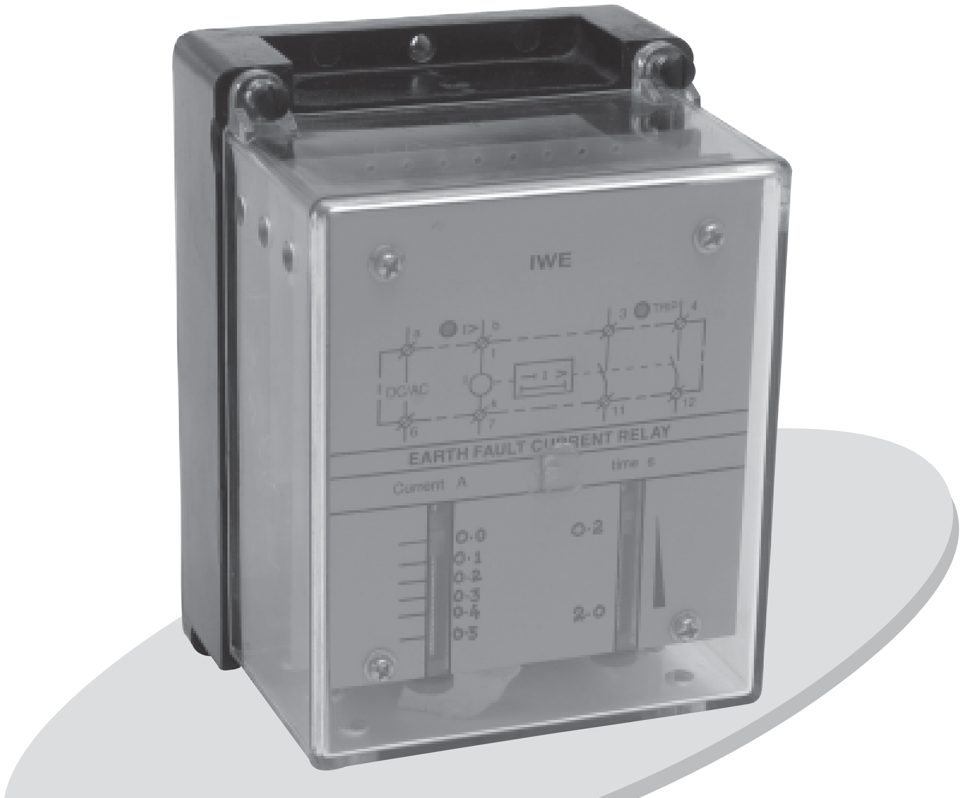
Functional Range

IWE - Earth Fault Relay



C&S Protection & Control Ltd.

Contents

1. Application

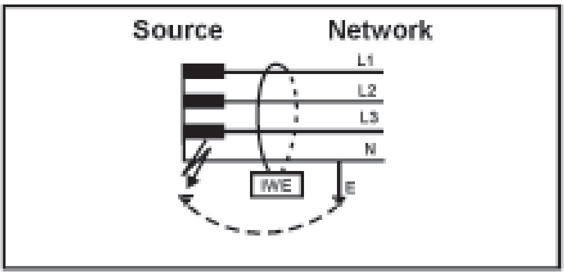
The *IWE* relay is a definite time relay suitable for earth fault protection of generators, motors, transformers, capacitor banks, shunt reactors and radial feeders in distribution networks.

Examples of the application of non-directional earth fault protection using the relay type IWE are shown below.

Example 1: Generator Stator Earth Fault Protection.

With the generator neutral point earthed as shown in Fig.1, the earth fault relay type **IWE** responds only to phase-earth faults between the generator and the location of the current transformers supplying the relay. Earth faults beyond the current transformer, i.e. on the consumer or line side, will not be detected.

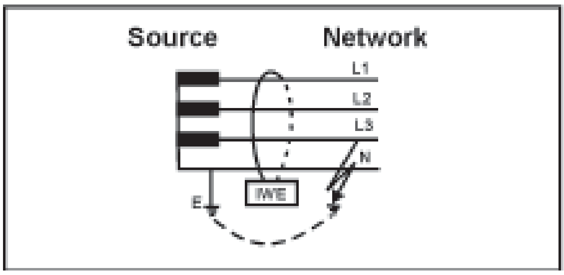
Fig. 1



Example 2 : System Earth Fault Protection.

With the generator neutral point earthed as shown in Fig.2, the earth fault relay type *IWE* responds only to earth faults in the power system connected to the generator. It does not respond to earth faults on the generator terminals or in the generator stator.

