High-Tech Range

IRI1-ER (Stablized Earth Fault Current Relay)

C&S electric

C&S Electric Limited

(Protection & Control Division)

Contents

1. Introduction

The application of powerful microprocessors with *MR-* and *IR*-relays of the *HIGH TECH RANGE* provides a large variety of advantages over power protection systems of the traditional type.

The *MR*-protection relays are based exclusively on the microprocessor technology. They represent our most efficient generation of power protection systems. Because of their capabilities to process measured values digitally and to perform arithmetical and logical operations, they are superior to the traditional analog systems.

Besides, the digital protection relays offer important additional advantages such as very low power consumption, adaptability, flexible construction, selection of relay characteristics etc.

The *IR*-protection relays are based on the microprocessor technology or on the analog technology. They represent a more cost saving generation of relays of the *HIGH TECH RANGE*, used for basic equipment protection.

The *IR*-protection relays are superior to conventional protective devices because of their following characteristics:

- Integration of multiple protective functions into one compact housing
- User-friendly setting procedure by means of DIP-switches
- Compact construction type by SMD-technology

MR-protection relays are used for more complex protective functions, such as earth fault directional detection, and also in cases where easy operation, quick fault-analysis and optimal communication capabilities are required.

All relays of the *HIGH TECH RANGE* are available for flush mounted installation, as well as for 19" rack mounting. Plug-in technology is used. Of course, all relays comply with the IEC/DIN regulations required for the specific protection application.

2. Applications

The stabilized earth fault current relay *IRI1-ER* serves as a supplement for the transformer differential protection. It allows for example implementation of a zero-current differential protection by integrating the star-point current (*IRI1-ER*). With the view to its higher resistance to disturbances from outside the protection area, it can be set much more sensitively than the simple transformer differential protection, in order to prevent false trippings.

The *IRI1-ER* can be used as:

- Zero-current differential protection of the star point winding (restricted earth fault) of a transformer (*IRI1-ER*), see figure 2.1
- Highly stabilized differential current relay for alternator, transformers and motors (*IRI-3ER*), see figure 2.2

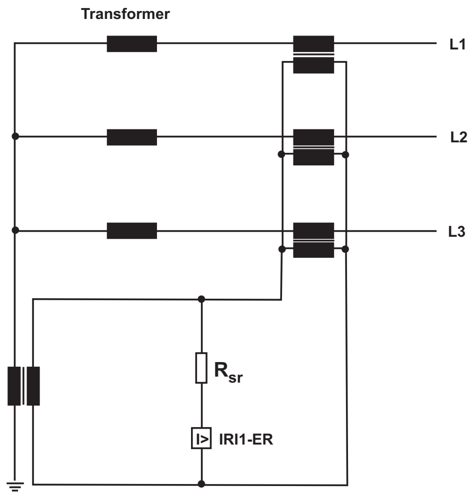


Fig. 2.1: Zero-current differential protection of a transformer in star-connection (IRI1-ER)

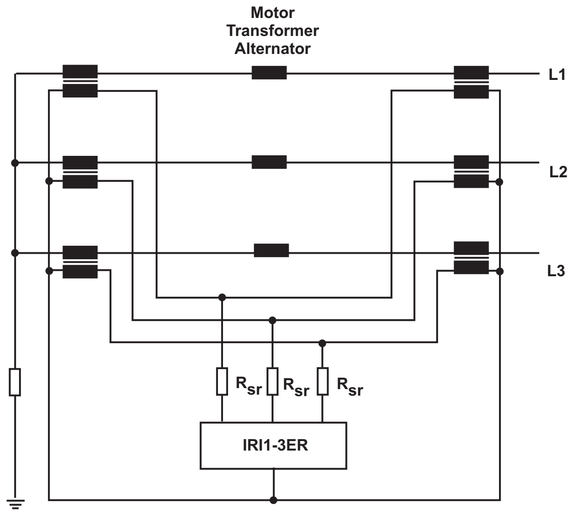


Fig. 2.2: Highly stabilized differential protection for alternators, transformers and motors (IRI-3ER)

3. Characteristics and features

- static protective device
- single-phase current measuring (IRI1-ER) as zero-current differential protection (restricted earth fault 64 REF)
- three-phase current measuring (IRI1-3ER) as phase-current differential protection
- high stability by serial stabilizing resistor Rsr per phase
- high sensitivity by low input burden of C.T.
- extremely wide setting range with fine grading
- wide range of operation of the supply voltage (AC/DC)
- 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

