GEC Measurements

TRANSFORMER PERCENTAGE BIASED DIFFERENTIAL RELAY

Type DDT

The type DDT relay is a medium or high bias-slope differential unit designed for protection of two-winding power transformers over about 1 MVA rating 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 DDT12 and DDT32 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 transformer. 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 transformers, 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. In addition a fairly high bias slope is required to prevent maloperation by C.T. differential currents arising from:

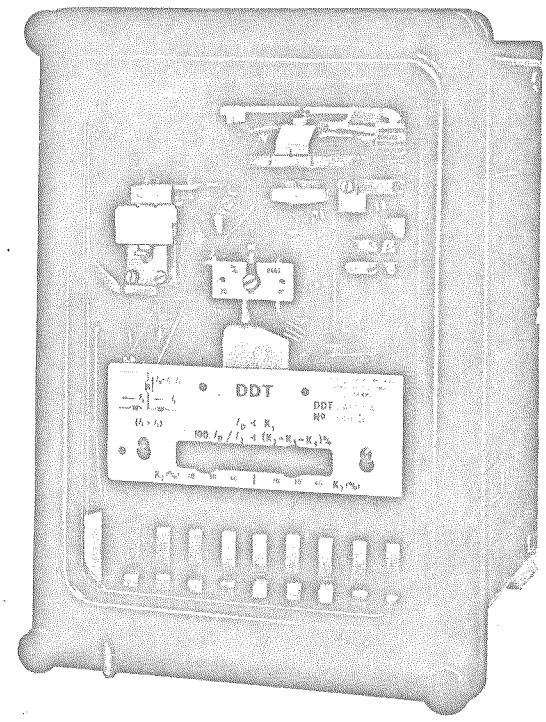
(a) tap changing on transformers giving mismatch of the C.T.'s.

(b) different C.T. ratios and hence saturation levels giving differential currents under through fault conditions.

(c) magnetising inrush giving secondary currents in one set of C.T.'s only.

To prevent maloperation by magnetising inrush the relay function is delayed by a selected time until the initial current peaks have decayed to a tolerable level (determined by the percentage bias).

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.



Type DDT12 relay

CURRENT SETTING

40–100% (adjustable) of 0·5, 1·0 or 5·0 amps (C.T. secondary) 50 or 60 c/s

PERCENTAGE BIAS

20%, 30% or 40% (selected by taps)

The percentaged bias is defined at the minimum current setting (40%) as $\frac{\text{spill current}}{\text{through current}} \times 100$

OPERATING TIME

0·10 second to 0·25 second (adjustable) at 5 times current setting (see characteristic)

BURDENS

Bias coil		
Bias	Burden (C.T.) at rated current	
	50 c/s	60 c/s
20%	0·2 VA	0·3 VA
30%	0·35 VA	0·4 VA
40%	0·4 VA	0·5 VA

Operating coil		
Current setting	Burden (C.T.) at current setting	
	50 c/s	60 c/s
40%	0·6 VA	0·7 VA
100%	3·7 VA	4·5 VA

Operating Coil Impedance

At the rated current, the operating coil impedance does not exceed 0·182 ohms and is 0·08 ohms at saturation.

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 is calculated as follows:

$$V_k = 2I_f\,(R_s + R_b + R_r) \text{ (star connected C.T.'s)}$$

$$\text{or } V_k = (2/\sqrt{3})\,I_f\,[R_s + 3(R_b + R_r)] \text{ (delta connected C.T.'s)}$$

where I_f = Maximum fault 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.

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.

