GEC Measurements

GENERATOR PERCENTAGE BIASED DIFFERENTIAL RELAY

Type DDG

The type DDG relay is a low bias slope differential unit designed for protection of large generators and reactors against internal phase and earth faults. Basically the relay is an induction disc unit with a pair of bias or restraint coils (in addition to an operating coil) to prevent operation by external faults. Types DDG11 and DDG31 are single and triple pole versions respectively.

OPERATION

The relay is connected in a Merz-Price configuration to corresponding matched current transformers on either side of the protected equipment. The C.T. secondaries provide a through current in the relay restraint coils which produce a continuous torque on the disc in the contact opening direction. The differential of the C.T. secondary currents flows in the relay operating coil.

Under normal load conditions the C.T. secondary currents are equal and no current flows in the operating coil. If these currents become unequal, due to a fault in the protected equipment, the unbalanced burdens in the external leads, the resulting differential current energises the operating coil which produces a torque on the disc in the contact closing direction. The contacts close when the ratio of the differential current to the through current exceeds the slope of the relay operating characteristic determined by the turns ratio of the operating and restraint coils.

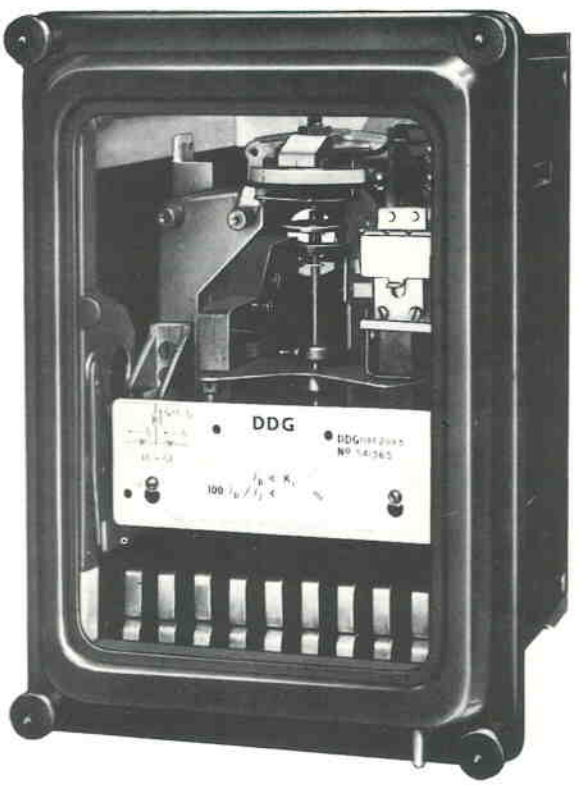
The bias slope is chosen so that the relay is insensitive to unbalanced external lead burdens which normally give a lower ratio of differential current to through current than an internal fault. The minimum operating current of the relay is determined by the tension of the disc control spring and can be adjusted by rotating a knurled moulded disc against a graduated scale.

CURRENT SETTING

Type A: 5–10% (adjustable) } of 0·5, 1·0 or 5·0 amps (C.T. secondary)
Type B: 5% (fixed) } 50 or 60 c/s

PERCENTAGE BIAS

Type A: 10%
Type B: 5%



Type DDG11 relay

The percentage bias is defined at the minimum current setting as $\frac{\text{spill current}}{\text{through current}} \times 100$

OPERATING TIME

Type A: 0·050 second at 10% current setting
0·065 second at 5% current setting
} at 5 times current setting
Type B: 0·045 second

BURDENS

Relay type	Bias coil			Operating coil		
	Bias	Burden (C.T.) at rated current		Current setting	Burden (C.T.) at current setting	
		50 c/s	60 c/s		50 c/s	60 c/s
A	10%	0·82 VA	0·95 VA	5%	0·5 VA	0·7 VA
				10%	1·9 VA	2·5 VA
B	5%	0·82 VA	0·95 VA	5%	2·1 VA	2·7 VA