4. Design

4.1 Connections

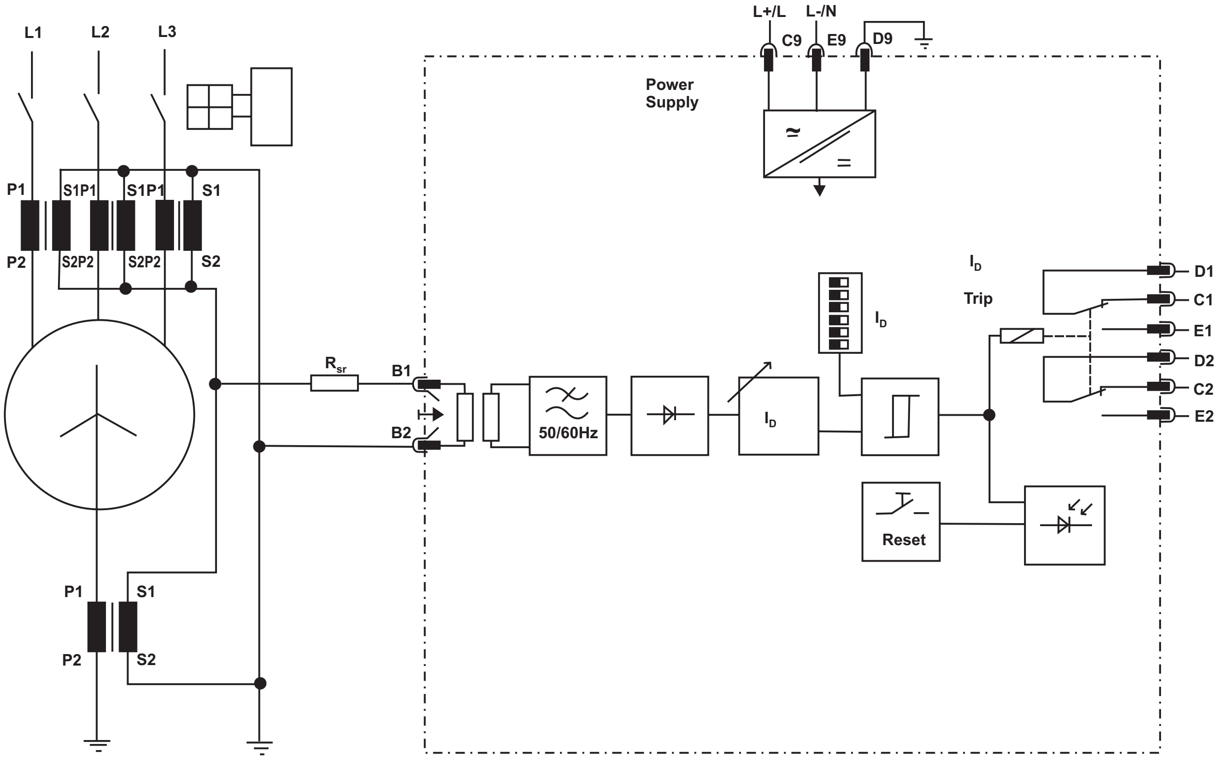


Fig. 4.1: Connection diagram IRI1-ER

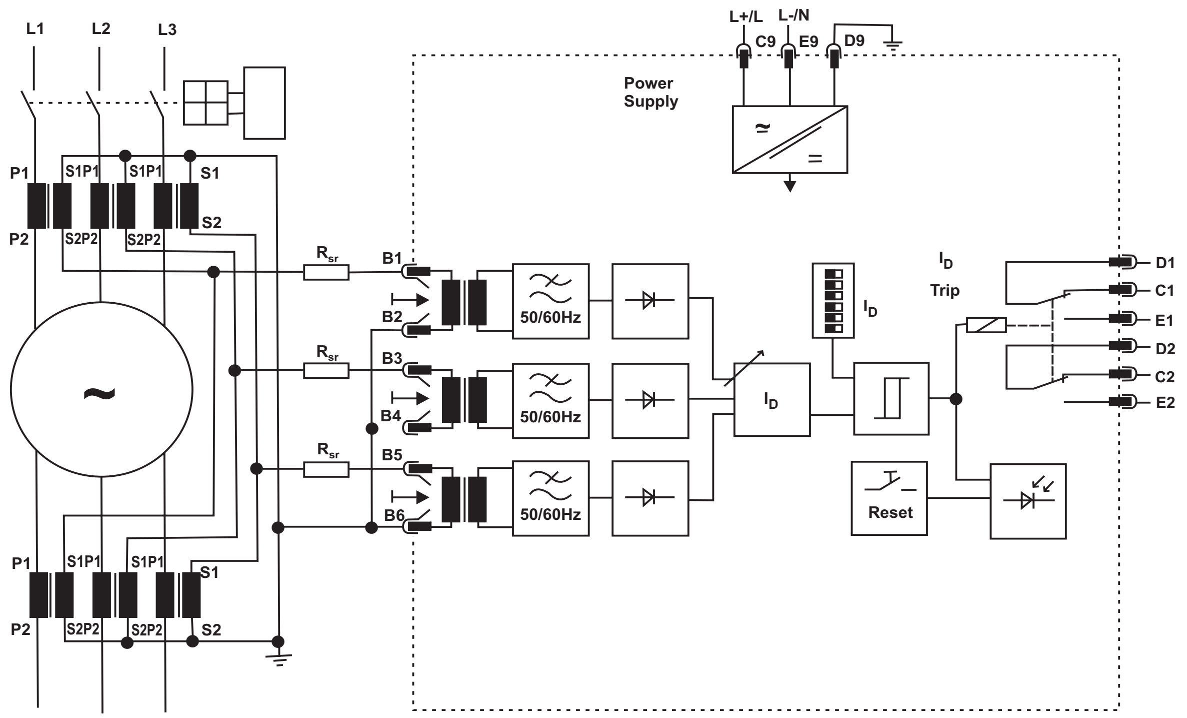


Fig. 4.2: Connection diagram IRI1-3ER

4.1.1 Analog inputs

At three-phase measuring, the analog input signals of the differential currents are fed to the protective device via terminals B1 to B6 (*IRI1-3ER*), respectively at single phase measuring via terminals B1/B2 (*IRI1-1ER*).

4.1.2 Output relays

Both relay types are equipped with a trip relay with two change-over contacts.

