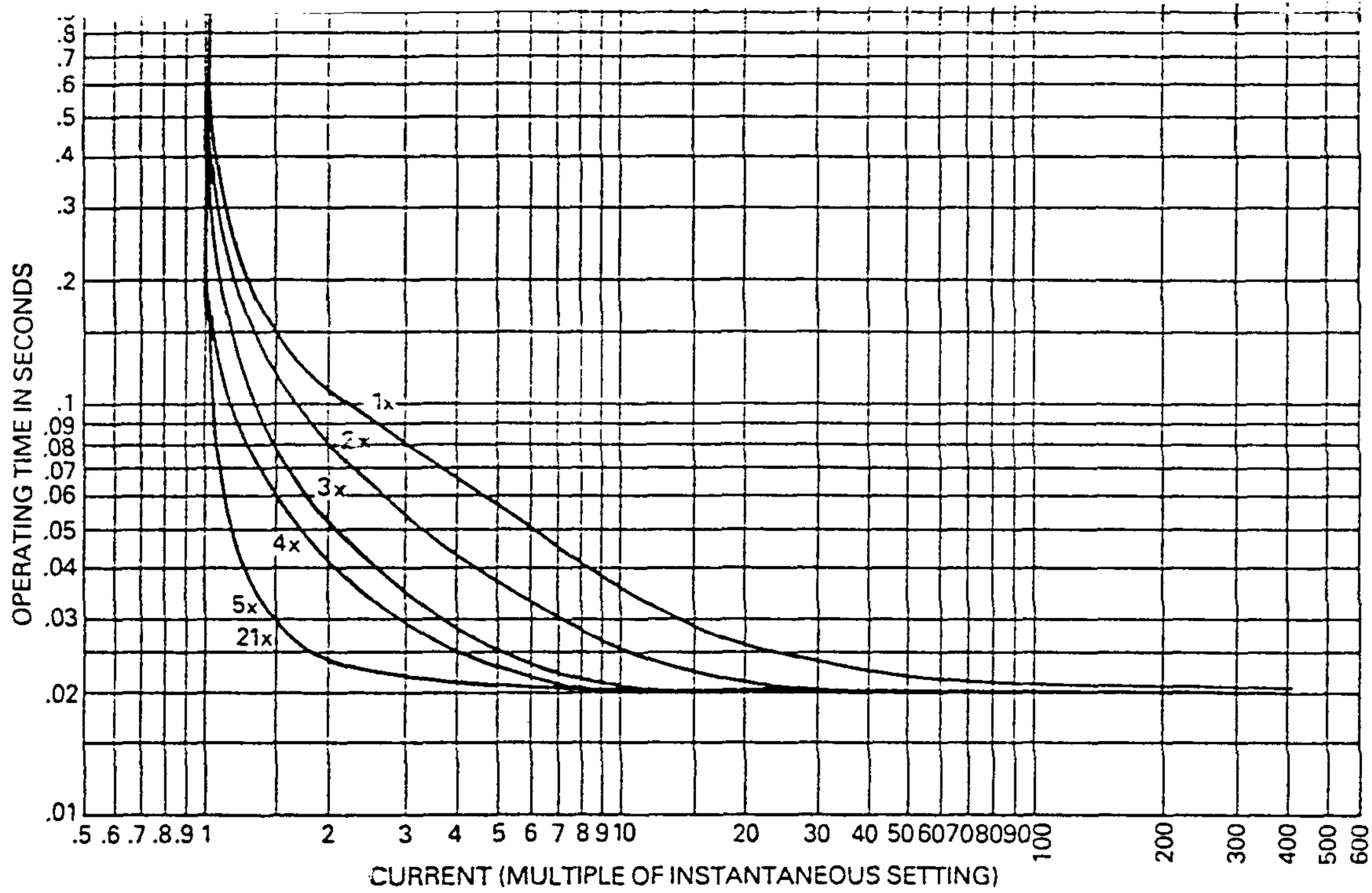


Figure 7. Instantaneous overcurrent element – operation time characteristics.

TECHNICAL DATA

Ratings

A.C. Current (I_n)	1A or 5A
Frequency	50Hz/60Hz
D.C. Supply (V_x)	30/34V, 48/54V, 110/125V. Relays suitable for 220/ 250V and 24V can be provided by the addition of a Type MSTZ d.c./d.c. converter.

Burdens

A.C. Burden

Less than 0.5VA at unity power factor and rated current on any setting.

The impedance of the relays over the whole of the setting range (10% to 200% rated current) is less than 0.5 ohms for 1A relays, and less than 0.02 ohms for 5A relays, and is independent of current.