Current Transformer Knee-point Voltage

The knee-point is defined as the point on the magnetisation curve at which a 10% increase in excitation voltage produces a 50% increase in excitation current. The minimum knee-point voltage and maximum excitation current are calculated as follows:

Relay bias	Minimum knee point voltage (V_k)	Max. excitation current
5%	$2{\cdot}4I_f (R_s + R_b + R_r)$	$\frac{1}{2}(I_s - I_r)$ at relay operating voltage
10%	$2I_f (R_s + R_b + R_r)$	

Where I_f = Maximum fault current (C.T. secondary amps)

I_s = Effective current setting (C.T. secondary amps)

I_r = Relay operating current (C.T. secondary amps)

R_s = C.T. secondary resistance (ohms)

R_r = Lead resistance between C.T.'s and relay (ohms)

R_b = Impedance of one half of relay bias winding (ohms)

$$= \frac{\text{bias winding burden (VA)}}{2 \times (\text{rated current})^2}$$

AUXILIARY UNITS AND OPERATION INDICATORS

An auxiliary attracted armature unit with a hand reset operation indicator for either shunt (seal in) or series seal in is fitted as standard.

Standard Coil Ratings

Voltage operated (shunt) auxiliary units are available with nominal ratings of 30, 110, 125 or 220 volts d.c. at a nominal burden of 3 watts continuously rated.

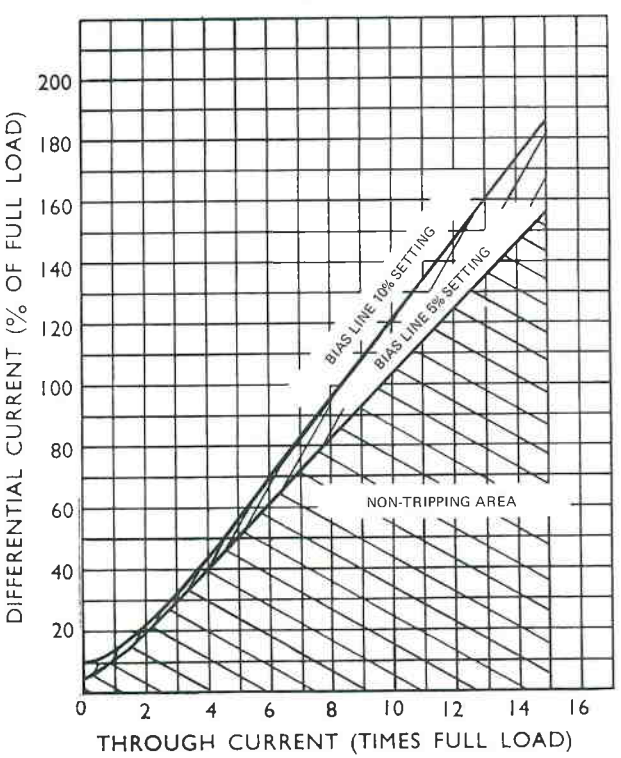
Current operated (series) auxiliary units:

Minimum operating current in amps (two taps)	0·5 second current rating in amps	Coil resistance in ohms
0·1 and 0·3	18 and 22	9·2 and 2·1
0·2 and 2·0	22 and 92	6·0 and 0·125
0·6 and 2·4	92 and 188	0·29 and 0·031