Tripping I_D : D1, C1, E1
D2, C2, E2

4.2 Front plate

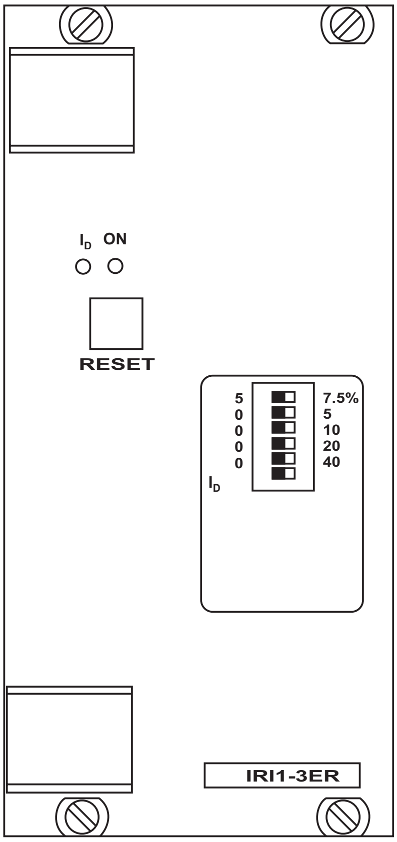


Fig. 4.3: Front plate

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

- 1 set of DIP-switches for setting the tripping value
- 2 LEDs for indication of faults- and readyness 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): readyness for service
- LED I_D (red): tripping

4.2.2 DIP-switches

The set of DIP switches on the front plate serves for setting the tripping value for the differential current I_D.

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 preset value (see 4.3).

4.3 Code jumper

Behind the front plate, two coding jumpers are installed at the bottom side for setting the LED-display, as well as for the tripping function of the output relay.

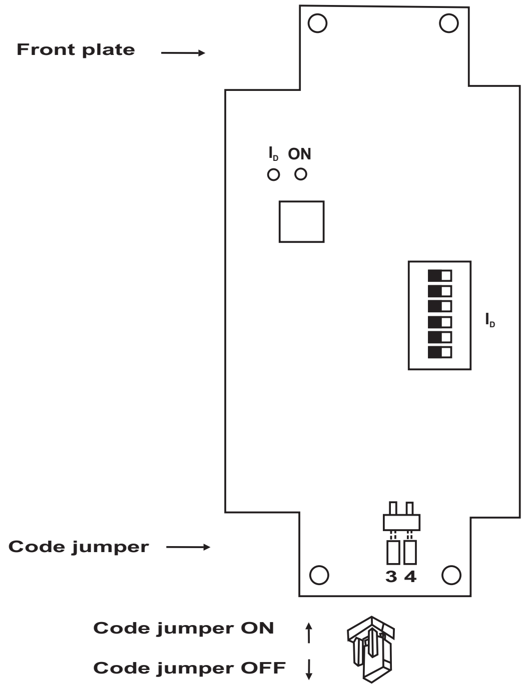


Fig. 4.4: Code jumper

Code jumper	Function	Position of code jumper	Operating mode
3	Differential current indication	OFF ON	latching of the red LED I_D automatic reset of the red LED I_D
4	Differential current tripping	OFF ON	latching of the tripping relay automatic reset of the tripping relay

Table 4.1 Code jumper

5. Working principle

The protection relay IRI1-ER is connected to the differential circuit of the c.t.s as a current differential protection relay. When used as zero-current differential protection (restricted earth fault), the relay (IRI1-ER) is to be connected acc. figure 2.1. When used as highly stabilized differential current relay, the relay (IRI1-3ER) is to be connected acc. figure 2.2.

The knee voltage U_{Kn} is an important characteristic of the transformer. The transformer does not work linearly anymore above this voltage. Two transformers of the same class still show the same behavior below U_{Kn} within the scope of their precision class. Above U_{Kn} they can, however, show very different saturation behavior.

Connected in a differential current circuit an apparent fault current can thus be measured at large primary current intensity which really results only from the different saturation of both transformers.

An additional stabilizing resistor R_{ST} counteracts this effect. It attenuates the current flow through the measuring device. This way the unsaturated transformer drives part of its current into the saturated

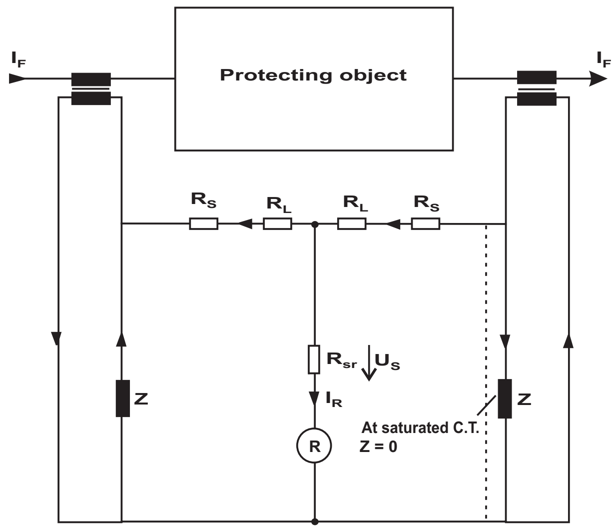


Fig. 5.1 Single line diagram IRI1-ER

transformer and minimizes the faulty differential current effect on secondary side. By small currents the stabilizing resistor effects however also the accuracy of the real fault current measurement. Because this effect lies in a linear range it can be taken into consideration mathmatically by adjusting the protection device.

