IRI1-ES – Sensitive Earth Fault Current Relay

Manual IRI1-ES (Revision A)

Content

1. Summary

When compared with traditional protection systems the protective relaying with MR- and IR-relays of our HIGH TECH LINE offers several advantages.

All MR protection relays are based on microprocessor technology. They present the generation of our most efficient protection relays, because of their capabilities to process the measuring values digitally and to perform arithmetical and logical operation. Additional advantages such as very low power consumption, adaptability, possibilities for self-supervision, flexible construction, selection of relay characteristics are completely utilized.
Some IR protection relays are based on microprocessor and some like the IRI1-ES on analog technology. They present our low-priced protection relay generation and are used for all basic protection application.

The following properties of the IR protection relays, such as:

- Integration of multiple protection functions into one compact housing,
- User-friendly setting procedure by means of DIP-switches,
- Compact design due to SMD-technique,

are their superiority over the traditional protection systems.

For all applications of a more complex nature, e.g. directional earth fault detection and where operating convenience, fault analysis and communication ability are required, MR-relays are used. All relays of the HIGH TECH LINE are available for through panel mounting and in 19“ racks. Connection terminals are of plug-in type. All IEC/DIN regulations required for the individual application are reliably met by these relays.

2. Application

The sensitive earth fault relay IRI1-ES detects high impedance earth faults with very small currents.
Conventional earth fault relays (IDMT) do not provide the required sensitivity.
For this application the IRI1-ES is the optimal solution.

3. Characteristics and features

- Static protective device
- Earth fault detection with core balance C.T. or in Holmgreen circuit
- Low pass filter for suppression of harmonics
- Coding for the self-holding function or automatic reset of the LED`s and trip relays
- Frequency range 50/60 Hz
- Rated current 1A or 5A
- Output relay with 2 change-over contacts
- Extremely large setting range for current reaction value with fine grading
- Wide range of operation of the supply voltage (AC/DC)

4. Design

4.1 Connections

4.1.1 Current measuring input

The analog input signal of the earth fault current is fed to the terminals B1/B2 of the protection relay.

4.1.2 Output relay

The IRI1-ES has one output relay with two change-over contacts:

State of IRI1-ES	Contact terminals closed:
Normal operation, pickup and dead condition	D1-C1, D2-C2
Trip	D1-E1, D2-E2