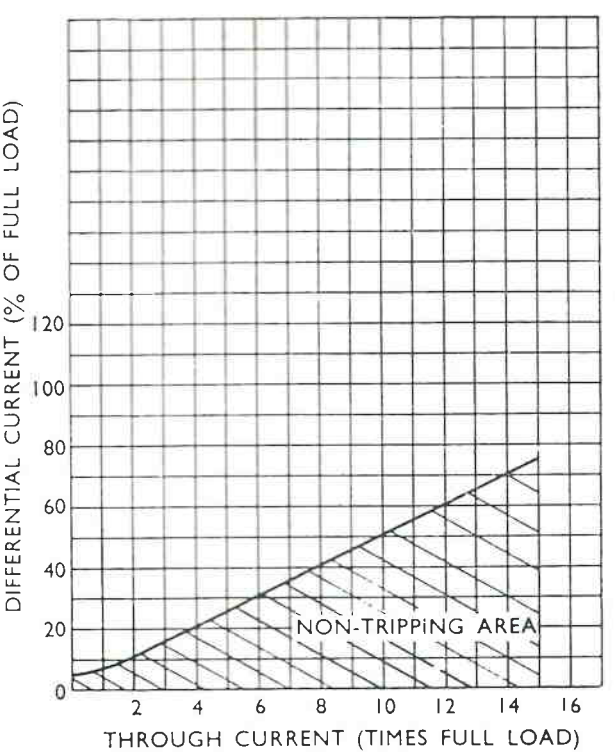
Other coil ratings can be supplied for both types of auxiliary unit.

Contacts

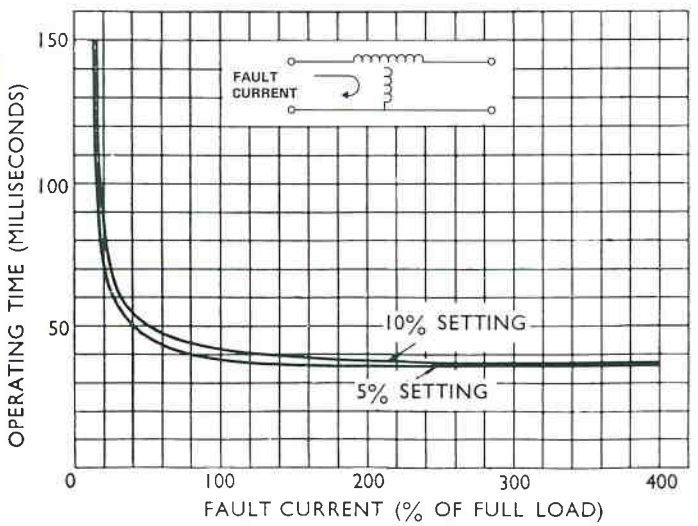
Two pairs of electrically separate normally open self or hand reset contacts are fitted and will make and carry 7500 VA for 3s with maxima of 30 A and 660 V a.c. or d.c.



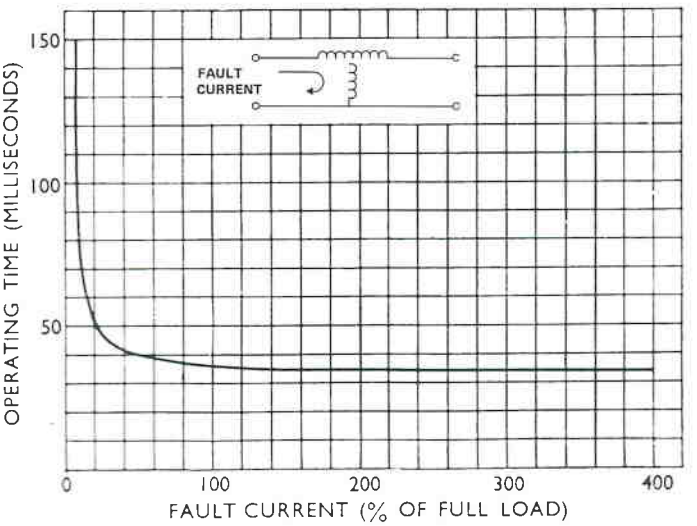
Operating characteristic (type A relay)



