Station
Automation
& Protection

Circulating current relay
Type IRXm

Preliminary information
Data subject to change without notice

ABB Substation Automation Products

Features

- Wide current setting range
- Sensitive high speed protection on internal faults
- Operation largely immune to DC components and harmonics
- Hand reset LED operation indicator
- Single pole static relay of draw-out type design

Application

The IRXm relay can be used for high speed restricted earth fault protection of generators and transformer windings. For the selective detection of faults, current transformers in summation connection are employed with an external stabilizing resistor for high impedance method of measurement.

Description

The relay type IRXm is a high-speed static over current relay which measures one energizing current - the differential current ΔI_0. The relay is suitable for current transformers with secondary rating of both 1A and 5A. The operate time is typically < 25 msec. The measuring inputs of the relay have low impedance. The relay is provided with band-pass filter which suppresses harmonics and DC components of the input current.

A short circuit current often contains a DC component that is larger in one phase than in the other two. In most cases this direct current, having a time constant of, for example 10 to 300 ms, causes the current transformer to become saturated, which means that it is not capable of transforming correctly eighter the AC of the DC component. This results in a high unbalance current with harmonics. The relay would therefore, if no special measures were taken, sense a “fault current” that does not exist on the primary side.

The IRXm relay operates instantaneously, when the differential current ΔI_0 exceeds the set value. The relay operates exclusively on earth-faults inside the area of protection. The area of protection is the area limited by the phase current transformers and the current transformer of the neutral earthing circuit.

The operation of the restricted earth-fault relay exclusively on faults inside the area of protection is based on the fact, that the impedance of a current transformer (CT) decreases as the CT saturates. The reactance of the excitation circuit of a fully saturated CT goes to zero and the impedance is composed purely of the resistance of the winding. Under the influence of the stabilizing resistor in the differential current circuit, the secondary current of a non-saturated CT is forced to flow through the secondary circuit of a saturated CT. Thus, the operation of the relay on faults outside the area of protection is prevented with a stabilizing resistor, which is connected in series with the current transformer of relay, see fig.-1

When an earth-fault appears inside the area of protection, current transformers strive to feed current into the differential current circuit and the protection operates. To keep the resistance of the secondary circuit as low as possible, the summing point of the currents should be located as close to the current transformers as possible.

Current transformer requirements

The sensitivity and reliability of a resistor-stabilized restricted earth-fault protection depends to a great extent on the current transformers to be used. The number of turns of all the current transformers of the same differential circuit must be equal. In the differential protection systems class PS current transformers are used, and the important parameters of the current transformers are the knee-point voltage and the resistance of the secondary circuit. The knee-point voltage is the secondary voltage value, from which a 10% voltage increase causes the excitation current to grow by 50%.

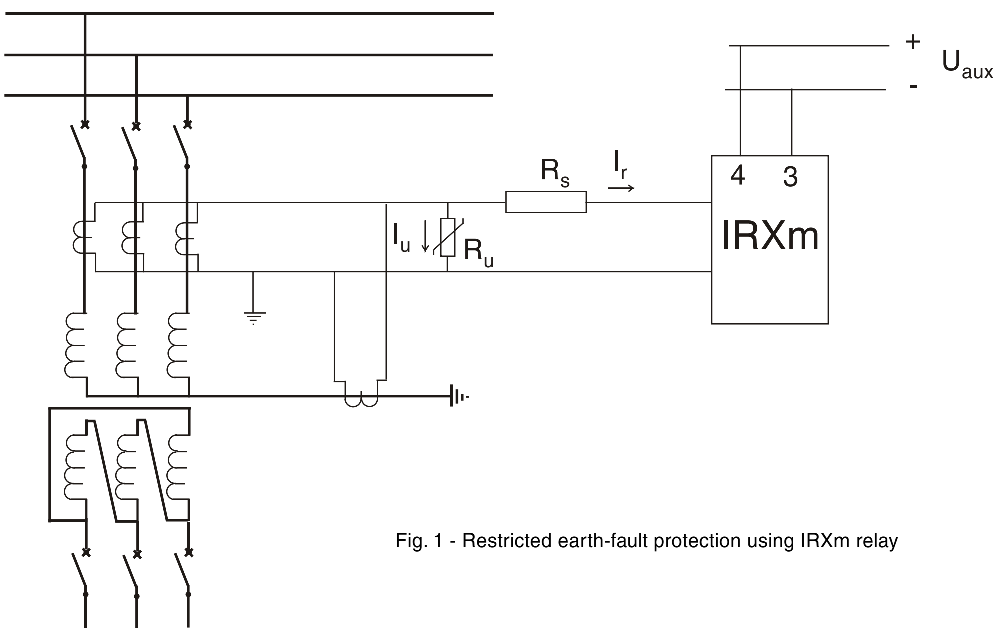


Fig. 1 - Restricted earth-fault protection using IRXm relay

When the sensitivity of the protection is considered, the excitation current of the current transformers and the current through a possible voltage dependent resistor (VDR) must be noted.

