High-Tech Range

IRI1- WD - Overcurrent, Short-circuit and
Earth Fault Relay

C&S electric

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(Protection & Control Division)

Contents

1. Introduction

The application of powerful microcontroller opens a new chapter for power protection systems. Because of their capabilities to process the measuring values digitally and to perform arithmetical and logical operations, the digital protective relays are superior to the traditional analogue devices. In addition, the digital protective relays offer some additional advantages such as very low power consumption, adaptability, possibilities for self supervision, flexible construction, selection of relay characteristics etc.

The development of microcontroller-based protective relays and their introduction into the market are stimulated by the trend nowadays to replace analogue with digital protective equipment.

The superiority of digital protective relays to the traditional systems is enhanced by the MR relay family which has the following characteristics:

- Integration of multiple protective functions into one compact housing
- High measuring accuracy due to digital processing of measuring values
- Digital relay setting with very wide setting ranges and the fine setting steps
- Operation reliability due to continuous self-supervision

The digital time relay IRI-WD was designed as a universal over-current relay for application to medium voltage networks.

2. Application

The digital over-current time relay IRI-WD is a universal protection device for low and medium voltage networks. It is used in radial networks and combines the following functions in one unit:

- Independent (Definite) time over-current relay
- Inverse definite minimum time over-current relay with following selectable characteristics:
- Normal inverse
- Very Inverse
- Extremely inverse
- Integrated independent and dependent over current time protection for the earth fault

Furthermore, the device, providing the above functions, can be employed as back-up protection for differential and distance protection relays

3. Characteristics and Features

- Digital processing of the sampled measuring values
- Digital filtering of the measured values by using discrete Fourier analysis to suppress the high frequency harmonics and transient dc components during short circuit.
- Selectable protective functions between: definite time over-current relay and inverse time over-current relay.
- Selectable inverse time characteristics according to BS 142 and IEC 255-4:
  Normal inverse
  Very inverse
  Extremely inverse
- Field selectable 1A/5A CT
- Independent stage for the fast tripping of short-circuit (protection)
- Two stage over-current time protection for phase current
- Two stage over-current time protection earth fault current
- Extremely wide setting ranges and fine steps for current and time settings
- Continuous self-supervision of software and hardware
- Wide operating ranges of the supply voltage (AC/DC)

4. Design

4.1 Analog Input

The analog input signal of the conductor currents as per the terminal detail section 7.3, are fed to the protective device via separate input transformers.
The continuously measured current values are galvanically isolated, analog filtered and finally fed to the analog/digital converter.

4.2 Front Panel

The front panel of the protective device IRI-WD comprises the following operation and indication elements:

- 1 LCD- Liquid crystal display (8 x 2)
- 4 keypads- for the setting of the tripping values and time.
- 3 LEDs for the fault indication.
- 1 RESET button

4.2.1 LCD

The over-current, short-circuit and earth fault relay IRI-WD is equipped with a back-lit LCD display having two lines of eight alpha-numeric characters to display current, faults, setting parameters names and values etc.

4.2.2 Keypads

The front panel keypad consists of five soft-touch keys. These keys are marked as “RESET”, “+”, “-” “➤” and “➤”. The “RESET” key provides reset functions to the relay. The keys marked “➤” and “➤” are meant for backward and forward scrolling respectively. The keys marked “+” and “-” are used for decrementing and incrementing selected parameter value.

4.2.3 LEDs

On the front panel there are 3 LEDs. Their functions are indicated by the appropriate inscriptions along with them. At the time of pickup the Alarm LED starts blinking.

On fault trip LED gives the indication. Similarly when there is a pickup in any of the phase, one can't change the setting of the relay. At that time all functions will be blocked & this is indicated by BLOCK LED.

5. Working Principle

5.1 Analog circuits

The incoming currents from the main current transformers on the protected objects are converted to voltage signals in proportion to the currents via the input transducers and shunt resistors. The noise signals caused by inductive and capacitive coupling are suppressed by an analog R-C filter circuit. The analog voltage signals are fed to the A/D-converter of the microprocessor and transformed to digital signals through Sample and Hold circuits. All the processing is carried out on these digitized values. The measuring values are detected with a sampling frequency of 1600 Hz, a sampling rate of 625 μs for each measurement (at 50 Hz).