CASES

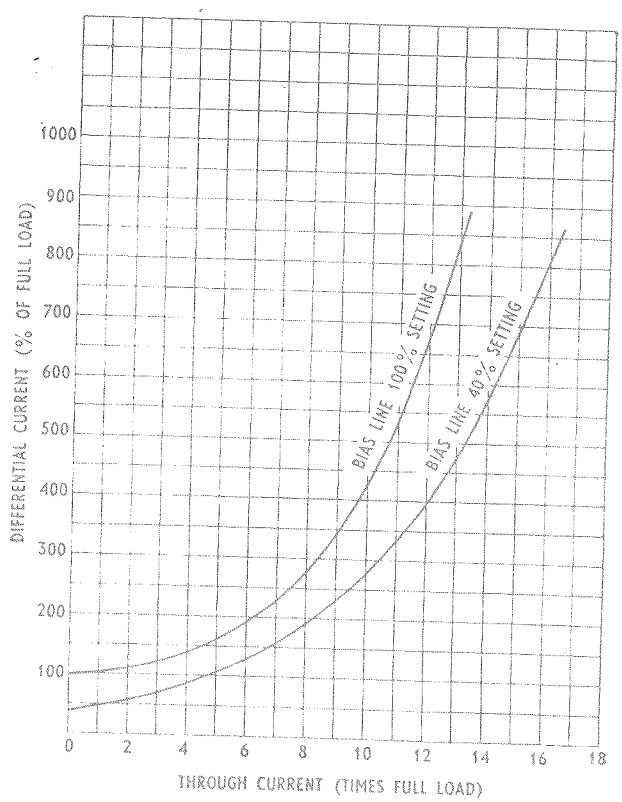
The relays are supplied in drawout cases available for either flush or projecting mounting and finished in phenolic black.
Standard relays are finished to BS.2011:20/40/4 and are suitable for normal tropical use; relays for use in exceptionally severe environments can be finished to BS.2011:20/50/56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

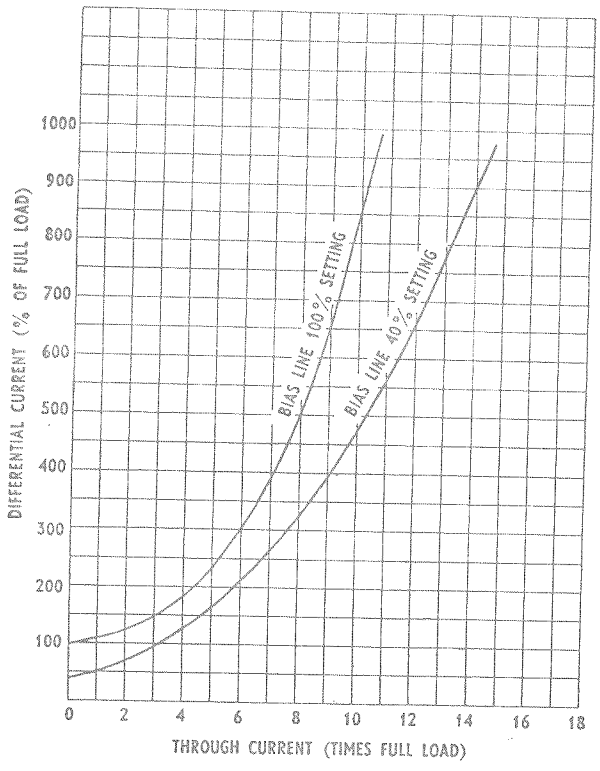
Relay	Case	Maximum Overall Dimensions					
		Height		Width		Depth*	
		ins	mm	ins	mm	ins	mm
DDT 12 (Single Pole)	1D	9 3/16	233	6 11/16	170	7 3/4	197
DDT 32 (Triple Pole)	3D (Vert.)	20 5/8	524	6 11/16	170	7 3/4	197
	3D (Horiz.)	9 1/4	235	17 7/8	454	7 3/4	197