The knee-point voltage of the current transformers must be about 2 times the stabilizing voltage to secure a safe operation and a fast operate time of the relay.

It is recommended that current transformers with a secondary resistance same as that of the measuring circuit are used. In this way the knee-point voltage requirements imposed to the current transformer can be kept within reasonable values.

The sensitivity of the protection can be determined with the stabilizing resistor; the higher the selected resistor value the lower a relay setting can be used and the more sensitive a protection is obtained.

During faults inside the zone of protection, the voltage of measuring circuit may grow so high that it can exceed the insulation level of the circuit. This can be avoiding by installing a voltage dependent into the circuit. The voltage dependent resistor must be so selected that the current through the resistor at the stabilizing voltage level is as low as possible.

Three types of voltage dependent resistors are available, see fig.-2.

The calculations for restricted earth-fault protection are performed using an iteration method. First the current transformer are defined and then their suitability for the intended application is checked.

The stabilizing voltage U_s required by the protection in through-fault situations is determined according to the following expression:

$$U_s = \frac{I_{kmax} \times (R_{in} + R_m)}{n}$$

Where,

I_{kmax} = Maximum though-fault current, for which the relay must not operate. If the current is unknown the generator is given the value $I_{kmax} \sim 6 \times I_n$

R_{in} = Resistance of the CT secondary circuit

R_m = Total resistance of the longest measuring circuit, i.e. from the summing point of the current transformer

n = CT Transforming ratio, for example n= 2000/5 = 400

In order to secure a safe operation of the protection at in-zone faults the stabilizing voltage U_s must not exceed half the value of the knee-point voltage U_k of the current transformers.

The excitation current I_e corresponding to the stabilizing voltage U_s is determined either from the excitation curves provided by the CT manufacturer or by assuming a linear excitation curve for voltage values below the knee-point voltage.

The value of the stabilizing resistor can be calculated from the expression:

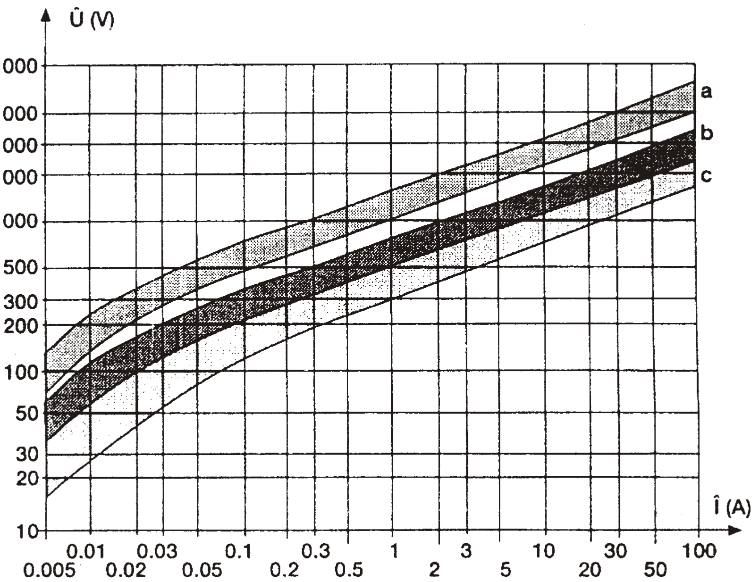
$$Rs = \frac{Us}{I_r}$$

The start current Ir can be changed, if needed, with corresponding change in the value of R_s. It is recommended that the start current I_r is greater than the sum of the excitation currents of the CTs. That is, the start current is to be $I_r \geq m \times I_e$, where m is the number of CTs in the differential current circuit.