D.C. Burden

Single phase and 3 phase relays

V_x	Watts
30/34	less than 1
48/54	less than 2
110/125	less than 5

Two phase and earth fault relays

30/34	less than 2
48/54	less than 4
110/125	less than 9

The figures above are maxima under quiescent conditions. With output elements operated they are increased by a factor of 3.

Current transformer requirements

Relay and CT Secondary rating (A)	Nominal output (VA)	Accuracy Class	Accuracy Limit current (X rated current).	Limiting Lead resistance (ohms)
1	2.5	10P	20	1
5	7.5	10P	20	0.15

The limiting lead resistance is given for the leads between the CT's and the relay. The respective limiting value should include go and return leads when the relay includes an earthfault element.

relay and earth fault pole of two phase and earth fault relay.
10% to 200% of I_n in 10% steps.

Three phase relay and phase poles of two phase and earth fault relay.
50% to 200% of I_n in 10% steps.

Instantaneous settings (I_{INST}) all relays.
1 x I_s to 31 x I_s in steps of 1 x I_s.

Operating Time

Time delayed element	Shown in Figure 6
Operating characteristics selectable to give:	Standard inverse IDMT Very inverse IDMT Extremely inverse IDMT Long time earth fault IDMT Definite time 2s 4s 8s
Time multiplier setting:	0.05 to 1.0 in 0.025 steps (applicable to all time characteristics)
Instantaneous elements:	Shown in Figure 7 For settings of 5 x I_s and above < 35ms at 2x setting

Accuracy – Reference Conditions

Current setting: (I_s):

Reference range:
Single phase 0.1 x I_n to 2.0 x I_n
Three phase 0.5 x I_n to 2.0 x I_n

Input current:

Time Characteristic	Reference Range
Standard inverse Very inverse Long time inverse	2 x I_s to 31 x I_s
Extremely inverse	2 x I_s to 20 x I_s
Definite time	1.3 x I_s to 31 x I_s

Ambient temperature:	20°C
Frequency:	50Hz or 60Hz
Time multiplier setting:	1x
D.C. auxiliary voltage:	Reference range 30/34V, 48/54V, 110/125V

Accuracy

Current setting:

Time delayed element: 1.0 x I_s to 1.1 x I_s
Instantaneous elements:
1 x setting: 1.0 x I_{INST} to 1.1 x I_{INST}
All other settings: I_{INST} ± 5%

Operating time:

Time Characteristic	Accuracy
Standard inverse Very inverse Long time inverse	± 5%
Extremely inverse	± 7.5% or 30ms whichever is the greater
Definite time	± 3%

Repeatability (within basic accuracy claim)	Pick-up current: better than ± 1% Operating time: better than ± 2% or 30ms whichever is the greater

Accuracy – Influencing Quantities

Time multiplier:

On settings 0.05 to 1.0:
± 2% or 30ms whichever is the greater

Ambient temperature:

Operative range: −25°C to +55°C
Variations over this range:
Setting current: ± 5%

Operating time:

Time Characteristic	Time Variation
Standard inverse Very inverse Long time inverse	± 5%
Extremely inverse	± 7.5%
Definite time	± 3%

Frequency:	Frequency range: 47Hz to 62Hz Variations over this range: Setting current: ± 1% Operating time: ± 2%

D.C. auxiliary voltage:

V_xd.c. (V)	Operative Range (V)
30/34	24 to 37.5
48/54	37.5 to 60
110/125	87.5 to 137.5

Variations over these ranges:
Setting current: ± 1%
Operating time: ± 2%

Accuracy – General

Overshoot time:	Less than 30ms
Resetting current:	Time delayed and instantaneous elements: not less than 95% of time delayed current setting
Resetting and disengaging times:	Less than 70ms
Transient overreach: (instantaneous elements)	System time constant up to 30ms: ± 5% System time constant up to 100ms: ± 10%

Thermal Withstand

Continuous withstand	2 x I_s or 2.2 x I_n whichever is lower, with a minimum of 1 x I_n
Short time withstand:	For 1s: 100 x I_n with 400A maximum For 3s: 57 x I_n with 230A maximum

Contacts		Changeover	Make – self reset	Type of operation indicator
3 phase and 1 pole relays	Time delayed element	1	1	Hand reset
	Instantaneous element	1	1	Hand reset
2 phase and earth fault relays	Phase time delayed element	1	1	Hand reset
	Earth fault time delayed element	1	1	Hand reset
	Instantaneous phase element	—	2	Hand reset

Contact Ratings

Make and carry for 0.2s:	7500VA subject to maxima of 30A and 300V a.c. or d.c.
Carry continuously:	5A a.c. or d.c.
Break:	a.c. – 1250VA d.c. – 50W resistive 25W, L/R = 0.04s } subject to maxima of 5A and 300V.