5.2 Digital circuits

The protective device is equipped with an efficient microprocessor which is the main processing unit. It digitally carries out all of the operations, from the digitization of the measuring values to the protective tripping.
The relay program is located in an EPROM (Read-Only-Memory). With this program the microprocessor processes the voltages at the analog inputs and calculates the fundamental components of the current. For the calculation of the current value an efficient digital filter based on the Fourier Transformation (DEFT-Discrete Fast Fourier Transformation) is applied to suppress high frequency harmonics and d.c. components during a short circuit.
The measured current values are continuously compared with the set values and when activated, the over-current tripping time is determined according to the selected characteristic curve. When the calculated time delay has elapsed, a tripping command is given.

5.3 Power Supply

It has a universal auxiliary supply. The voltage range is (16 to 270) VAC & (16 to 360) VDC

5.4 Demands imposed on the main current transformers

The current transformers have to be rated in such a way, that a saturation should not occur within the following operating current ranges:
Independent time over-current function K1 = 2
Inverse time over-current function K1 = 20
High-set function K1 = 1.2 - 1.5
K1 = Current factor related to set value with the current transformer not yet operating in the saturation range.

Moreover, the current transformers have to be rated according to the maximum expected short circuit currents of the network or the object to be protected.

The lower consumption of the IRI--WD i.e. 0.2 VA, has a positive effect on the rating of the current transformers. It implies that, if an electromechanical relay is replaced by IRI-WD, a high accuracy limit factor is automatically obtained by using the same current transformer.

6. Operation and Settings

6.1 Layout of operating elements

All keys and "RESET" button required for the setting of parameters are located on the front panel.

6.2 Calculation of the Setting values

1A / 5A choice is site selectable. Separate terminals are provided for 1A and 5A CTs. User must make correct choice from front panel.

6.2.1 Phase-over-current stage (I >)

The main criterion for the setting of the over-current response value is the normal maximum operating current which is therefore adjusted to about 20% for power line, about 50 % for transformers and motors, above the maximum expected load currents. The delay of the trip signal is selected according to the selectivity and time grading, and the system overload capacity of the protected object.

6.2.2 Dependent over-current time protection

Apart from the selection of the tripping characteristics, the response value for the phase-current is also adjustable.

6.2.3 Phase-over-current stage (I >)

The starting current is determined according to the maximum expected load current. For example:

Current transformer ratio: 400/5 A
Maximum expected load current: 300 A
Overload coefficient: 1.2 (assumed)
Starting current setting: I_S = (300 / 400) x 1.2 = 0.9 x I_N

6.2.4 Time multiplier setting

The time multiplier setting for inverse time over-current is a scale factor for the selected characteristics. The characteristics for two adjacent relays should have a time interval of about 0.3 - 0.4 s.

6.2.5 Fast tripping short circuit protection (I >>)

The high-set current setting is set as a multiplier of the nominal current. The time delay is always independent to the fault current.
Short Circuit Protection: The Current setting range is from 0.5 x In to 25 x In. It is possible to have selectable time delayed/Instantaneous protection.
High set E/F protection: The Earth fault current setting range is from 0.5 to 15 x In.

6.2.6 Fault Recording

IRI records last three faults. It saves following information

Type of fault : SC / OL
Faulty phase / Earth : R / Y / B / E
Value at Fault : Ir, Iy, I_b, Ie in Amps
Fault1 is the latest fault & Fault 3 is the oldest fault.
(True RMS record available when trip time ≥ 40msec.)

6.2.7. Reset Delay

This parameter (RST-D) introduces a delay in opening of relay contacts, when the current goes below the drop up value for overload and short circuit.

7. Housing

The IRI-WD can be supplied in an individual housing for flush-mounting for installation in a 19" mounting rack according to DIN 41494. Both versions have plug-in connections.