(see para. 6.4).

For demonstrating the working principle, figure 5.1 shows the single-line diagram of the *IRI1-ER*.

The harmonics existing during a transformer saturation and the DC-component are suppressed by a filter circuit located in the input circuit of the relay; the filter circuit is adjusted to the mains frequency (50/60Hz).

The *IRI1-ER* has a single-phase differential current supervision with an adjustable pick-up value. The current measured in the differential circuit is constantly compared with the set reference value.

Measuring principle IRI1-ER

The analog current signals are galvanically decoupled via the input transformer and are led over a low pass with subsequent band-pass for suppression of the harmonics, then rectified and compared with the set reference value of a comparator. In case the current measured exceeds the reference value, an instantaneous tripping takes place (figure 4.1).

The *IRI1-3ER* has a three-phase differential current supervision with adjustable pick-up value. The currents measured in the individual differential circuits are constantly compared with the set reference value.

Measuring principle *IRI1-3ER*

The analog current signals are galvanically decoupled via three input transformers and led over a low pass with subsequent band-pass for suppressing the harmonics. Then rectified and compared with the set reference value of a comparator. In case one of the three currents measured exceeds the reference value, an instantaneous tripping takes place (figure 4.2).

6. Operations and settings

6.1 Layout of the operating elements

The DIP-switch required for setting of parameters is located on the front plate of the relay.

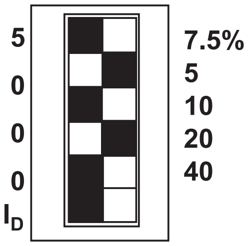
6.2. Setting of the pick-up value for the differential current I_D

The pick-up value of the differential current tripping I_D can be set by means of the DIP-switches set I_D in the range of 5% to 82.5% x I_N with a grading of 2.5%.

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

Example:

A pick-up value of 30% of the rated current is required.



$I_D = 5 + 5 + 20 = 30\% \times I_N$

6.2.1 Indication of fault

The fault alarm is shown by the LED I_D on the front plate of the relay, which lights up red at tripping.

Depending on the coding by means of the code jumper (see chapter 6.3.2), the fault alarm extinguishes automatically or after pressing the <RESET> push button, after the fault is eliminated.

6.3 Reset

6.3.1 Reset by pressing the <RESET>-push-button

By pressing the <RESET> push button, the tripping relay is reset and the LED-signal extinguishes. All coding switches must be plugged out for this (see chapter 4.3).

6.3.2 Automatic reset

Code jumper 1

If no code jumper is plugged in at coding place 1, the red fault alarm LED I_D is coded latching.

The fault signal can only be reset manually by pressing the <RESET> push button.

If the code jumper is plugged in at coding place 1, the red fault signal LED I_D is automatically reset, after the fault is eliminated.

Code jumper 2

The tripping relay is coded latching, if no code jumper is plugged in on coding place 2.

The tripping relay can only be reset manually by pressing the <RESET> push button.

If the code jumper is plugged in on coding place 2, the tripping relay is automatically reset after elimination of the fault.

6.4 Calculation of the tripping current and the stabilizing resistance

Prior to setting the relay, the stabilizing resistance R_{sr}, as well as the tripping current I_{set} must be calculated. For the correct setting, the knee-point voltage in the magnetizing circuit of the c.t. is of special importance. In order to obtain a sufficient differential current for tripping on account of internal faults, the knee-point voltage U_{kn} of the transformer should be twice as high as the maximum expected stabilizing voltage U_S in case of faults from outside the protection zone. From this results the following calculation:

$$U_{Kn} = 2 \times U_S = 2 \times I_{f,sek} \times (R_S + R_L)$$

Explanation:

U_{kn} knee-point voltage of the magnetizing circuit of the transformer

U_s maximum stabilizing voltage in case of external faults

$I_{f,sek}$ maximum expected fault current (secondary-side) in case of external faults

R_S secondary resistance of the transformer

R_L Resistance of the connection line between c.t. and relay

The tripping current of the relay is then calculated, as follows:

$$I_D \geq \frac{U_{Kn}}{2 \cdot R_{Sr}}$$

Explanation:

R_{Sr} stabilizing resistance

The strength of the stabilizing resistance must be selected in a way to ensure that the tripping current is within the setting range (5% to 82.5% of I_N).

When the pick-up value is exceeded, nearly an immediate tripping is initiated. With 30 ms the tripping time is approx. five times as high as the tripping value. In case of lower currents, the tripping time is slightly higher (about 100ms), in order to reach a stabilization of the protective function against external faults (see also chapter 5).

6.4.1 Sample calculation - alternator

An *IRI1-ER* protection relay is used for the earth-fault protection of an alternator. In the starpoint, the following c.t. is provided:

transformation ratio	:	100/1A
class	:	5 P 10
output	:	2.5 VA
secondary resistance of the transformer	:	<0.7Ω

A primary-side fault current of 20% x I_N shall be recorded. The secondary current is used for calculation.

Calculation of the knee-point voltage

If the knee-point voltage is not indicated by the manufacturer, as is the case in our example, the approximate value can be calculated, as follows:

$$U_{kn} = \left(\frac{S \times k_{lu}}{I_N}\right) \Rightarrow \left(\frac{2.5 \times 10}{1}\right) = 25V$$

Explanation:

S output of the c.t.

k_{lu} overcurrent factor of the c.t.