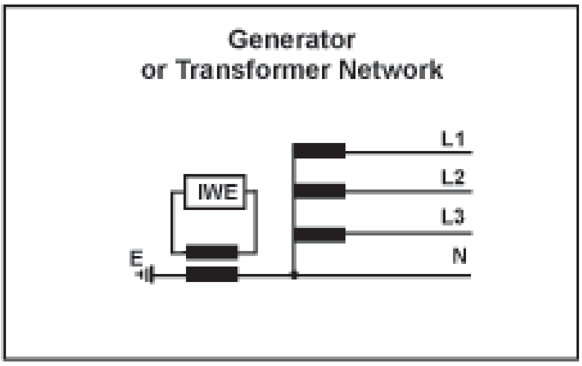
Fig. 2



Example 3 : Back-up Earth Fault Proteciton

With the earth fault relay type *IWE* connected as shown in fig.3 it responds to any earth fault on the generator (or transformer) or on the network. In order to discriminate with other system earth fault protection the relay type IWE must have a tripping delay time which is longer than all other system earth fault protection devices.

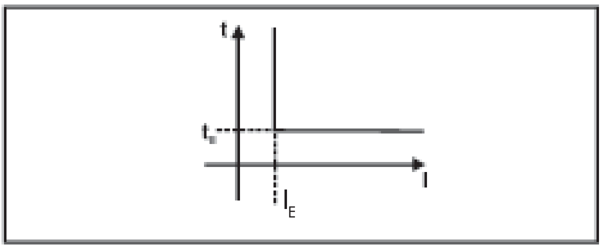
Fig. 3



2. Operating Principle

The earth fault relay type **IWE** is a definite time over current relay with an additional low-pass filter.

Fig. 4 Relay characteristic



It comprises a current input circuit, an electronic current measuring circuit and a time delay unit. It also includes a low pass filter which blocks higher harmonic currents such as third, fifth, seventh etc. Third and triple harmonics (e.g. 9th, 27th etc.) are of particular importance when applying earth fault protection since these harmonics are additive and co-phasal in a three phase system and thus appear in the system neutral or in an earth fault relay as zero sequence (or earth fault) current. Such a current would be detected by an earth fault relay and may cause unwanted tripping. The relay measuring system responds and initiates a timing circuit, if the effective current exceeds the relay current setting. If the earth fault current remains above the setting for the set time delay the output tripping contacts operates.

The tripping time delay is independent of the current level. When applied in a power system the relay time delay must be selected so that it coordinates with other earth fault relays.

Fig.5a and 5b illustrate the operating characteristic of the relay. Consider a relay with a current setting I_E=1.5 A and a time delay setting t_E=0.8s:

Fig.5a:

At t=0.4s, the current exceeds the relay current setting and initiates the time delay circuit. The indicating LED “I” on the relay fascia is illuminated.

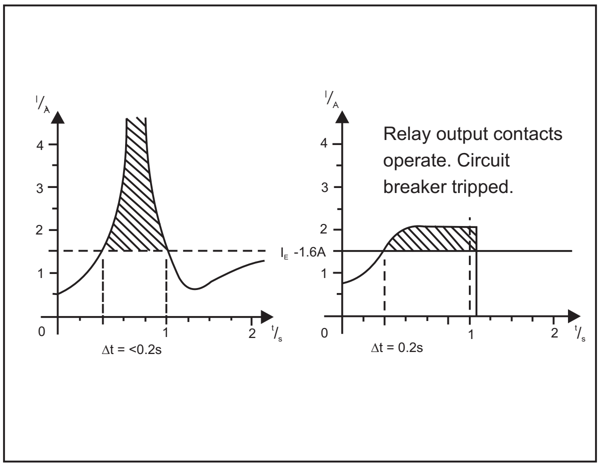
At t=1s the earth fault current drops below the current setting. The LED “I” extinguishes and the time delay circuit reset to zero. There is no trip output.

Fig. 5b:

At t=0.4s the current exceeds the relay current setting and initiates the relay time delay circuit as in the example described above and illustrated in fig.5a.

At t=1.2s, e.g. 0.8s, after the current exceeded the relay setting the time delay has elapsed and the “TRIP” LED is illuminated. The relay produces a trip output and the relay current is interrupted.

Fig. 5a and 5b



3. Current Transformer Connections

Current transformer must be arranged so that the relay type ***IWE*** measures zero sequences (or earth fault) currents as indicated schematically in figs. 1 and 2.