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

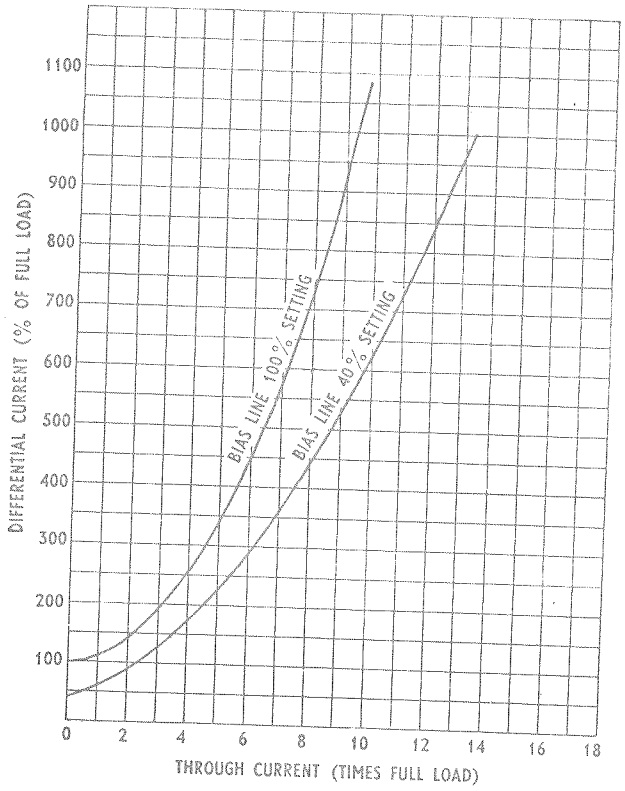
Dimensioned drawings of case outlines, panel cut-outs and mounting details are available on request.



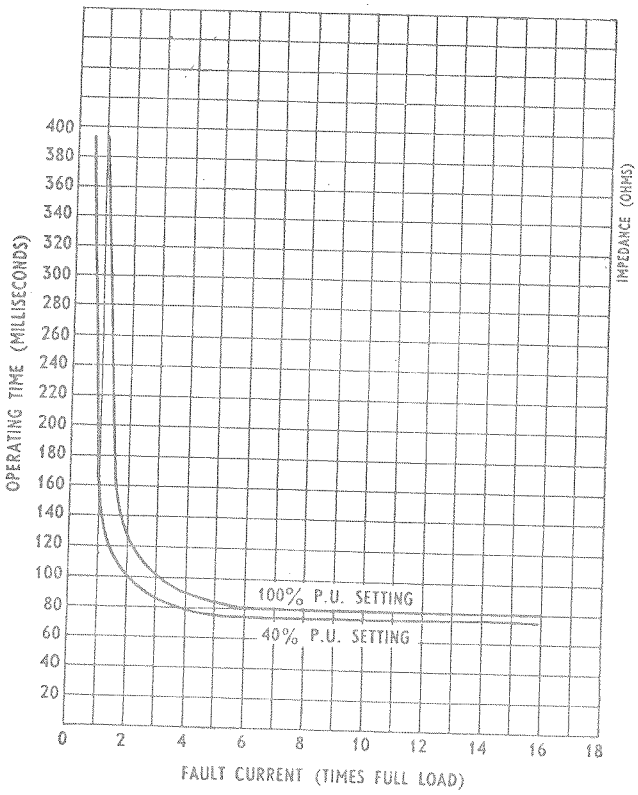
Operating characteristics (20% bias tap)



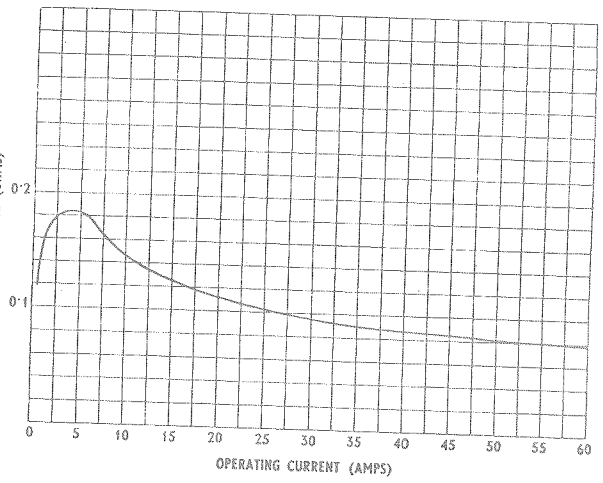
Operating characteristics (30% bias tap)



Operating characteristics (40% bias tap)