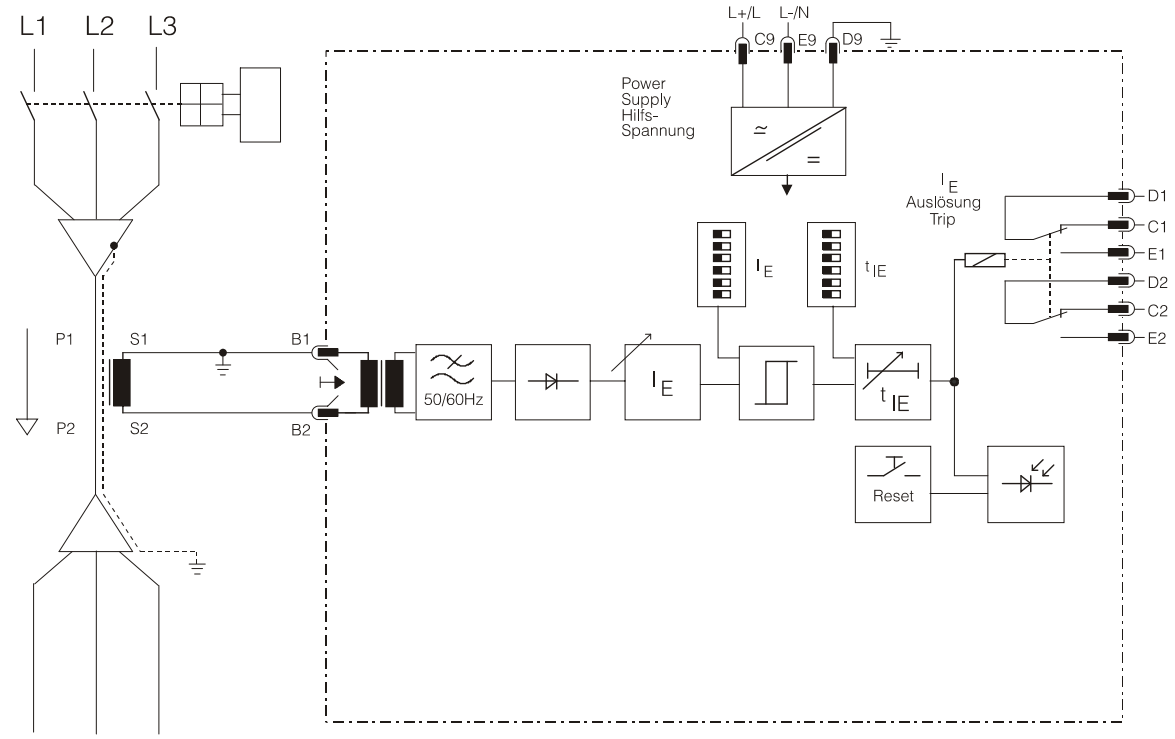


Figure 4.1: Connection diagram of IRI1-ES

4.2 Front plate

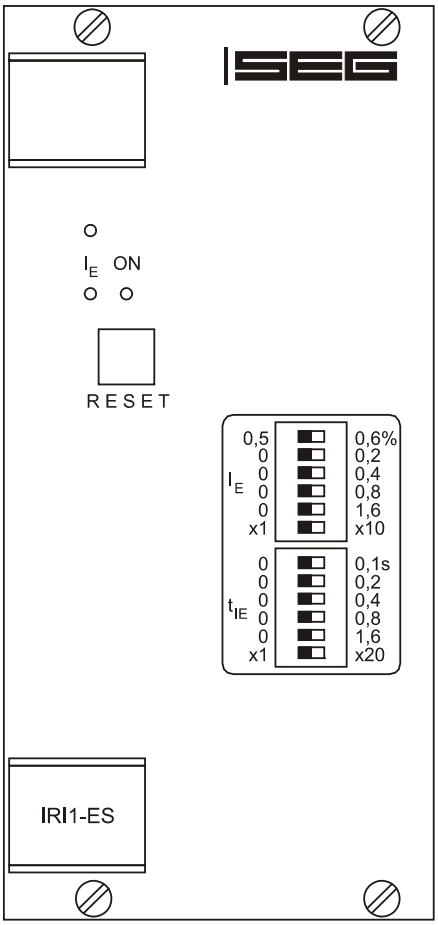


Figure 4.2: Front plate

The front plate of the IRI1-ES comprises the following operation and indication elements:

- 2 sets of DIP-switches for setting the current pickup value and the trip delay
- 3 LEDs for indication of faults- and readiness for operation
- 1 <RESET> push button

4.2.1 LEDs

On the front plate of the IRI1-ER 2 LEDs are installed, signalizing the following 2 service conditions:

- LED ON (green): readiness for service
- LED I_E (yellow): pickup
- LED I_E (red): tripping

4.2.2 DIP-switches

The set of DIP switches on the front plate serves for set-ting the tripping value for the earth fault current I_E.and the trip delay t_{IE}.

4.2.3 <RESET>-push button

The <RESET> push button is used for acknowledgement and reset of the LED and the tripping relay after tripping at the specifically presetting (see 4.3).

4.3 Code jumpers

There are two code jumpers behind the front plate which determine the function of the <RESET> pushbutton with regard to the LED indication and the output relay.
The following table explains the coding possibilities.

Code jumper		Reset function	Reset
3	ON	Earth fault indication LED I_E (red)	manual
	OFF		autom.
4	ON	Earth fault trip Relays	manual
	OFF		autom.