The primary current value corresponding to the start current I_r is obtained from the expression:

$$I_{prim} = n \times (I_r + m \times I_e + I_u)$$

I_u = Current through the VDR at U_s
See fig2.



b = resistor 1MRK002059-B

Fig. 2 - Characteristics of the voltage dependent resistor

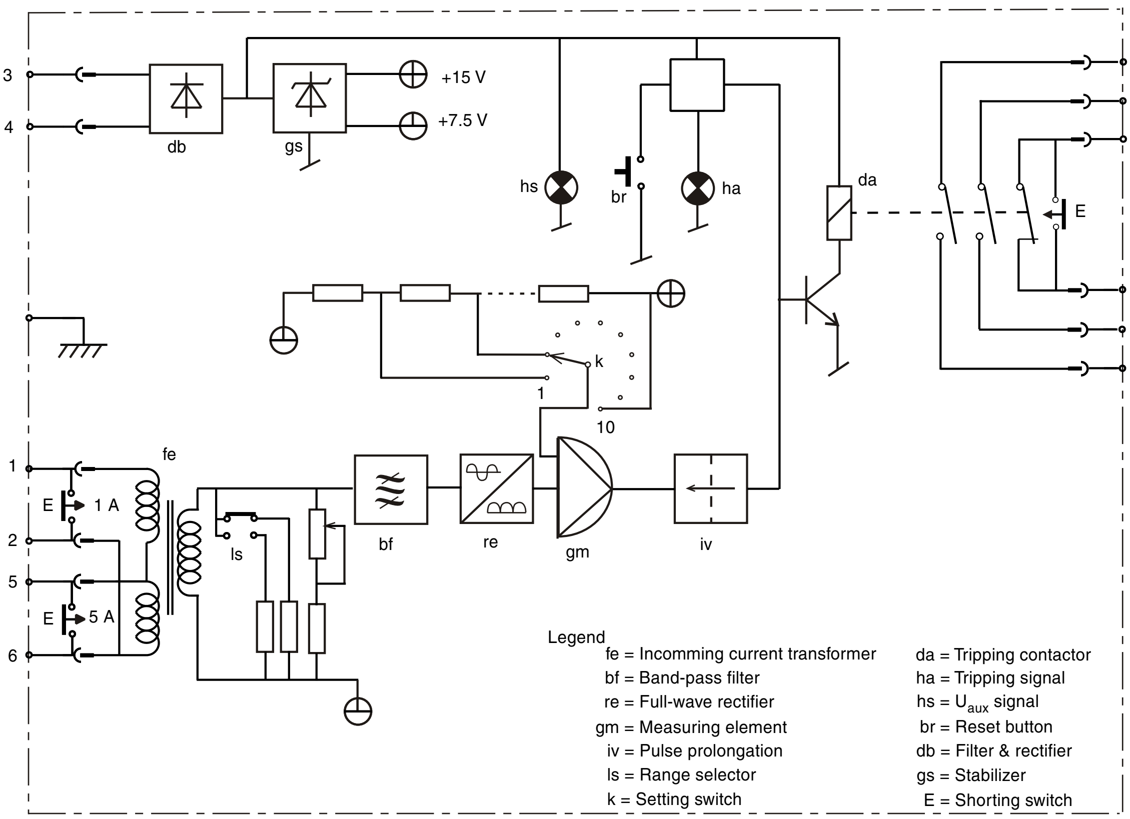


Fig. 3 - Block schematic diagram of IRXm relay

Setting example

ΔI_0	Setting switch (k) position	Range selector (I_s) position	Input terminal
20 mA	4	0.5%	1 - 2 (I_n = 1A)
1.25 A	5	5.0%	5 - 6 (I_n = 5A)

The range selector (I_s) position (5% or 0.5%) may be marked on the space provided on front plate during commissioning.