7.1 Flush mounting

The individual housing of the IRI-WD is constructed for flush-mounting. The dimensions of the mounting frame correspond to the requirements of DIN 43700 (76 x 142 mm). The cut-out for panel mounting is 68.7 x 136.5 mm.

The front panel of the IRI-WD is covered with a transparent, sealable flap (IP54).

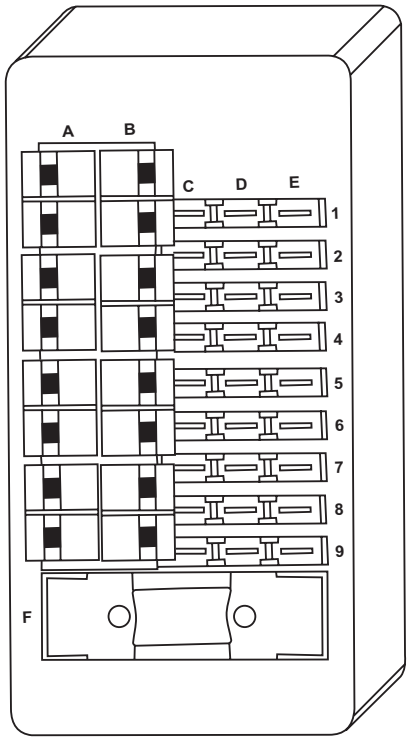
For case dimensions and cut-out refer to "technical data". The individual housing is fixed with the supplied clasps from the rear of the panel.

7.2 Rack mounting

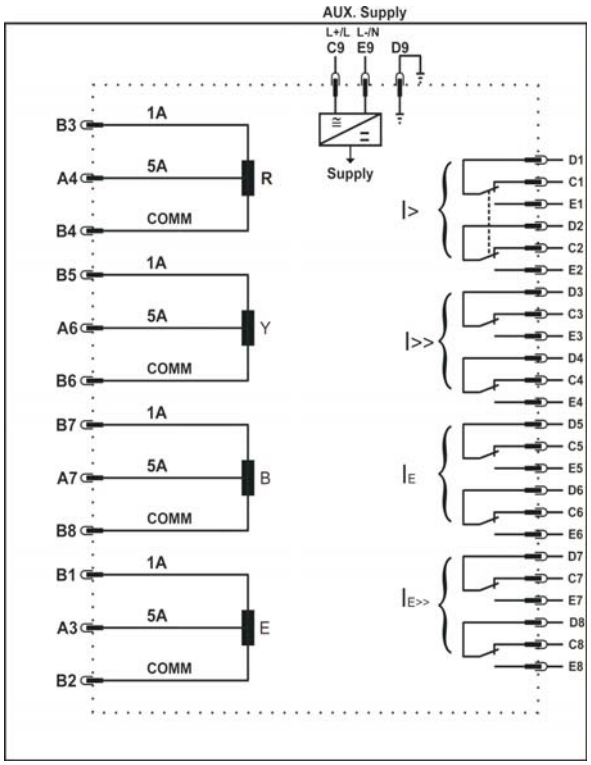
The IRI-WD is in general suitable for installation in a modular carrier according to DIN 41494. The installation dimensions are: 12 TE; 3 HE. According to requirements, The IRI-WD devices can be delivered mounted in 19" racks.

7.3 Terminals

The following figure shows the terminals back of IRI-WD.



7.4 Circuit Diagram



8. Test and maintenance

The measuring input circuits are of completely static design and the relay functions are entirely digital so that the IRI-WD has no requirement for maintenance.