This can be achieved by using several current transformers connected suitable or by using a single ring type current transformer.

Earth fault measurement using several current transformers

The arrangement shown in figs. 6 and 7 should be used only where significant levels of earth fault current are available (e.g. in solidly earthed or low impedance earthed networks) since the errors associated with each current transformer are additive and these are recognized by the relay as zero sequence current. Such an arrangement can therefore only be used where the relay current setting is in excess of the sum of the CT errors.

Guide for dimensioning of CT’s arrangement as shown in figs. 6 and 7

- CT’s must be matched and have the same current ration, accuracy class, rated output, secondary winding resistance and magnetising characteristic.
- The current ratio and primary current withstand should be selected according to the maximum rated current of the circuit.
- The combination of rated output, overcurrent factor and secondary winding resistance should be chosen such that a CT does not saturate at the maximum short circuit current. If this combination is not correct the CT may saturate under external phase fault conditions (i.e. for a 2 or 3 phase fault which the relay should remains unoperated). In this case the several line CT’s may saturate unequally. Therefore the sum of the secondary currents in no longer zero and the relay maloperates.

Fig. 6 and 7

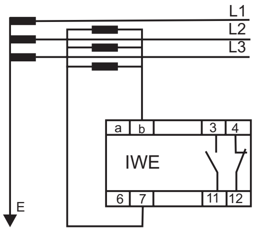


Fig. 6
Holmgreen connection, three phase three wire system

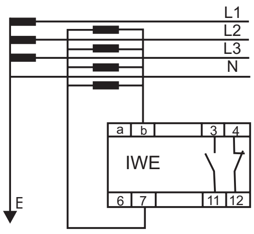


Fig. 7
Three Phase, four wire system

Relationship between CT actual overcurrent factor, rated overcurrent factor rated output, connected burden and secondary winding resistance.

If the burden connected to the secondary winding of a current transformer does not match exactly the rated burden, the actual overcurrent factor of the CT will no longer be equal to the rated overcurrent factor.

For example, if the total connected burden is less than the rated output of the CT, the actual overcurrent factor will be greater than the rated overcurrent factor. Conversely, if the total connected burden is greater than the rated output the CT, the actual overcurrent factor will be less than the rated overcurrent factor.

Actual overcurrent factors can be calculated as follows:

$$n' = n \frac{P_N - P_E}{P_B - P_E}$$

where

n' = actual overcurrent factor

n = rated overcurrent factor

P_N = Nominal rated output of CT (VA)

P_E = Burden of secondary winding resistance of CT rated current

= $I_N^2 \, R_{CT}$ (VA)

P_B = Burden connected to CT secondary circuit (VA)

Earth fault current measuring using ring type CT's

The use of ring type current transformers for supplying earth fault relays as shown in fig. 8 and 9 is preferred wherever possible to the arrangement using separate CT's connected in parallel as indicated in figs. 6 and 7.

Such an arrangement is particularly recommended for earth fault protection on high impedance earthed systems where the level of earth fault current is low.

A ring type CT comprises a single magnetic core which surrounds all conductors and therefore under normal load conditions, or during two or three phase fault conditions, the resultant magnetic flux is zero and the CT produces no secondary current. Only in the presence of zero sequence current is the resultant flux not equal to zero and the CT produces a secondary current. Therefore, unlike the arrangement which summates, the secondary currents from several CT's under normal load and other non earth fault conditions, and which is the therefore sensitive to individual CT errors, a single ring type CT is not subject to the same errors and a very high degree of sensivity can be achieved.

Fig. 8 and 9

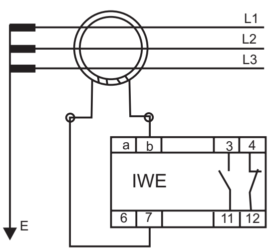


Fig. 8
Measurement of earth fault current in a three phase, three wire system using a Ring type CT

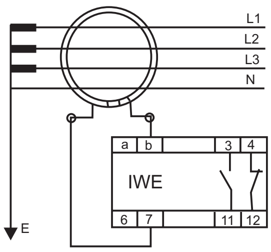


Fig. 9
Measurement of earth fault current in a three phase, four wire system using a Ring type CT

Guide for Dimensioning of Ring Type CT's

- The inside diameter of the CT must be large enough to slide over the cable.

  The primary rated current of the CT should match the maximum earth fault current in the case of high impedance earthed system.