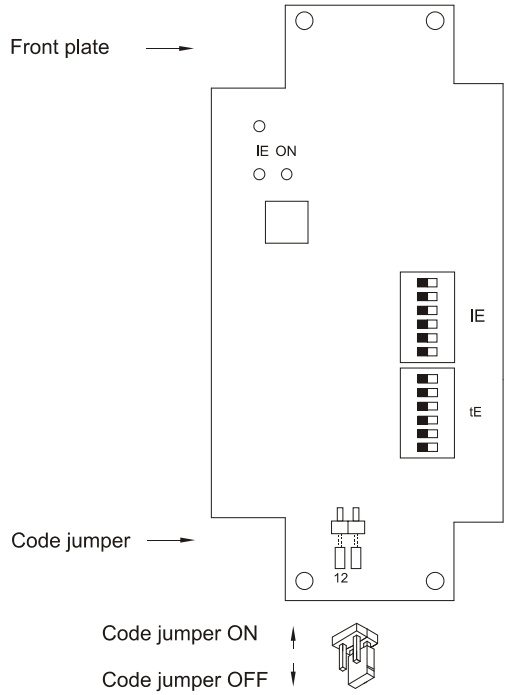


Figure 4.3: Code jumpers

5. Working principle

The earth fault protection relay IRI1-ES can be connected into the differential path of the C. T.s in a Holmgreen circuit or connected to a core balance C.T.

The analog measuring current is galvanically isolated and then fed to a low pass filter to suppress harmonics. Thereafter the signal is rectified and fed to a comparator where it is continuously compared with the preset threshold. If the measuring current exceeds a preset pickup value, the relay trips after the set trip delay has elapsed (see 4.1).

6. Operations and settings

6.1 Setting of the pickup value for the earth fault current I_E

The pick-up value of the earth fault current element I_E can be set by means of the DIP-switches set IE in the range of 0.5% to 36% x I_N with a grading of 0.1%.

The pick-up value is calculated by adding up the values of all DIP-switches.

Example:
A pick-up value of 10% of the rated current is required.

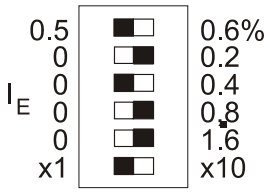


Figure 6.1: Setting example for the earth fault current pickup value

6.2 Trip delay t_E

The of the earth fault element can be set by means of the DIP-switches set t_{IE} in the range of 2.0 s to 62 s with a grading of 0.1 s or 0.2 s.

The trip delay is calculated by adding up the values of all DIP-switches.

Example:
A trip delay of 2.5 s is required.

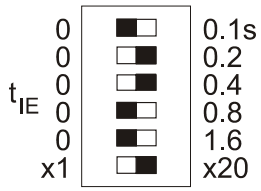


Figure 6.2: Setting example for the trip delay

6.3 Reset

Dependent on the code jumper's position (see 4.3) the relay can be reset manually by the <RESET> pushbutton. If the function is coded for automatic reset, the LED extinguishes and the output relay releases automatically after fault clearance.

7. Housing

The IRI1 can be supplied in an individual housing for flush-mounting or as a plug-in module for installation in a 19" mounting rack according to DIN 41494. Both versions have plug-in connections. Relays of variant D are complete devices for flush mounting, whereas relays of variant A are used for 19“ rack mounting. Housing variant A to be installed in switchboards of protection class IP51. For switchboards of lower protection classes housing variant D can be used.

7.1 Individual housing

The individual housing of the IRI1 is constructed for flush-mounting. The dimensions of the mounting frame correspond to the requirements of DIN 43700 (72 x 144 mm). The cut-out for mounting is 68 x 138 mm.

The front of the IRI1 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 switchboard panel.

7.2 Rack mounting

The IRI1 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 IRI1-devices can be delivered mounted in 19" racks.

7.3 Terminal connections

The plug-in module has very compact base with plug connectors and screwed-type connectors.

- max. 15 poles screw-type terminals for voltage and current circuits (terminal connectors series A and B with a short time current capability of 500 A / 1 s).
- 27 poles tab terminals for relay outputs, supply volt-age etc.(terminal connectors series C, D and E, max. 6 A current carrying capacity). Connection with tabs 6.3 x 0.8 mm for cable up to max. 1.5 mm^2 or with tabs 2.8 x 0.8 mm for cable up to max. 1 mm^2.

By using 2.8 x 0.8 mm tabs a bridge connection between different poles is possible.
The current terminals are equipped with self-closing short-circuit contacts. Thus, the IRI1-module can be un-plugged even with current flowing, without endangering the current transformers connected.