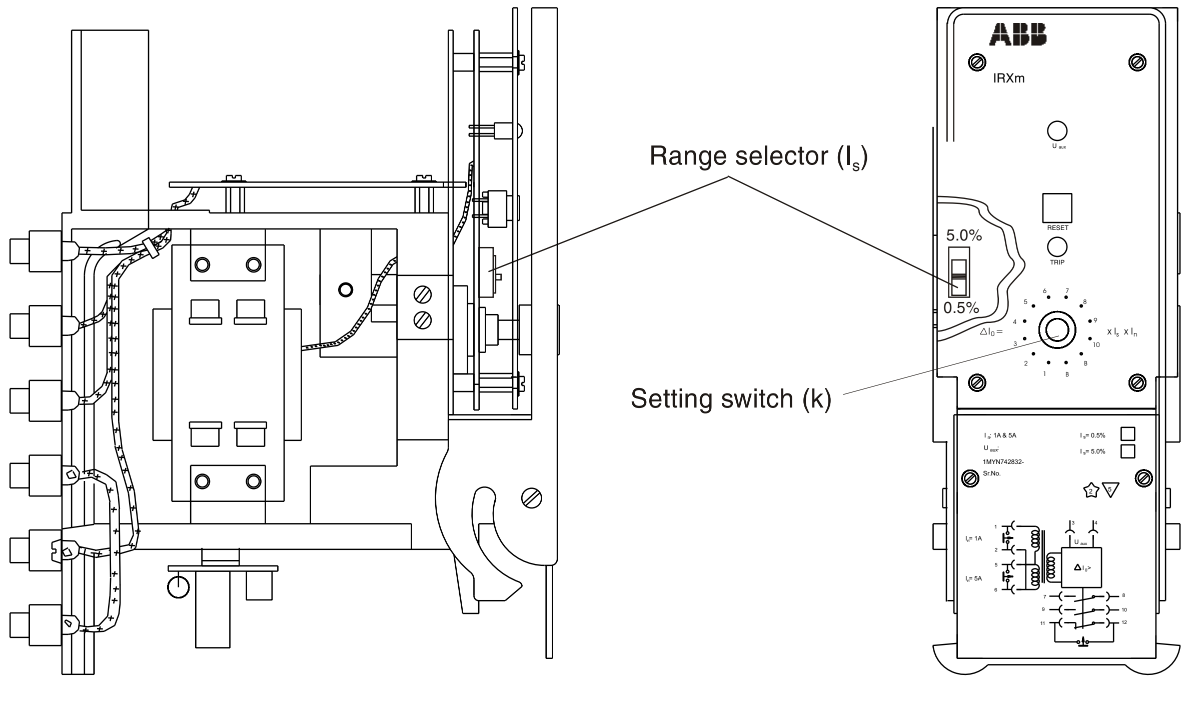


Fig. 4 - Draw-out module

Technical data

Energizing quantities, rated values and limits

Energizing inputs			
Rated current I_n	:	1 A	5 A
Thermal withstand value			
- Continuous	:	4 A	20 A
- for 1 sec.	:	100 A	500 A
Dynamic withstand half wave value	:	250 A	1250 A
Input circuit impedance	:	< 100 m	< 20 m

Rated frequency fn	:	50 Hz				
Power supply						
Operating range	:	+10% to -20% of rated voltage				
Rated voltage	:	24	30	48	110-125	220-250
Power consumption (W)	:	1.1	1.5	1.6	4.1	5.3

Setting range	:	0.5%........5.0% in ten equal steps.
	:	5.0%......50.0% in ten equal steps.
Operation accuracy	:	+/- 5.0% of set value or +/- 1 mA
Operating time	:	< 25 ms.
Mechanical durability	:	1 Million switching operations 200 Draw-out operations
Terminals	:	Suitable for M5 ring type lug
Weight	:	3 Kg

Contact data

Contact configuration (self reset)	:	2 N/O +1 N/C
Max voltage within a contact system	:	250 V dc / ac
Rated current	:	5 A.
Make and carry for 0.5 s	:	10 A
Make and carry for 3.0 s	:	8 A
Breaking capacity for dc with circuit time-constant L/R $\leq$ 40 ms, at 48/110/220 Vdc	:	1A/0.25A/0.15A
Electrical endurance tested according to IEC 255-23	:	10,000 operations, at 110 V dc, 0.35A resistive, 360 op/hr

Electrical tests

Temperature-rise; Tested acc. to IEC 255-6	:	Enclosure, pcb relays, heat dissipating components
Insulation resistance; Tested acc. to IEC 255-5	:	>100 M Ohm at 500 V dc
Dielectric; Tested acc. to IEC 255-5	:	2,0 kV, 50 Hz, 1 min
Impulse; Tested acc. to IEC 255-5	:	5 kV, 1,2/50us, 0,5J
1 MHz burst disturbance test acc. to IEC 255-22-1	:	Class III
- common mode	:	2,5 kV, 1 MHz, 400 pls/s
- differential mode	:	1 kV, 1 MHz, 400 pls/s
Electrostatic discharge test acc. to IEC 255-22-2	:	Class III
- contact discharge	:	6 kV, 150 pF/330 ohm
- air discharge	:	8 kV, 150 pF/330 ohm
Fast transient disturbance test acc. to IEC 255-22-4	:	Class IV
- common mode	:	4 kV, 5/50 ns, 5kHz, Rs = 50 ohm
Surge immunity test acc. to IEC 255-22-5		Class III
- common mode	:	2 kV, 1,2/50 us, Rs = 10 ohm
- differential mode	:	1 kV, 1,2/50 us, Rs = 2 ohm