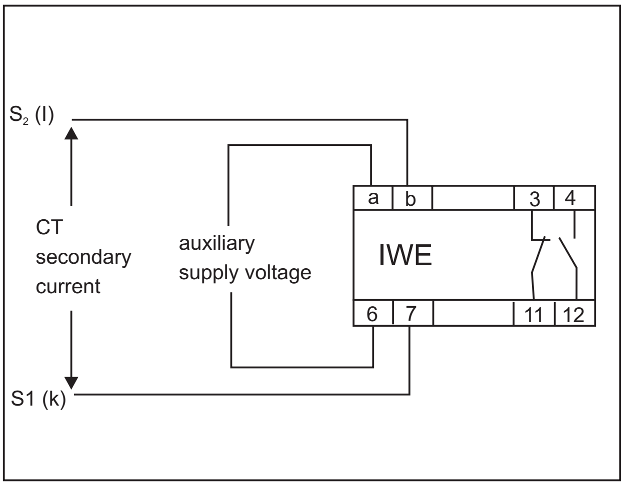
  The rated secondary current is generally 1A or 5A.

  the case of a feeder comprising several cables in parallel, a ring CT can be fitted to each cable. The CT secondary windings should then be connected in parallel and connected to a single earth fault relay type IWE. CT's should have identical magnetising characteristic, ratio, rated output, accuracy class etc.

4. Connections, Contact Arrangement and Setting Adjustments

Fig.10 shows the main connections to the relay type IWE. The auxiliary supply should be connected to terminals "a" and "6" and should be a secure supply with a variation of not greater than 10 per cent.

Fig. 10 Relay connections



If a ring type CT is used, it is important to ensure that the cable and CT are installed precisely as shows in fig. 11 and cable gland must be insulated from the cable terminating box, and the cable sheath and armour must be earthed by taking the earth connection back through the CT as shown. If the earth lead is not connected as shown, the earth return current in the cable sheath or armour sets up a magnetic flux which cancels the flux produced by the earth current in the cable, and therefore the relay would not operate during an earth fault.

Fig. 11 Cable and earthing arrangements when using Ring type CT

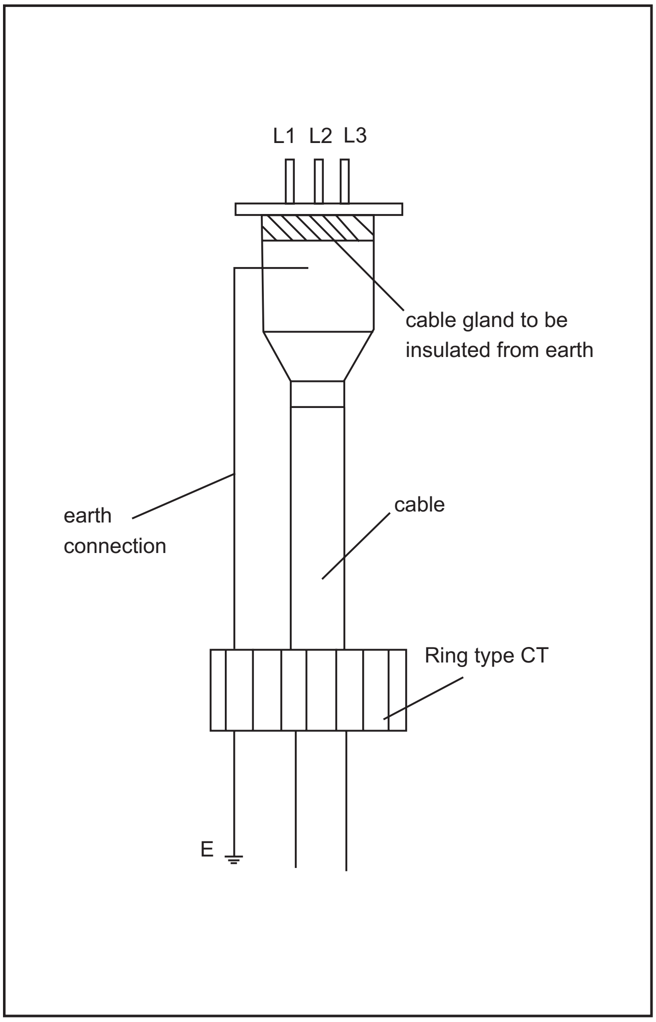


Fig.12 shows the position of the relay contacts. Under normal healthy conditions, or with no auxiliary voltage supplied the contacts are as shown in position 1. With the relay operated after the set time delay has elapsed, the contacts are shown as in position 2.