Directional Control	Directional control can be exercised over each pole individually by connecting the output contact of a relay type METI across appropriate case terminals.

Environmental Withstand

Mechanical durability	The relay will perform more than 10000 operations.
Vibration:	0.5g between 10Hz and 300Hz. Complies with BS 142, Category 2.
Insulation:	The relay meets the requirements of IEC 255-5 Series C – 2kV for 1 minute.
Impulse voltage:	The relay complies with the requirement of IEC 255-4, Appendix E, to Class III.
High frequency interference:	The relay complies with IEC 255-4 Appendix C to Class III.
Storage temperature range and humidity withstand:	The relay will meet the requirements of BS 2011 (IEC 68), Class 25/070/56. This specifies a transport and storage range of –25°C to +70°C, and 95% humidity at 40°C for 56 days.

CASES

Size 4 case, except for two phase and earth fault relay with instantaneous element, which uses a size 6 case.

The dimensions of the cases are shown in Figures 8 and 9.

INFORMATION REQUIRED WITH ORDER

Relay type (See models available).
Rated current and frequency.
D.C. auxiliary voltage.
Case mounting: flush
semi-projecting
rear flange

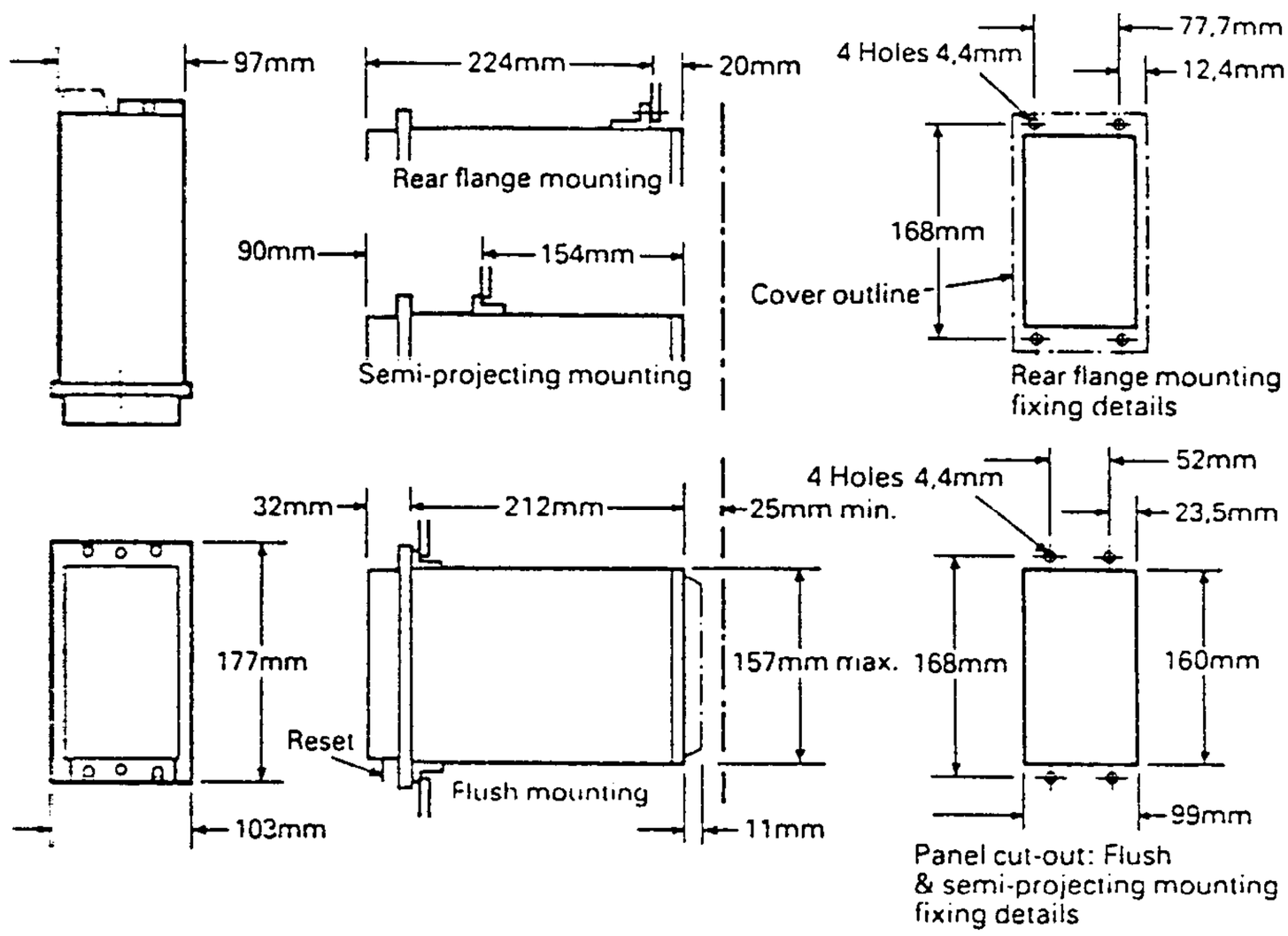


Figure 8. Case outline size 4.