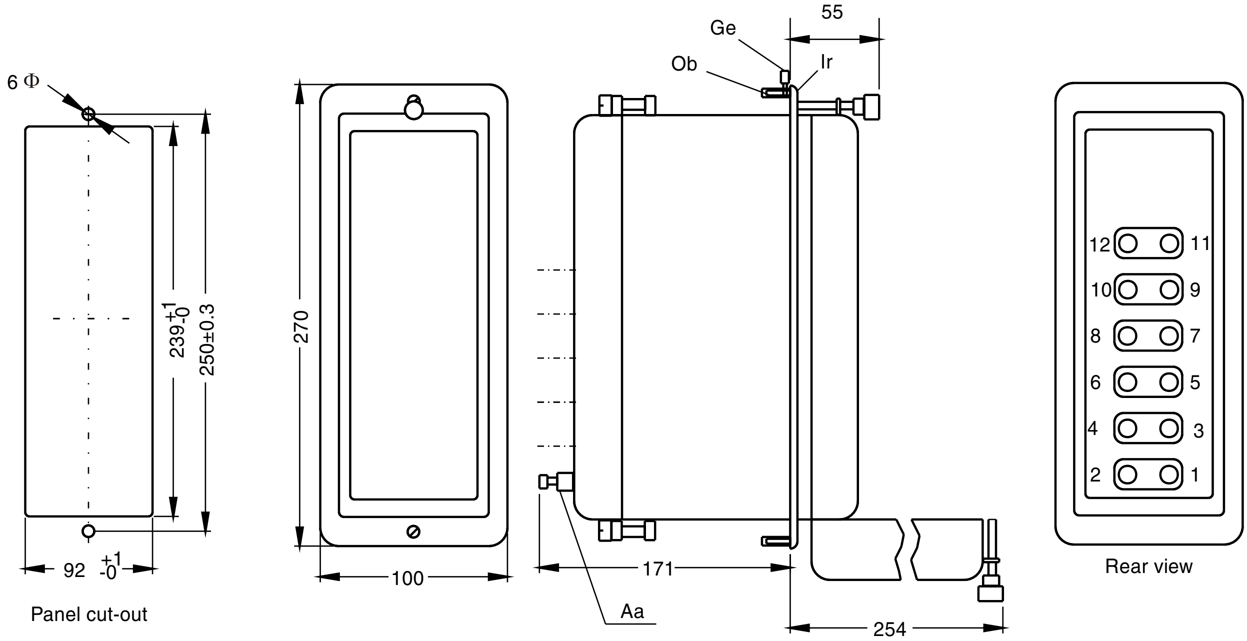
Environmental tests

Vibration response and endurance		
Tested acc. to IEC 255-21-1	:	Class I, 10......150Hz
Shock response and endurance		
Tested acc. to IEC 255-21-2	:	Class I, 11 ms
Dry heat; test acc. to IEC 68-22-2	:	+55° C /+70° C
Dry cold; test acc. to IEC 68-2-1	:	-10° C / -25° C
Damp heat (cyclic - 12+12 Hr) test acc. to IEC 68-2-30	:	12 Hr/55° C + 12 Hr/25° C x 6 days at 95% RH

Ordering details:

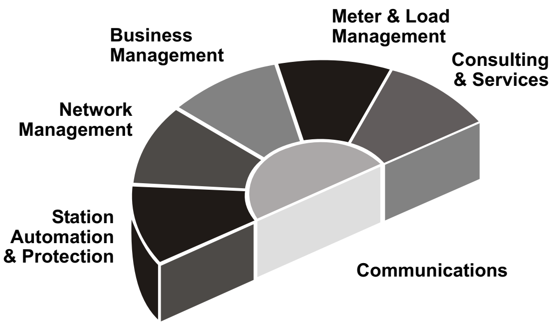
Relay type	Contact	Rate voltage	Article no
IRXm	2N/O+1N/C	24	1MYN742832-A
		30	1MYN742832-B
		48	1MYN742832-C
		110-125	1MYN742832-E
		220-250	1MYN742832-G
Stabilizing resistor.		680 Ohm / 100 W	INMR-430131-P536
Voltage Dependent Resistor (optional)			1MRK002059-B

Dimensions



Legend:
Aa : Terminals M5
Ir : Mounting frame
Ge : Earthing lug
Ob : Fixing screw

Fig. 5 - Dimensions for mounting



Panorama is the standard for a comprehensive range of integrated solutions for efficient and reliable management of power networks. Using innovative information technology, Panorama delivers total control of the power process, from generation to consumption. The Panorama standard covers six application areas, each offering specific solutions.

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