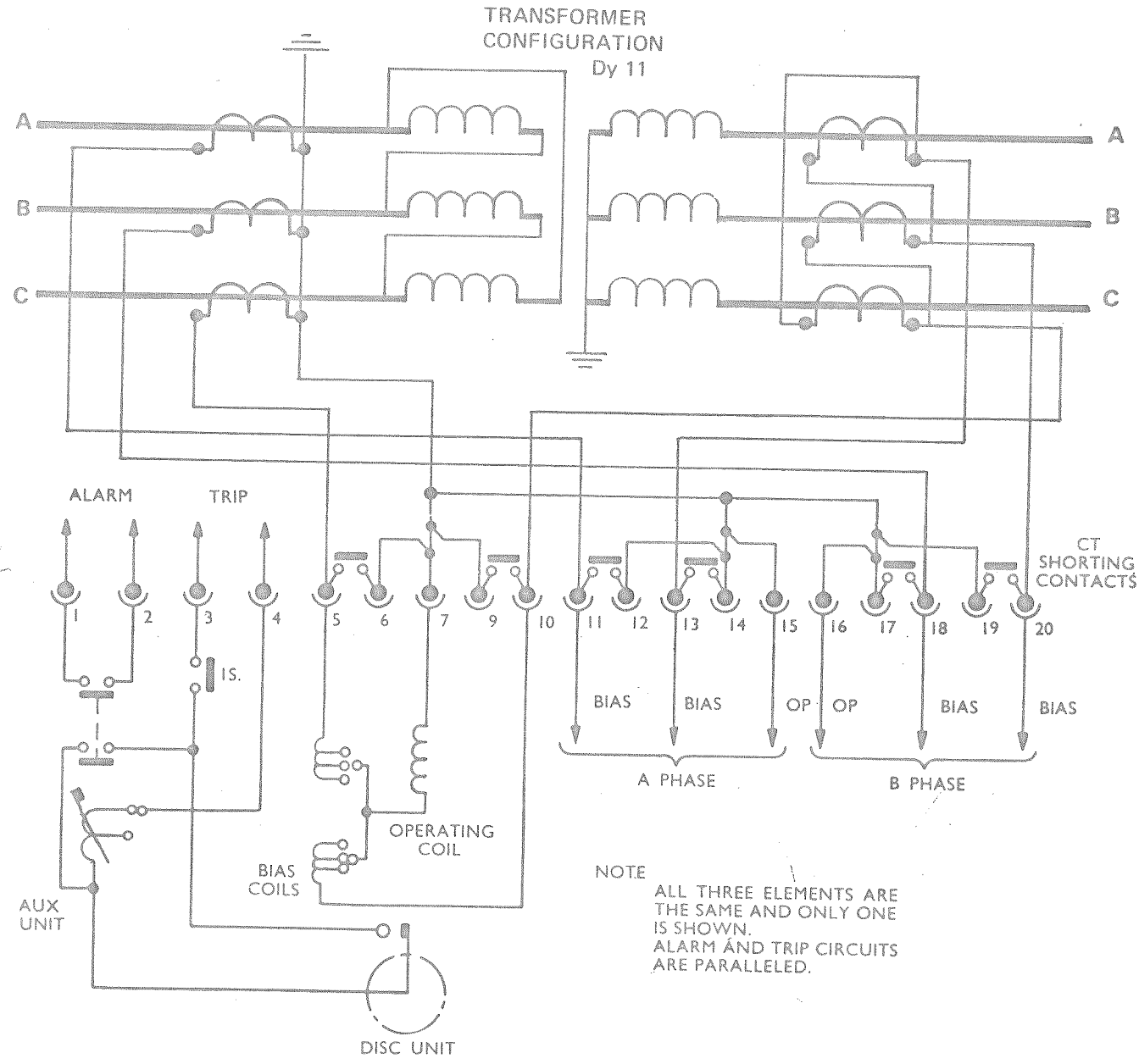
Time current characteristics at 30% bias, time multiplier setting 1·0



Differential circuit impedance characteristic

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



Typical application and internal circuit diagram of type DDT32 relay with series seal in

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

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