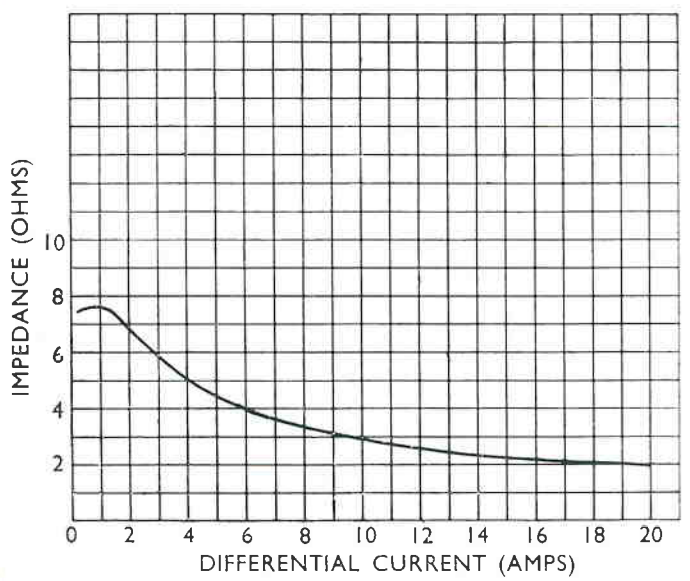
Operating characteristic (type B relay)



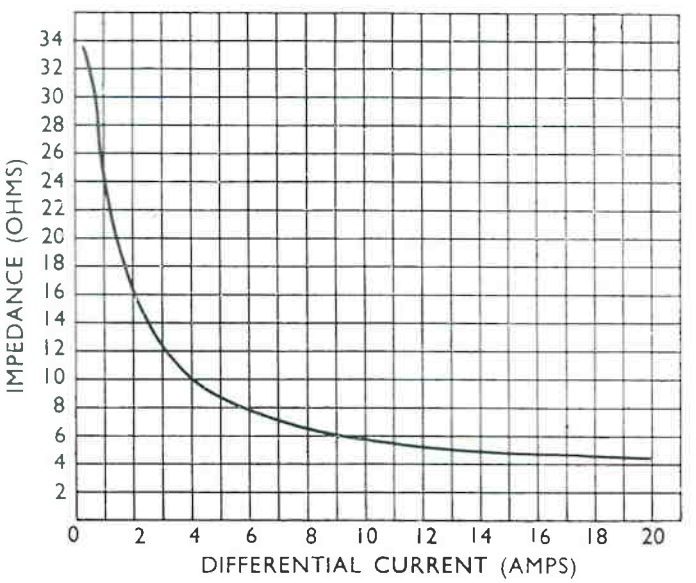
Time/current characteristic (type A relay)



Time/current characteristic (type B relay)



Operating coil impedance characteristic (type A relay)



Operating coil impedance characteristic (type B relay)