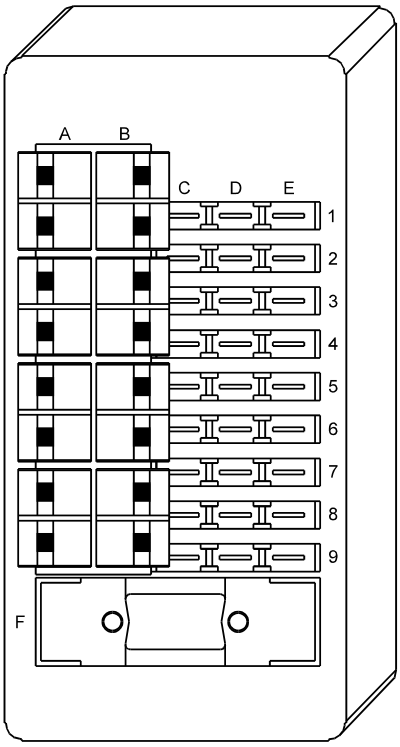


Figure 7.1: Terminal block

8. Relay testing and commissioning

The following test instructions should help to verify the protection relay performance before or during commissioning of the protection system. To avoid a relay damage and to ensure a correct relay operation, be sure that:

- the auxiliary power supply rating corresponds to the auxiliary voltage on site.
- the rated current and rated voltage of the relay correspond to the plant data on site.
- the current transformer circuits are connected to the relay correctly.
- all signal circuits and output relay circuits are connected correctly.

8.1 Power-On

NOTE!
Prior to switch on the auxiliary power supply, be sure that the auxiliary supply voltage corresponds with the rated data on the type plate.

Switch on the auxiliary power supply to the relay (terminals C9/E9) and check that the LED "ON" on the front lights up green.

8.2 Checking the set values

Check all relay set values and see if they are set correctly as you have desired. Set values can be modified by means of the DIP-switches on the front.

8.3 Secondary injection test

8.3.1 Test equipment

- Ammeter with class 1 or better
- Auxiliary power supply with the voltage corresponding to the rated data on the type plate
- Single-phase current supply unit (adjustable from 0 to 1.0 x I_N)
- Timer to measure the operating time (Accuracy ±10 ms)
- Switching device
- Test leads and tools

8.3.2 Example of test circuit for IRI1 relays

For testing IRI1-ES relays, only current input signals are required. Figure 8.1 shows a simple example of a single phase test circuit with adjustable current energizing the IRI1-ES relay under test.