9. Technical Data

9.1 Measuring input

Rated data	:	Rated current I_N	1A or 5A
		Rated frequency F_N	50Hz
Power consumption in	:	At I_N = 1A	0.2 VA
Current circuit		At I_N = 5A	0.1 VA
Thermal withstand capability	:	dynamic current withstand	250 x I_N
in current circuit		(half-wave)	
		for 1 s	100 x I_N
		for 10 s	30 x I_N
		continuously	4 x I_N

9.2 Auxiliary voltage

Rated auxiliary voltage U_H	:	Universal	16 VAC to 270 VAC 16 VDC to 360 VDC
Power consumption	:	Quiescent approx. 3W	Operating approx. 6W

9.3 General data

Dropout ratio	:	> 97 %
Returning time	:	30 ms
Time lag error class index E	:	± 10 ms
Minimum operating time	:	30 ms
Transient overreach at instantaneous operation	:	5 %

9.4 Setting ranges and steps

9.4.1 Independent time phase over-current, earth fault and short circuit protection

Parameter	Display	Setting Range	Step	Tolerances
I>	I_S t>	0.20 - 2.5xI_N 0.1 - 150$_s$	0.05 x I_N 0.01$_S$	± 5% from set value ± 3% ± 10 ms
I>>	I_S t>>	0.5-25 x I_N 0.02-20$_S$	0.5 x I_N 0.01$_S$	± 5% from set value ± 3% ± 10 ms
I_E>	I_S t_E>	0.05-2.5 x I_N 0.03-150$_S$	0.5 x I_N 0.01$_S$	± 5% from set value ± 3% ± 10 ms
I_E>>	I_E>> tI_E>>	0.05-15 x I_N 0.02-20$_S$	0.5 x I_N 0.01$_S$	± 5% from set value ± 3% ± 10 ms
Reset Deley	RST-D	0-20 Sec	0.1 Sec	± 3% or ± 10 ms (Which ever is higher)

9.4.2 Dependent time phase over-current and earth fault protection

Parameter	Display	Setting Range	Step
I>	I_S ti>	0.20 - 2.5xI_N 0.1 - 1.500	0.05 x I_N 0.005
I_E>	I_S ti_E	0.05-2.5 x I_N 0.01-1.500	0.05 x I_N 0.005
Reset Deley	RST-D	0-20 Sec	0.1 Sec

Tripping characteristics according to IEC 255-4 or BS 142

Normal Inverse 3.0 $$t = \frac{0.14}{(I / I_S)^{0.02} - 1} ti \quad [s]$$

Normal Inverse 1.3 $$t = \frac{0.061}{(I / I_S)^{0.02} - 1} ti \quad [s]$$

Very Inverse $$t = \frac{13.5}{(I / I_S)^{2} - 1} ti \quad [s]$$

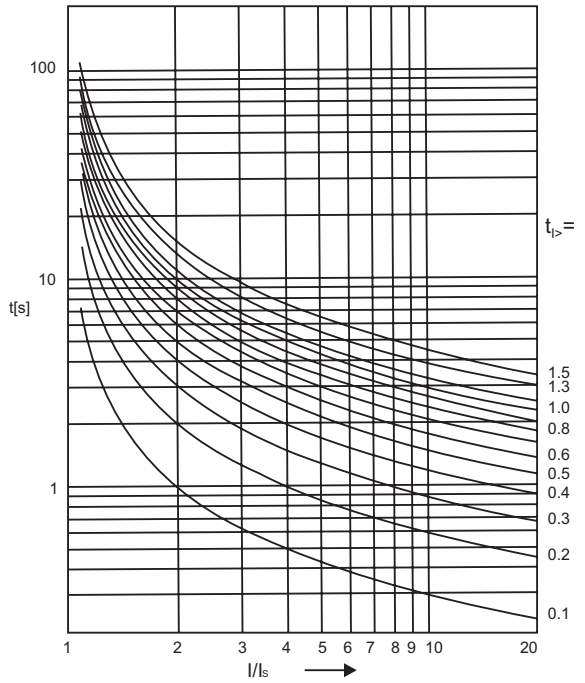
Extremely Inverse $$t = \frac{80}{(I / I_S)^{2} - 1} ti \quad [s]$$