I_N secondary-side rated current of the transformer

Calculation of the active resistances

The relevant resistances in the differential circuit add up to a total (circle-) resistance:

$$R_{circuit} = \left(\frac{U_{Kn}}{2 \times I_{Set}}\right) = R_{Sr} + 2 \times R_L + R_S + R_r$$

Explanation:

R_{kreis} total resistance in the differential circuit

R_{sr} stabilizing resistance

R_L resistance of the connection line between c.t. and relay

R_s secondary resistance of the transformer (<0.7Ω)

R_r relay input resistance (B1 - B2 = 0.02 W)

I_D tripping current

The individual resistance values are:

2 x R_L = 150 mΩ, at 20 m, 2.5 mm² Cu

2 ×R_L + R_r + R_S = 0.87 Ω

Therefore, the following is valid:

$$R_{kreis} = \left(\frac{25\ V}{2 \times 0.2\ A}\right) = 62.5\ \Omega$$

Calculation of the stabilizing resistance

The stabilizing resistance is calculated from above ratios, as follows:

$$R_S = S_{r\ circuit} - (2 \times R_L + R_r + R_S)$$
$$= R_{circuit} - 0.87\ \Omega$$
$$= 61.6\ \Omega$$

In operational mode ≤ I_D, the output requirement P_N is as follows:

$P_N \leq I^2 \times R_{sr} = 0.2^2\ A^2 \times 61.6\ \Omega \leq 2.47\ W$

In this case, P_N represents the minimum output required (pure current-heat losses). A considerably increased output P_F is required in the event of a fault.

Example: The fault current is: $I_{F,prim}$ = 13.1 kA

If one neglects the transformer saturation, the following peak voltage U_P occurs:

$$U_p = \frac{I_{F,prim}}{n} \quad (R_{Sr} + 2 \times R_L + R_r + R_S)$$

$$U_p = \frac{13100A \times 1}{100} \times (62.5\Omega) = 8187.5\ V$$

If one considers the transformer saturation, a short-term peak voltage U_{SS} occurs, as shown in the following calculation:

$$U_{SS} = 2 \times (2 \times U_{Kn} \times (U_p - U_{Kn}))^{+0.5} \leq 3\ kV$$

$$U_{SS} = 2 \times (2 \times 25\ V \times (8187.5\ V - 25\ V))^{+0.5}$$
$$= 1.28\ kV$$

$$Pr = \frac{U_{SS}^2}{R_{Sr}} = \frac{1280^2\ V^2}{61.6\ \Omega}\ 26.6\ kW$$

The calculation of P_N and P_F must be effected in any case, in order to get the exact power range of the stabilizing resistor.

Take over of power by the resistor in the event of a fault P_F creates a short-term peak value.

6.4.2 Example calculation -transformer

An *IRI1-ER* protection relay is used for the earth-fault protection of a 1.6 MVA-transformer (11000/415 V, 6%), see figure 2.1. The following c.t.s are used in the rigidly earthed starpoint:

transformation ratio:	2 500/1A
class:	X
resistance Rs:	8 Ω
knee-point voltage:	250 V

The relay is situated about 20m away from the c.t.s and is connected with a 2.5 mm² cable.
Calculation of the stabilizing voltage

The primary-side fault-current $I_{F,prim}$ is:

$$I_{F,prim} = \frac{1600000\ VA}{\sqrt{3}\ X\ 415\ V\ X\ 6\%} = 37.1\ kA$$

Line resistance R_L (2.5 mm² ≃ 7.46 Ω /km)

$$RL = 20\ m\ X\ \frac{7.46\ \Omega}{1000\ m} = 0.15\ \Omega$$

Additional resistance R_r (ca. 0.02 Ω)

From this results the stabilizing voltage for:

$$U_S = \frac{I_{F,prim}}{n} \quad X\ (2\ X\ R_L + R_S + R_r)$$

$$U_S = \frac{37100\ A \times 1}{2500} \quad X\ (2\ X\ 0.15\Omega + 8\Omega + 0.01\Omega) = 123.5$$

Since the knee-point voltage shall be U_{kn} = 2x U_S (2 x 123.5V = 247 V), the above transformer with U_{kn} = 250 V can be used.

Calculation of the set current and the stabilizing resistance (sample value)

The rating for the set current of 20% is calculated:

I_D = 20 % x I_N = 0.2 x 1 A = 0.2 A

From this results the stabilizing resistance for:

$$R_{circuit} = \left(\frac{U_S}{I_D}\right) \simeq R_{Sr} => \left(\frac{123.5\ V}{0.2\ A}\right) = 617.5\Omega$$

In the event of a fault, the stabilizing resistance must withstand a secondary-side false current of:

$$I_{F\ sek} = \frac{1600000\ VA}{\sqrt{3}\ X\ 415\ V\ X\ 6\%\ X\ 2500} = 14.84\ A$$

The calculation of the short-term peak voltages provides the following result:

$$U_S = \frac{37.1\ kA \times 1}{2500} \quad X\ (8\Omega + 2\ X\ 0.15\Omega + 0.02\Omega + 615\Omega) = 9.25\ kV$$

Thus, the ratio

U_{SS} = 2 X (2 X U_{Kn} X $(U_p - U_{Kn}))^{+0.5} \leq$ 3 kV

U_{SS} = 2X(2X250 V X(9250 V - 250V))$^{+0.5}$

= 4.24 kV

is not reached and the calculation must be repeated with a higher set current.