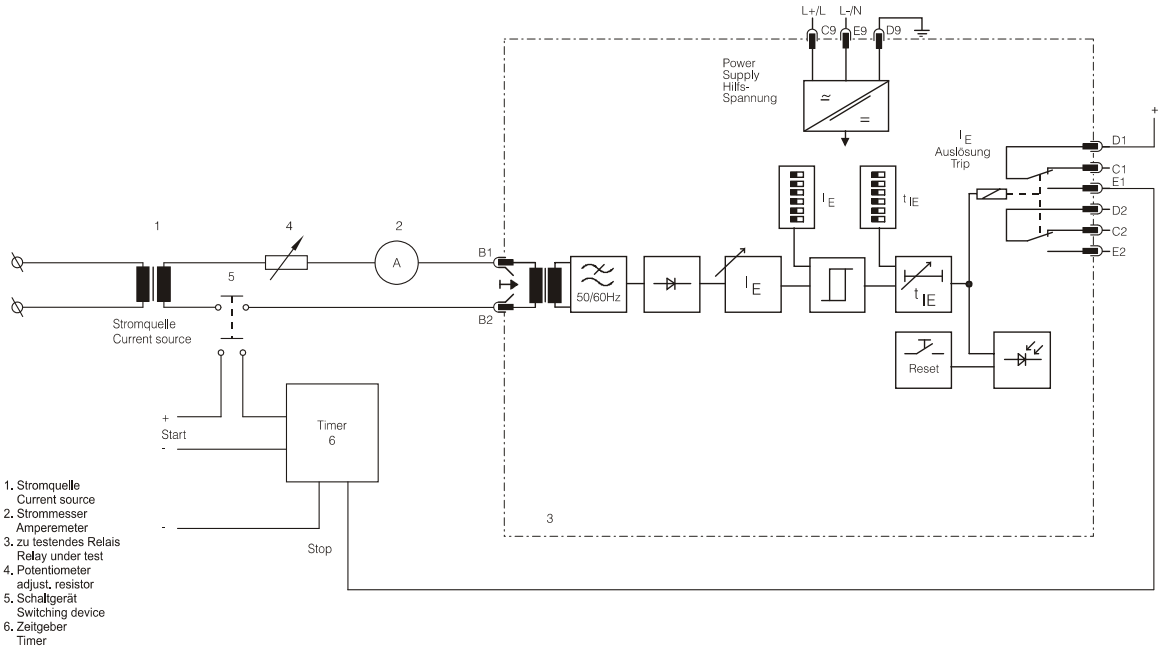


Figure 8.1: Example of a test circuit for IRI1-ES

8.3.3 Checking the pickup and tripping values

With the IRI1-ES, the analog input signal of the single-phase testing AC must be supplied to the relay via the terminals B1/B2 for checking the pickup value I_E.

For testing the earth fault current pickup value, first the testing AC must be set below the set pickup value I_E. Then the testing AC is increased gradually, until the relay picks up. This is indicated by the LED I_E lighting up yellow at the same time. Check that the value shown at the ammeter does not deviate by more than ±5% from the set pickup value I_E.

The resetting value of the earth fault element is deter-mined, by slowly decreasing the testing AC, until the output relay IE releases. The LED I_E extinguishes (sup-posed the respective coding was effected).

Check that the resetting value is not greater than 0.95 times the pickup value.

8.3.4 Checking the trip delay t_{IE}

To check the trip relay, a timer must be connected to the trip output relay contact. The timer should be started simultaneously with the current injection into the current input circuit and stopped by the trip relay contact. Set the current to a value corresponding to twice the operating value and inject the current instantaneously. The operating time measured by the timer should have a deviation of less than ±3% of the set value or ±20 ms.

8.4 Primary injection test

Generally, a primary injection test could be carried out in the similar manner as the secondary injection test described above. With the difference that the protected power system should be, in this case, connected to the installed relays under test „on line“, and the test currents and voltages should be injected to the relay through the current and voltage transformers with the primary side energized. Since the cost and potential hazards are very high for such a test, primary injection tests are usually limited to very important protective relays in the power system.

8.5 Maintenance

Maintenance testing is generally done on site at regular intervals. These intervals vary among users depending on many factors: e.g. the type of protective relays employed; the importance of the primary equipment being protected; the user's past experience with the relay, etc.

For static relays such as the IRI1-ES, maintenance testing once per year is sufficient, as experience has shown.

9. Technical Data

9.1 Measuring input

Rated data:

Nominal current I_N	1A/5A	
Nominal frequency f_N	50/60 Hz	
Power consumption in current circuit:	<1 VA/at I_N = 1A <5 VA/at I_N = 5 A	
Thermal withstand capability of current circuit	dynamic current withstand (half-wave)	250 x I_N
	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:

24 V - working range	16 - 60 V AC / 16 - 80 V DC	
110 V - working range	50 - 270 V AC / 70 - 360 V DC	
Power consumption:		
24 V - working range	standby approx. 3 W	operating approx. 6 W
110 V - working range	standby approx. 3 W	operating approx. 6 W

9.3 General data

Permissible interruption of the supply voltage without influence on the function	50 ms
Dropout to pickup ratio:	>95%
Returning time:	30 ms
Minimum operating time:	30 ms

9.4 Output relay

The output relay has the following characteristics:
Maximum breaking capacity: 250 V AC / 1500 VA / continuous current 6 A