Fig. 12 Contact positions

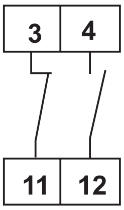
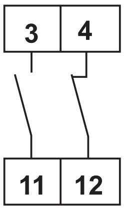
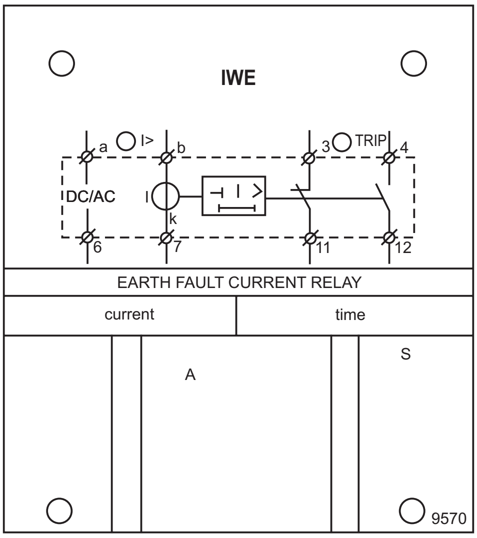
Contact position 1	Contact position 2
	
No auxiliary voltage	
Protected system healthy **Relay non-operated**	**Relay operated** **Tripping**

Fig. 13 Front cover of unit *IWE*



5. Functional Check

A simple functional check can be made with the aid of a secondary injection test set and an ammeter as follows:

Connect rated auxiliary supply voltage to terminal "a" and "6".

Connect the injection test set output current terminals via an ammeter to the relay terminals "7" and "b".

Note that the injected current should be kept less than the rated current of the relay i.e. less than 1A or 5A as appropriate.

Adjust the time delay setting potentiometer to t=0s.

With the current setting potentiometer set to a suitable value increase the current from the test set until the relay LED "I" is illuminated. This indicates that the relay has picked up. Since the set time delay t=0s, the tripping LED "TRIP" will be illuminated simultaneously. Check that the pick up current is within 5 per cent of the current setting on the relay. Switch off the test current.

Adjust the time delay setting potentiometer to the required time delay.

Switch on the test set, increase the test current to a value which is higher than the current setting. The relay will only operate and produce a trip output after the set time delay has elapsed.

6. Technical Data

IWE-Earth Fault Current Relay

General Data

Design	:	electronic state definite time overcurrent relay with low-pass filter
Maintenance	:	none
Permissible operating time	:	continuous
Mounting position	:	independent

Auxiliary Supply Voltages

Supply Voltage	:	24 V, 110 V d.c
Own consumption	:	2.5 W
Permissible voltage variation	:	± 10%

Measuring circuit

Rated current I_N	:	1 A or 5 A
Rated frequency	:	50 Hz or 60 Hz
Burden of current circuit	:	0.5 VA at rated current
Short time current setting	:	$20.I_N$ for max. 1_S
● Current settings	:	1 A relay: 0 - 100 mA/ 0-0.5 A 5A relay: 0 - 2A / 0 -4A
● Time delay settings	:	0.2-2s/0.5-4s
Reset radio	:	99.5 %

Output Circuits

Contacts	:	1 NC, 1 NO potential free
Breaking capacity	:	1000 VA at 250 V AC 2 A at 24 V dc
Contact life	:	greater than 10^6 switching operations
Terminals	:	M4, wire termination max. conductor $2.5mm^2$

Ambient Conditions

Ambient temperature range:

for storage	:	-40 ^{0}C up to +70 ^{0}C
for operation within claimed accuracy	:	-20^{0}C up to +60^{0}C