Calculation of the set current and the stabilizing resistance (actual value)

The rating for the set current of 40% is calculated again:

I_D = 40 % x I_N = 0.4 x 1 A = 0.4 A

From this results the stabilizing resistance for:

$$R_{circuit} = \left(\frac{U_S}{I_D}\right) \simeq R_{Sr} => \left(\frac{123.5\ V}{0.4\ A}\right) = 308.75\ \Omega$$

Thus, the requirement of the short-term peak voltage is met.

$$U_p = \frac{37.1\ kA \times 1}{2500}\ X\ (8 + 2\ X\ 0.15\Omega + 0.02\Omega + 308.75\Omega) = 4.7\ kV$$

U_{SS} = 2 X (2 X 250 V X (4700 V X 250 V))$^{+0.5}$

= 298

Since the requirement is met, the set values and the resulting resistance values can be accepted.

The calculation of the output requirement for the stabilizing resistance can be carried out similar to the calculation of sample 6.4.1.

6.5 Application of IRI1-3ER relay as High Impedance Bus Differential Protection:

IRI-1ER or IRI1-3ER (a 3-phase version of IRI1-1ER) relays also offers reliable Bus protection based on High Impedance Differential Principle.

The figure below indicates a typical Single Bus system using IRI-ER relay for Bus Protection. This sample system incorporates two incoming and two outgoing bays.

In case of normal operation, following Kirchoff's law, the currents terminating on bus and going put adds up to Zero with corresponding reproduction on CT secondary side of respective bays. As the vector summation of the currents balances each other out, the Relay does not operate.

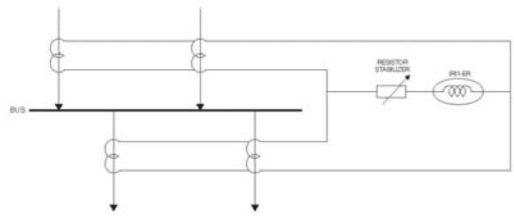


Fig. 6.1

In case of internal faults, as the fault currents will be fed from all sources possible, the differential current will operate the relay.

For External fault, though the amount of current flowing into the fault will increase, the net summation of the current again will zero and the relay will restrain.

Here, it is important to consider unequal saturation characteristics of the Current transformers involved. It is also important to ascertain that the relay remains stable in presence of Harmonics and DC currents.

Especially for a Bus Differential relay, following factors are vital:

- Because of higher concentration of fault MVA, the Relay should operate very fast for heavy internal faults.
- The Relay should be reliably stable in presence of Harmonics – especially 2^{nd} and 3^{rd} harmonics – and presence of DC currents.

  IRI1-ER relays ensure:

- Operating time of less than 15 milliseconds at more than 5 times of the setting.
- 2^{nd} Harmonic rejection ratio of more than 4.
- 3^{rd} Harmonic rejection ratio of more than 40.
- Remains very stable against superimposed DC currents.

Rs : Stabilising Resistance in Ohms

Id : Differential Current Setting

Up : Peak Voltage neglecting Saturation

Uss : Short term peak Voltage considering Saturation

Ifs: Secondary value of Fault Current

Ifmax : 40000 kV : = 220 CTR : = 1500

MVAf : $=\sqrt{3}$.kV.Ifmax MVAf = 1.524×10^7 Id : = 4

$Ifs := \frac{Ifmax}{CTR}$ Ifs = 26.667

RL : = 0.5 Rct : = 6 $Zr := \frac{0.02}{Id^2}$ Zr = 0.125

Kpv : = Ifs . (Rct + 2.RL)

Kpv : = 186.667

Knee point required for the CT core should higher than,

KpvCT : = 2 . Kpv KpvCT = 373.333

$Rs := \left[\left(\frac{Kpv}{Id}\right) - Zr\right]$ Rs = 466.542

Up : = Ifs . (Rs + 2.RL + Rct + Zr)

Up = 1.263×10^4 1.594 . 10000 = 1.594×10^4

Uss : = 2 . [2 . Kpv. (Up - Kpv]0.5

Uss = 4.311 x 103

$\frac{Kpv}{2.Rs} = 0.2$

The use of Metrosil can be avoided as the relay can reliably withstand Uss up to 5 kV. For fault currents exceeding this level, the Metrosils should be used.

7. Housing

The *IRI1-ER* 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.

7.1 Individual housing

The individual housing of the *IRI1-ER* 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 mounting is 68.7 x 136.5 mm.

The front of the IRI1-ER is covered with a transparent, sealable flap (IP54).

7.2 Rack mounting

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

If 19" racks are used the panel requires protection class IP51.

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 voltage 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-ER-module can be unplugged even with current flowing, without endangering the current transformers.