CASES

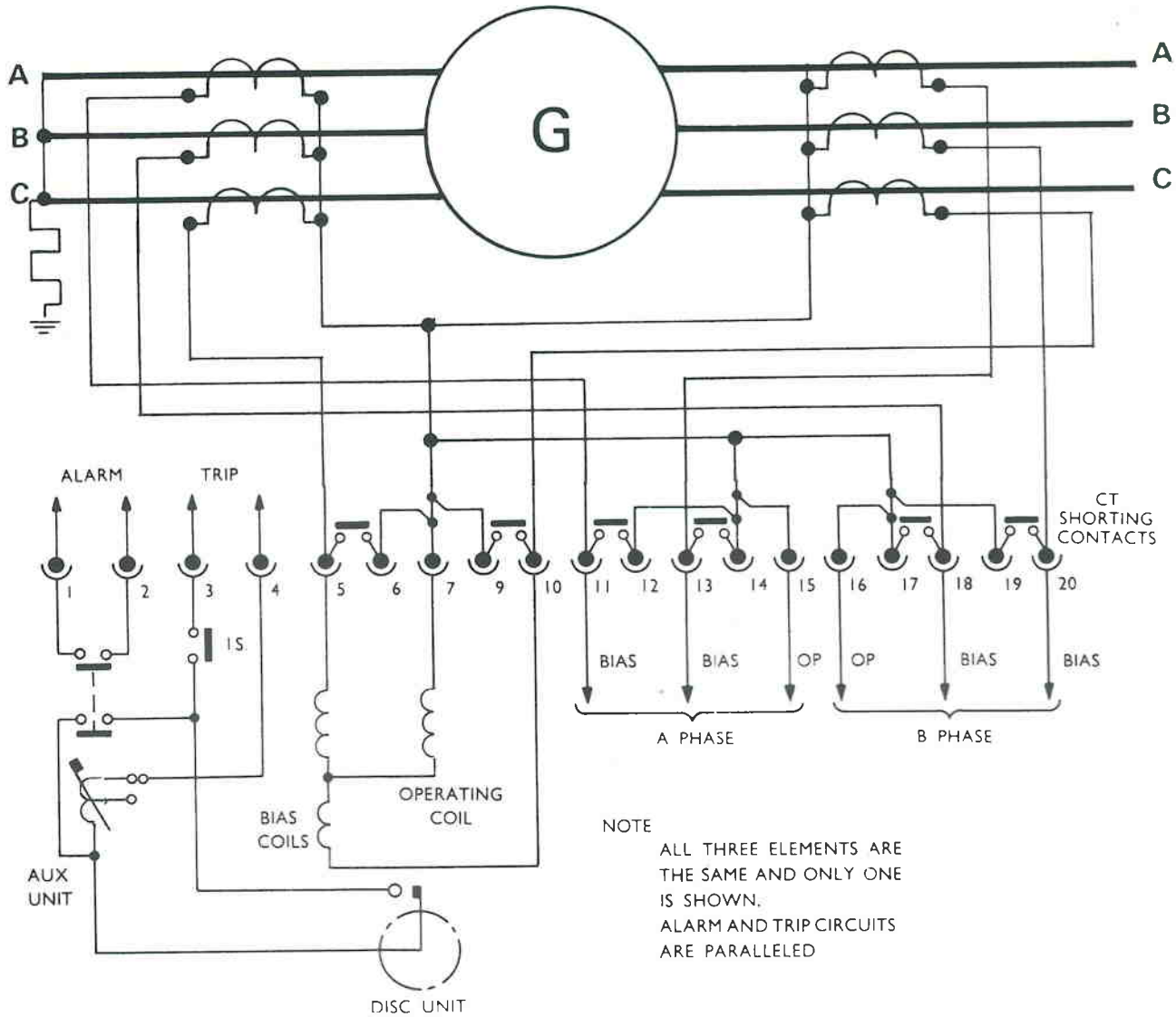
The relays are supplied in drawout cases available for either flush or projecting mounting and finished in phenolic black. Standard relays are finished to B.S.2011: 20/40/4 and are suitable for normal tropical use; relays for use in exceptionally severe environments can be finished to B.S.2011: 20/50/56 at extra cost.

The drawout case offers many advantages including ease of maintenance and testing, and is fitted with contacts which short circuit the associated current transformers on withdrawal of the unit. A filter is fitted to equalise the pressure inside and outside the case without admitting dust.

Relay	Case	Maximum Overall Dimensions					
		Height		Width		Depth*	
		ins	mm	ins	mm	ins	mm
DDG 11 (Single Pole)	1D	9 3/16	233	6 11/16	170	7 3/4	197
DDG 31 (Triple Pole)	3D (Vert)	20 5/8	524	6 11/16	170	7 3/4	197
	3D (Horiz)	9 1/4	235	17 7/8	454	7 3/4	197

*Add 3 ins (76 mm) for maximum length of 2 BA terminal studs.

Dimensioned drawings of case outlines, panel cut-outs and mounting details are available on request.



Typical application circuit and internal circuit diagram of type DDG 31 relay with series seal in

EARTHING ARRANGEMENTS

Although not included in the diagram, it is assumed that secondary C.T. and/or V.T. circuits will be earthed as necessary in compliance with standard safety requirements and determined by the switchgear contractor or user. If in doubt, please consult GEC Measurements for advice.

INFORMATION REQUIRED WITH ORDER

Relay type
Current transformer secondary rating
Frequency
Trip circuit (series seal in or shunt reinforcing)
Trip circuit current (series seal in)

Trip circuit voltage (shunt reinforcing)
Operation indicator inscription if required
Auxiliary contacts (hand or self reset)
Case finish and mode of mounting

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