Breaking capacity for DC:

	ohmsch	**L/R = 40 ms**	**L/R = 70 ms**
300 V DC	0.3 A / 90 W	0.2 A / 63 W	0.18 A / 54 W
250 V DC	0.4 A / 100 W	0.3 A / 70 W	0.15 A / 40 W
110 V DC	0.5 A / 55 W	0.4 A / 40 W	0.20 A / 22 W
60 V DC	0.7 A / 42 W	0.5 A / 30 W	0.30 A / 17 W
24 V DC	6.0 A / 144 W	4.2 A / 100 W	2.50 A / 60 W

Max. rated making current	64 A (acc. VDE 0435/0972 and IEC 65 / VDE 0860 / 8.86)
Making current:	minimum 20 A (16ms)
Mechanical life span:	30 x 10^6 switching cycles
Electrical life span:	2 x 10^5 switching cycles at 220 V AC / 6 A
Contact material:	silver-cadmium-oxyde

9.5 System data

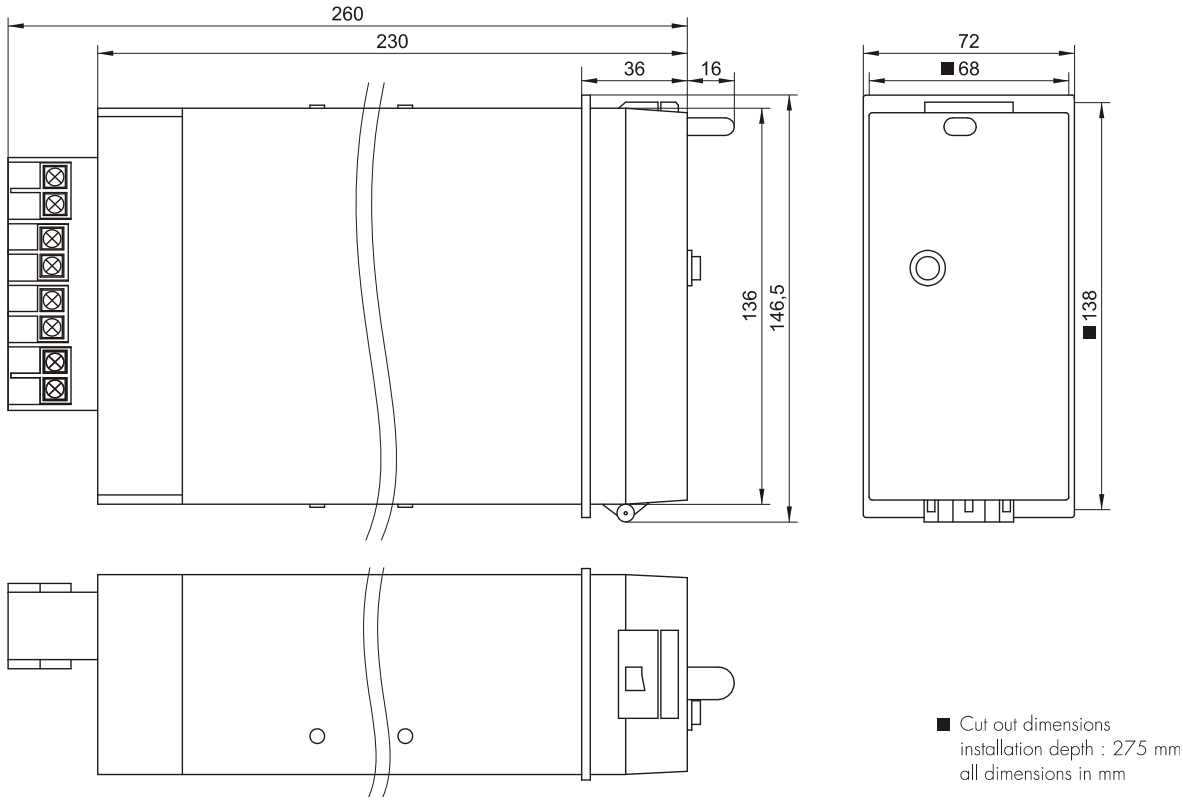
Design standard:	
Generic standard:	EN 50082-2, EN 50081-1
Product standard:	EN 60255-6, IEC 255-4, BS 142
Specified ambient service	
Storage temperature range:	- 40°C to + 85°C
Operating temperature range:	- 20°C to + 70°C
Environmental protection class F as per DIN 40040 and per DIN IEC 68 2-3:	relative humidity 95 % at 40°C for 56 days
Insulation test voltage, inputs and outputs between themselves and to the relay frame as per EN 60255-6 and IEC 255-5:	2.5 kV (eff.), 50 Hz; 1 min
Impulse test voltage, inputs and outputs between themselves and to the relay frame as per EN 60255-6 and IEC 255-5:	5 kV; 1.2 / 50 µs; 0.5 J
High frequency interference test voltage, inputs and outputs between themselves and to the relay frame as per EN 60255-6 and IEC 255-22-1:	2.5 kV / 1MHz
Electrostatic discharge (ESD) test as per EN 61000-4-2 and IEC 255-22-1:	8 kV air discharge, 6 kV contact discharge
Electrical fast transient (Burst) test as per EN 61000-4-8 and IEC 801-4:	4 kV / 2.5 kHz, 15 ms
Power frequency magnetic field test as per ENV 50141:	electric field strength 10 V/m
Surge immunity EN 61000-4-5:	4 kV
Radio interference suppression test as per EN 55011:	limit value class B
Radio interference radiation test as per EN 55011:	limit value class B
Mechanical tests:	
Shock:	class 1 acc. to DIN IEC 255-21-2
Vibration:	class 1 acc. to DIN IEC 255-21-1
Degree of protection - front of relay:	IP 54 by enclosure of the relay case and front panel (relay version D)
Weight:	approx. 1.5 kg
Degree of pollution:	2 by using housing type A 3 by using housing type D
Overvoltage class:	III