The following figure shows the terminal block of *IRI1-ER*:

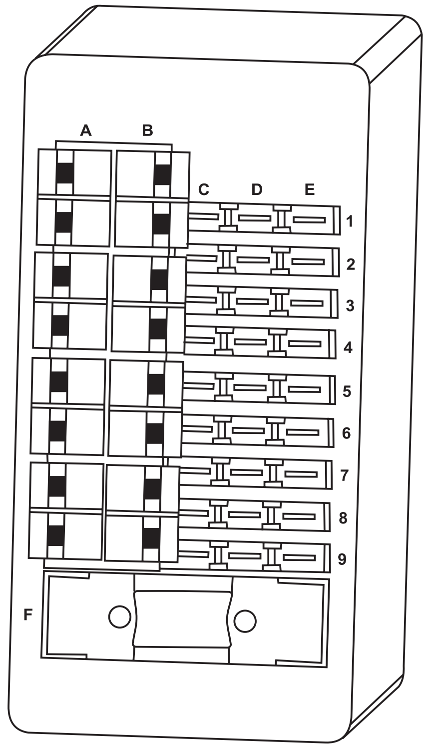


Fig. 7.1: Terminal block of IRI1-ER

8. Relay testing and commissioning

The following instructions should help to test 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 to the rated data on the type plate.

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

8.2 Checking the set values

Check the DIP-switch positions, in order to verify the parameterized set value. If necessary, the set value can be corrected by means of the DIP-switch.

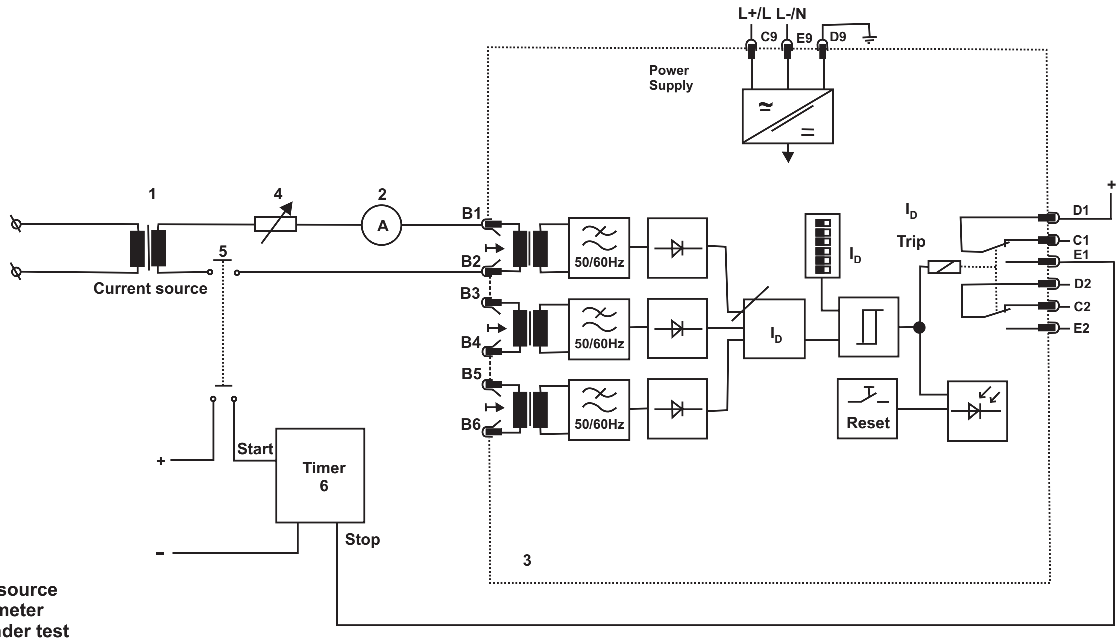
8.3 Secondary injection test

8.3.1 Test equipment

- ammeter
- auxiliary power supply with a voltage corresponding to the rated data on the type plate
- single-phase AC-power supply (adjustable from 0 - 2.0 x I_N)
- test leads and tools
- potentiometer
- switching device
- timer

8.3.2 Example of a test circuit for a *IRI1-3ER* -relay

For testing the *IRI1-3ER*-relay, only power signals are required. Fig. 8.3.1 shows an example of a test circuit with adjustable power supply. The phases are tested individually one after the other.



1. Current source
2. Amperemeter
3. Relay under test
4. Potentiometer adjust resistor
5. Switching device
6. Timer

Fig. 8.3.1 Test circuit IRI1-3ER

8.3.3 Checking the pick-up and tripping values (IRI1-ER)

With the *IRI1-ER*, the analog input signal of the singlephase testing AC must be supplied to the relay via the terminals B1/B2 for checking the pick-up value I_D.

For testing the differential current pick-up value, first the injected current must be set below the set pick-up value I_d. Then the injected current is increased gradually, until the relay trips. This is indicated by the LED I_D lighting up red, with the relay tripping at the same time. Check that the value shown at the ammeter does not deviate by more than +/- 3% from the set pick-up value I_D.

The resetting value of the differential current pick-up value is determined, by slowly decreasing the testing AC, until the output relay I_D trips. The LED I_D extinguishes (supposed the respective coding was effected).

Check that the resetting value is greater than 0.97 times the pick up value, i.e. the resetting ratio of the differential current supervision is below 1.

8.3.4 Checking the operating and resetting values (*IRI1-3ER*)

With the *IRI1-3ER*, all analog input signals of the single-phase current must be supplied to the relay via the terminals B1/B2; B3/B4; B5/B6 one after another for checking the pick-up value I_D in similar manner as indicated above in para 8.3.3.

8.4 Primary injection test

Principally, a primary injection test (real-time test) of a c.t. can be carried out in the same way as a secondary injection test. Since the cost and potential hazards may be very high for such tests, they should only be carried out in exceptional cases, if absolutely necessary.

8.5 Maintenance

Maintenance testing is generally done on site at regular intervals.These intervals may vary among users depending on many factors: e.g. type of protective relays employed; type of application; operating safety of the equipment to be protected; the user's past experience with the relay etc.