Accuracy

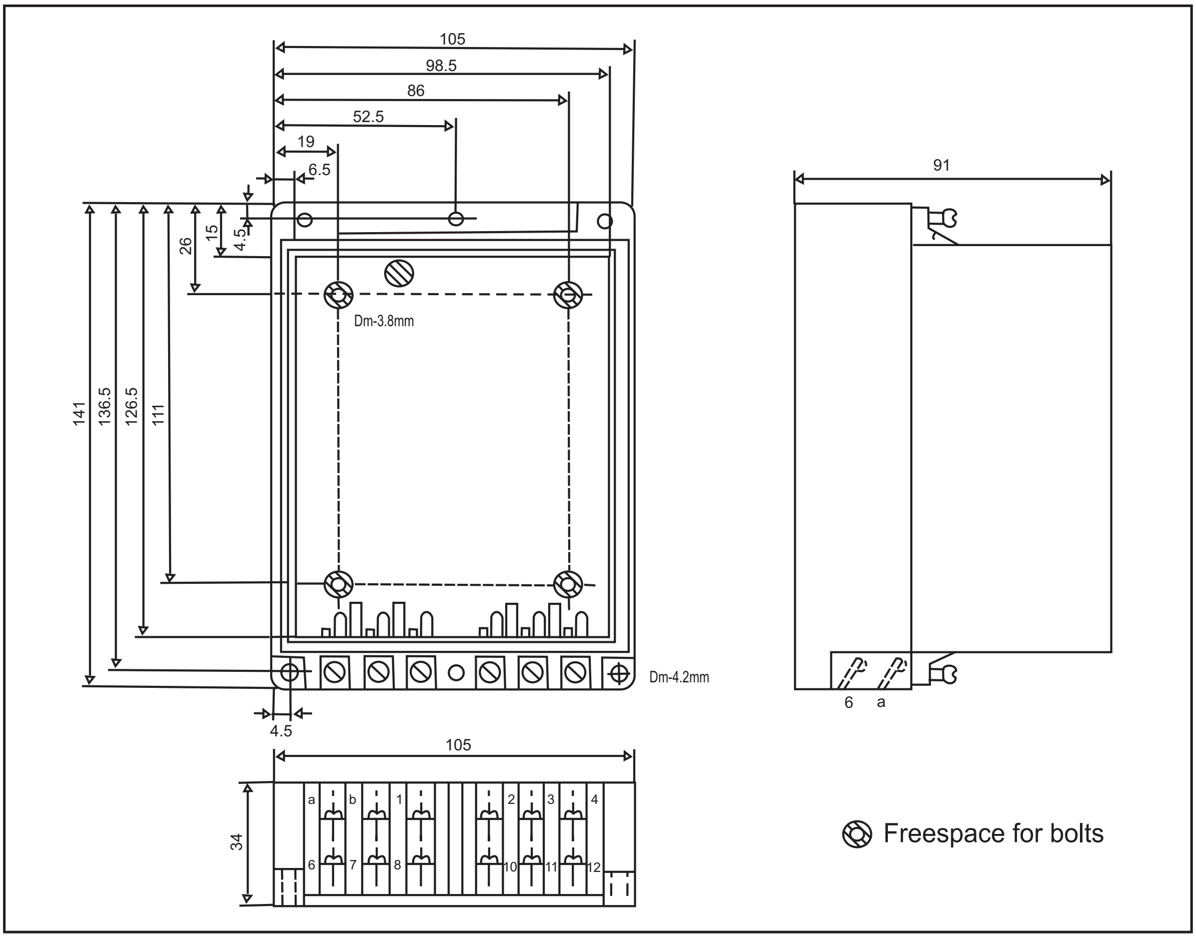
Effect of temperature	:	± 1% of the setting over the range $0^0C \leq V \leq 60^0C$

Case, Dimensions, Weight and Installation

Case	:	CSPC standard case
Material	:	track resistant moulded base and transparent cover
Height *width*depth	:	142 mm*105 mm * 90 mm
Weight	:	0.4 kg (approx.)
Mounting	:	Flush mounting
Protection class case	:	IP20
terminals	:	IP00

Dimensions and drill-holes

(dimensions in mm)



7. Information required with order

When placing an order, please fill in the form on the right.

Earth fault relay	IWE					
Rated Current 1A Rated Current 5A		1 5				
Current ranges 1A (0 - 0.1 A) (0 - 0.5 A) 5A (0 - 2 A) (0 - 4 A)			0.1 0.5 2.0 4.0			
Time Ranges 0.2 - 2 sec. 0.5 - 4 sec.					2 4	
Auxiliary Voltage 24 V DC 110 V DC						24 110

BASIC RANGE

- Micro-controller based compact economical design
- DIN rail mounted
- Status indication via LED
- Step-less settings through front potentiometer

HIGHTECH RANGE

- Microprocessor based numerical protection
- Event & fault recording
- RS 485 communication
- Bright alpha-numeric display

INTEGERATED RANGE

- Complete numeric protection, solution for sub-station in association with TEAM-ARTECHE, Spain
- Distance protection
- Comprehensive transformer protection –
  a. Three winding transformer
  b. Two winding transformer
- Multi-functional relay: variety of protection combination

For further information, please contact :

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