Where t = Tripping time ti = Time multiplier

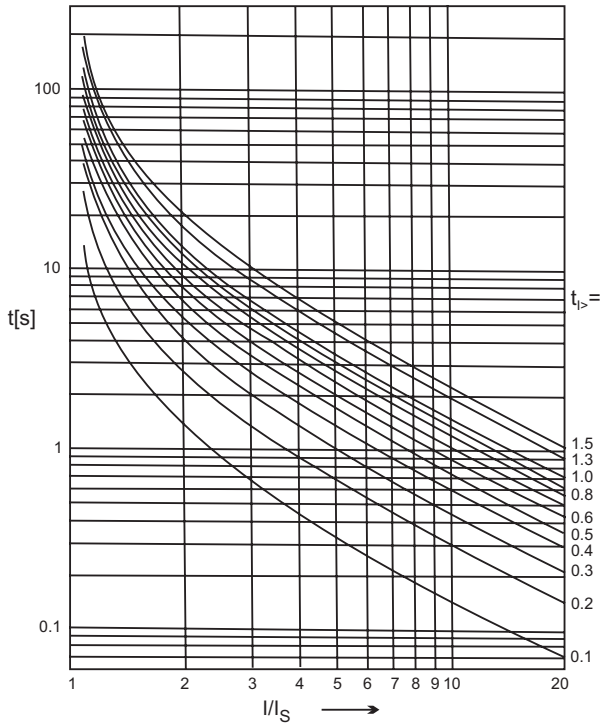
I = Fault current I_S = Setting value of current

Tripping Time Tolerance: Accuracy as per IEC-255-3 $I/I_s \geq 2$ to $I/I_s \leq 20$
For VINV / NINV :($\pm$ 5% or $\pm$ 20msec which ever is higher)
For EINV ($\pm$ 7.5% or $\pm$ 20msec which ever is higher)