For static relays such as the *IRI1-ER/-3ER*, maintenance testing once per year is sufficient.

9. Technical Data

9.1 Measuring input

Rated data:

Nominal current I_N	:	1A/5A	
Nominal frequency f_N	:	50/60 Hz	
Power consumption	:	<1 VA/at I_N = 1A	
in current circuit	:	<5 VA/at I_N = 5 A	
Thermal withstand	:	dynamic current withstand (half-wave)	250 x I_N
capability of current	:	for 1 s	100 x I_N
circuit	:	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	:	>97%
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:

	Ohmic	L/R = 4 ms	L/R = 7 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-oxide

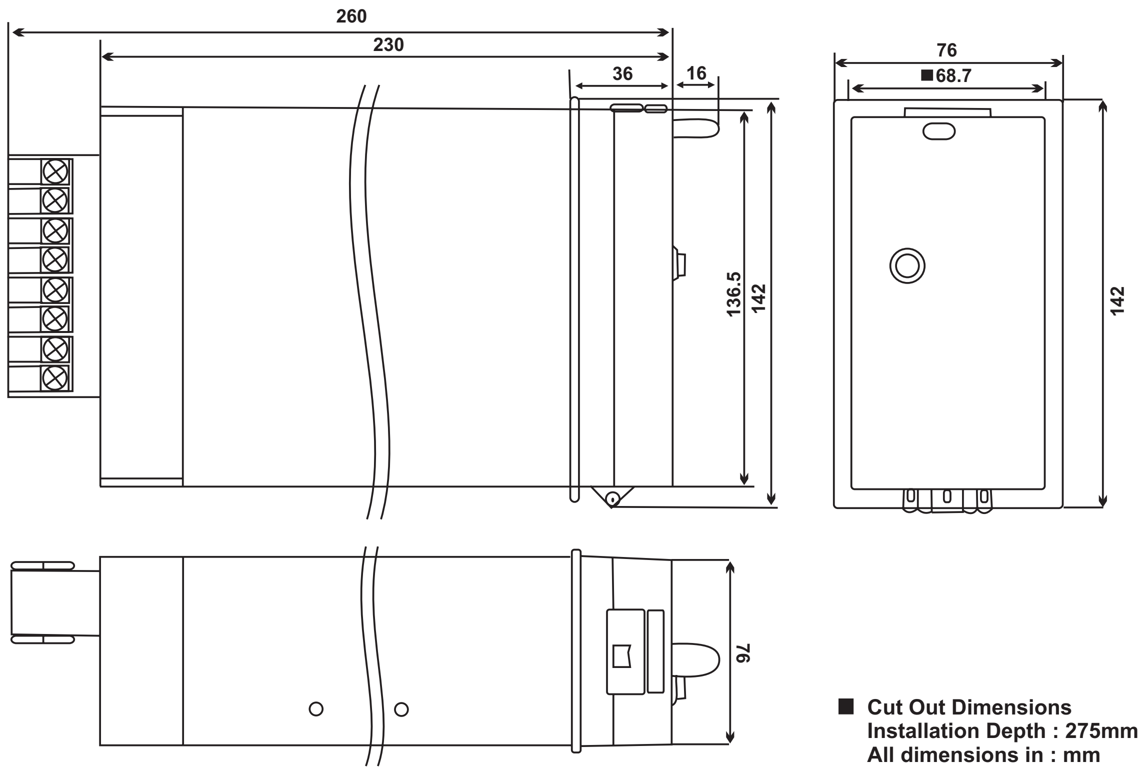
9.5 System data

Design standard	:	VDE 0435, part 303, IEC 255.4, BS 142
Specified ambient service Temperature range: for storage	:	- 40°C to + 85°C
for operating	:	- 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 VDE 0435, part 303 IEC 255-5	:	5 kV; 1.2/50 Hz; 1 min. (except supply voltage inputs)
Impulse test voltage, inputs and outputs between themselves and to the relay frame as per VDE 0435, part 303 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 DIN IEC 255-6	:	2.5 kV / 1MHz
Electrostatic discharge (ESD) test as per DIN VDE 0843, part 2 IEC 801-2	:	8 kV
Electrostatic discharge (ESD) test as per DIN VDE 0843, part 4 IEC 801-4	:	4 kV / 2.5 kHz, 15 ms
Radio interference suppression test as per EN 55011	:	limit value class B
Radio interference field test as per DIN DVE 0843, part 3 IEC 801-4	:	electrical field strength 10 V/m
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
Auxiliary voltage influence	:	no influence within the admissible range

9.6 Setting ranges and steps

Relay type	Parameter	Setting range	Steps	Tolerances
IRI1-ER	I_D	5 % ... 82.5 % x I_N	2.5 %	± 3 % of set value
IRI1-3ER	I_D	5 % ... 82.5 % x I_N	2.5 %	± 3 % of set value

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

Stabilized earth-fault current relay ***IRI1-***

Measuring of earth current	1 phase measuring 3 phase measuring	**1ER** **3ER**
Rated current in the earth-fault phase	1A 5A	**1** **5**
Auxiliary voltage	24 V (16 to 60 V AC/16 to 80 V DC) 110 V (50 to 270 V AC/70 to 360 V DC)	**L** **H**
Housing (12TE)	19" rack Flush mounting	**A** **D**

Technical data subject to change without notice!

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

C&S electric

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