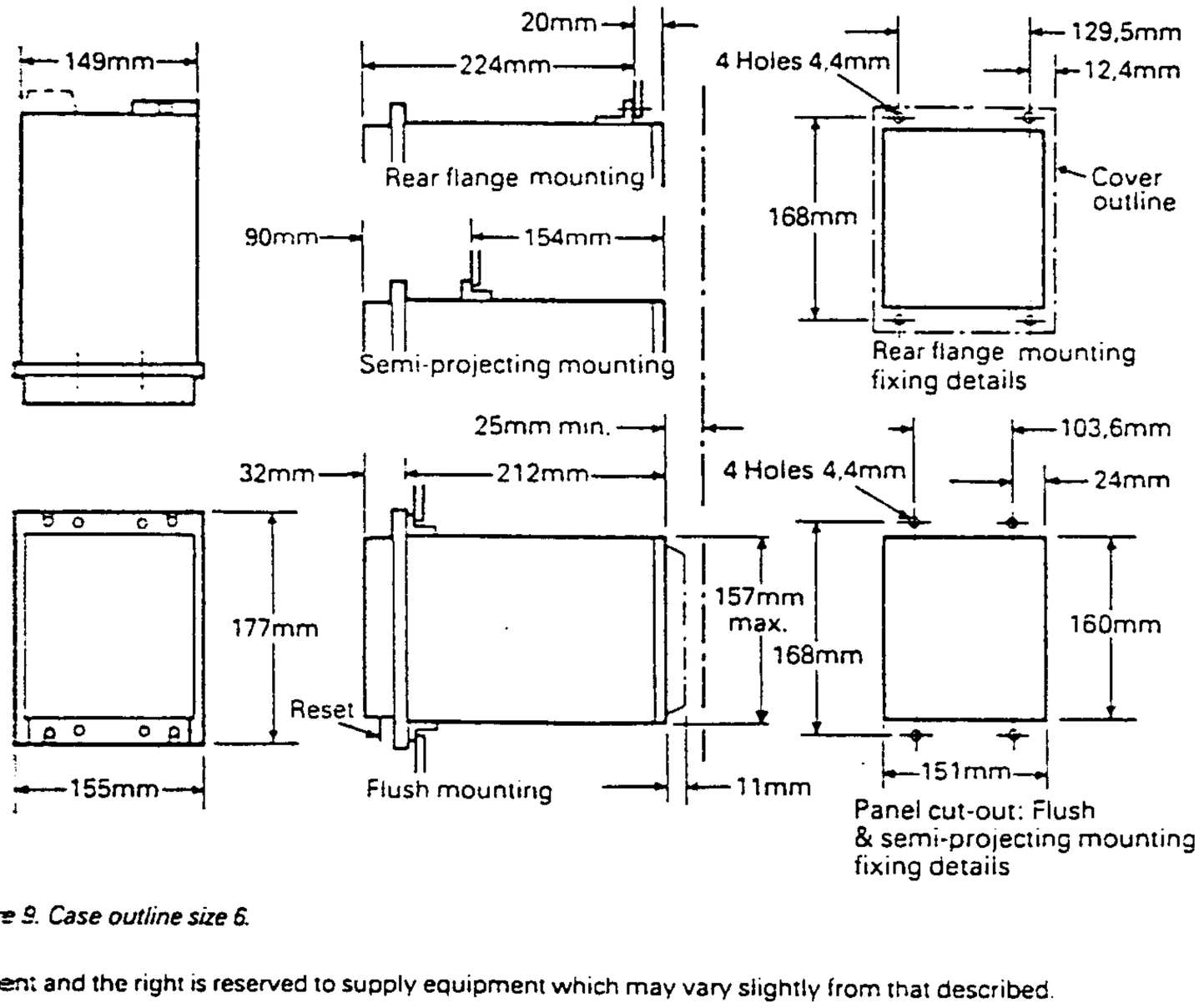


Figure 9. Case outline size 6.

Our policy is one of continuous product development and the right is reserved to supply equipment which may vary slightly from that described.

GEC Measurements

MiDOS

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