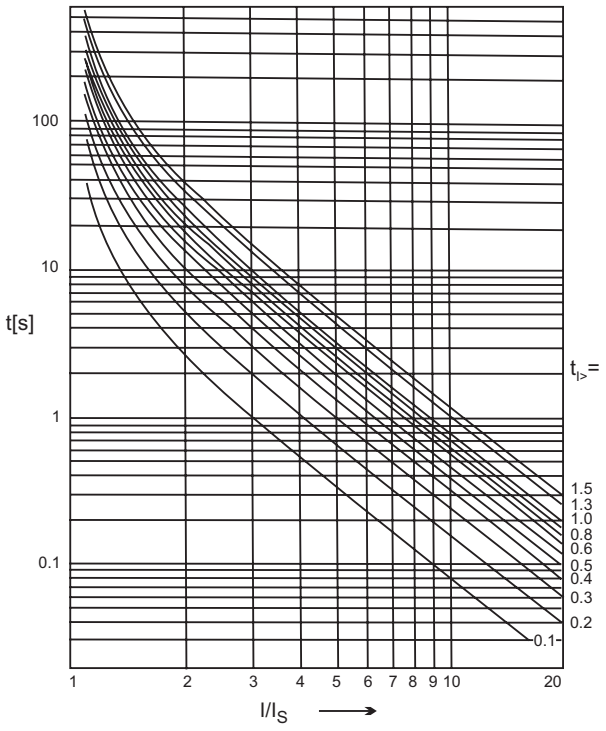
9.5 Tripping characteristics



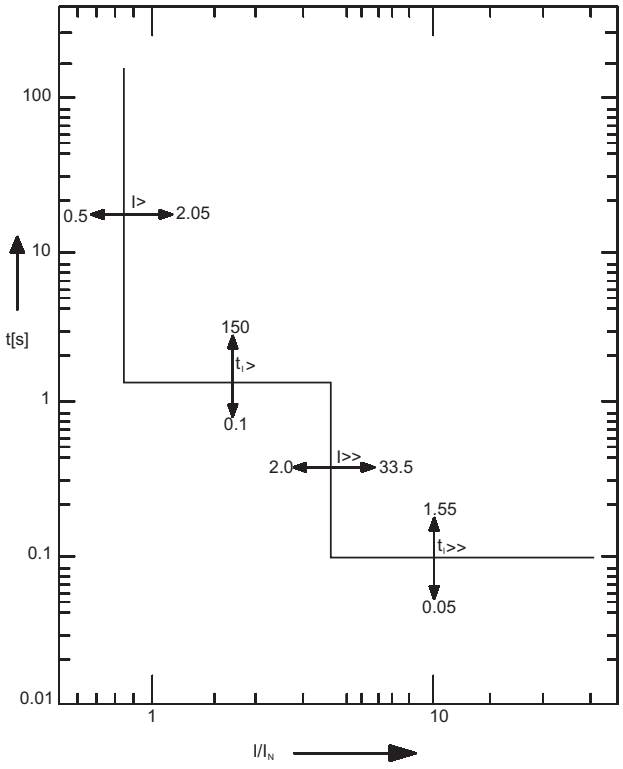
Normal inverse



Very inverse



Extremely inverse



Definite time overcurrent relay

9.6 Setting Procedure

Menu Frames

Menu 1 Default Page (Running Parameters)	Ir Iy Ib Ie XX XX A (RMS) <PICKUP> OL Status / SC Status
Menu 2 (Pressing Reset Key)	#STATUS# <FAULT1> <FAULT2> <FAULT3> <EDIT> <In> CHG PSWD ←BACK
Menu 3 (Pressing Reset Key on EDIT selection)	#EDIT# <CHAR> <O/L> <S/C> <Earth> <E-High> RST-D
Menu 4: (Pressing Reset Key on CHAR selection)	#CHAR# DEFT EINV VINV NINV1.3 NINV3.0 ←BACK
Menu 5: (Pressing Reset Key on O/L selection)	# O/L # I : X.XX In ti : X.XXX s t : XXX . X s ←BACK
Menu 6 (Pressing Reset Key on S/C selection)	# S/C # I : X.XX In t : XXX . X s ←BACK
Menu 7 (Pressing Reset Key on Earth selection)	# EARTH # I : X . XX In ti : X.XXX s t : XXX.X s ←BACK

Menu 8 Pressing Reset Key on In selection)	# In # 1A 5A ←BACK
Menu 9 Pressing Reset Key on E-High selection)	# E-HIGH # I : X.XX In t : XXX . X s ←BACK
Menu 10 Pressing Reset Key on FAULT 1, 2, 3 selection)	< TRIP> OL : R Y B E SC : R Y B E [F] Ir XX.XXA (Fault Current) [F] Iy XX.XXA (Fault Current) [F] Ib XX.XXA (Fault Current) [F] Ie XX.XXA (Fault Current) ←BACK
Menu 11 Pressing Reset Key on LOAD DEFAULT)	?PSWD? Loading...
Menu 12 Pressing Reset Key on CHG PSWD selection)	?PSWD? New PSWD Re PSWD SUCCESS PSWD CHG
Menu 13	Save ? YES NO
Menu 14	?PSWD? SAVING ...
Menu 15	PSWD ! INVALID

ti : Time multiplier setting only for Inverse time characteristic

t : Timer setting only for definite time characteristic

Basic Key Functions

KEY	FUNCTION
RESET	Reset annunciation / Enter Key confirm selection of item in the menu & save value
◁	Up scroll for the menu
+	Increment selected parameter
-	Decrement selected parameter
▷	Down scroll for the menu

NOTE: All keys can be used in selecting / specifying password Pressing Reset key for 1 sec, cursor will go back to the default page

9.7 Output Relays

Number of relays	:	4
Contacts	:	2 change-over contacts each for trip relay I > and I >> , I_E > and I_E >>
Max. breaking capacity	:	1250 VA / 150 W resistive 500 VA / 90 W inductive
Max. breaking voltage	:	400 V AC, 125 V DC
Max. continuous current	:	5 A
Max. making current (16 ms)	:	20 A