Influence variable values:
Frequency influence: 40 Hz < f < 70 Hz: <3 % of set value
Temperature influence: ±0,1%/K in the range from -20°C to +70°C, ref. = 20°C
Auxiliary voltage influence: no influence within the admissible range

9.6 Setting ranges and steps

Parameter	Setting range	Steps	Tolerances
I_E	0,5 % ... 3,6 % x I_N 5,0 % ... 36 % x I_N	0,1 % 1,0 %	±5 % of the setting value
t_{IE}	0,1 s ... 3,1 s 2,0 s ... 62 s	0,1 s 2,0 s	±5 % approx. ± 20 ms

9.7 Dimensional drawing



Please note:
A distance of 50 mm is necessary when the units are mounted one below the other in order to allow easy opening of the front cover of the housing. The front cover opens downwards.

10. Order form

Earth fault relay		**IRI1**				
Very sensitive measuring			**ES**			
Rated current	1 A			**1**		
	5 A			**5**		
Auxiliary voltage						
24 V (16 to 60 V AC/16 to 80 V DC)					**L**	
110 V (50 to 270 V AC/70 to 360 V DC)					**H**	
Housing (12TE)	19“-rack					**A**
	Flush mounting					**D**

Technical data subject to change without notice !

Setting list IRI1-ES

Note !
All settings must be checked at site and should the occasion arise, adjusted to the object / item to be protected.

Project: _____ Woodward job.-no.: _____

Function group: = _____ Location: + _____ Relay code: - _____

Relay functions: _____ Date:

Setting of parameters

Parameter		Unit	Default settings	Actual settings
I_E	Earth fault current	% In	0.5	
t_{IE}	Tripping delay I_E	s	0.1	

Setting of code jumpers

Code jumper	J1		J2		J3		J4	
	Default setting	Actual setting	Default setting	Actual setting	Default setting	Actual setting	Default setting	Actual setting
Plugged					X		X	
Not plugged	not used		not used					

Woodward Kempen GmbH
Krefelder Weg 47 · D – 47906 Kempen (Germany)
Postfach 10 07 55 (P.O.Box) · D – 47884 Kempen (Germany)
Phone: +49 (0) 21 52 145 1

Internet
www.woodward.com

Sales
Phone: +49 (0) 21 52 145 216 or 342 · Telefax: +49 (0) 21 52 145 354
e-mail: salesEMEA_PGD@woodward.com

Service
Phone: +49 (0) 21 52 145 614 · Telefax: +49 (0) 21 52 145 455
e-mail: SupportEMEA_PGD@woodward.com