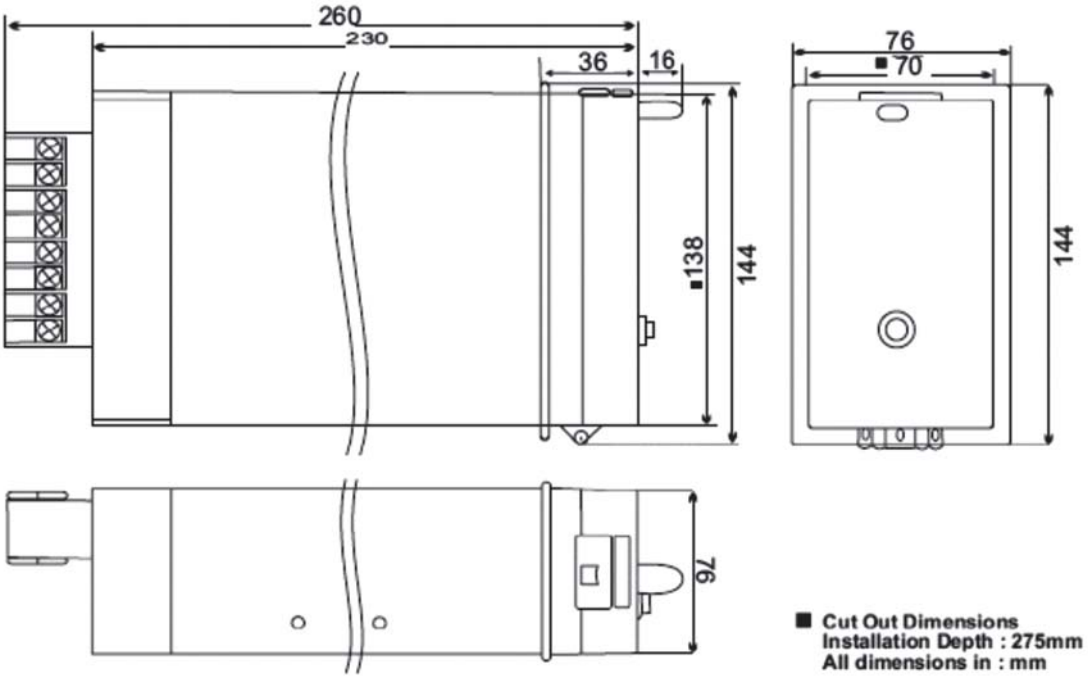
9.8 System data

Design standard	:	VDE 04335, part 303, IEC 255-4, BS 142
Specified ambient service Temp. range		
▪ For storage		- 40 °C to + 85 ° C
▪ For operation		- 20 °C to + 70 °C
Environmental protection class F as per DIN 40040 and per DIN IEC 68, part 2.3	:	Relative humidity 95 % at 40 °C for 56 days
Isolation test voltage, inputs and outputs between themselves and to the relay frame as per VDE 0435, part 303	:	2.5 kV (eff.) / 50 Hz, I min.
Impulse test voltage, inputs and outputs between themselves and to the relay frame as per VDE IEC 0435, part 303	:	2.5 kV (eff.) / 50 Hz, I min.
High frequency interference test voltage, inputs and outputs between themselves and to the relay frame as per DIN IEC 255, part 22-1	:	2.5 kV / 1 MHz
Electrical fast transient (Burst) test as per DIN VDE 0843, part 4	:	4 kV / 2.5 kHz, 15 ms
Radio interference suppression test as per DIN VDE 57 871	:	Limit value class B
Electrostatic discharge (ESD) test as per DIN VDE 0843 part 2	:	8 kV
Radiated electromagnetic field test as perVDE 0843 part 2	:	10V/m

Mechanical Tests

Shock	:	As per DIN IEC 41 B (CO) 38 : class 1
Vibration	:	As per DIN IEC 41 B (CO) 35 : class 1
Protection-front panel	:	IP 54
Protection-rear panel	:	IP 00
Weight	:	Approx. 1.5 kg

10.0 Dimensional Drawing



Range of Protection Relays

BASIC RANGE

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

FUNCTIONAL RANGE

- Genset Supervision & Control
- Auto Synchroniser
- Load Balancing & Control
- Related Protection

HIGH-TECH RANGE

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

INTEGERATED RANGE

- Numeric protection, solution for sub-station in association with INGETEAM T&D, Spain
- Distance protection
- Comprehensive transformer protection –

  a. Three winding transformer
  b. Two winding transformer
- Multi-functional relay: variety of protection combination

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