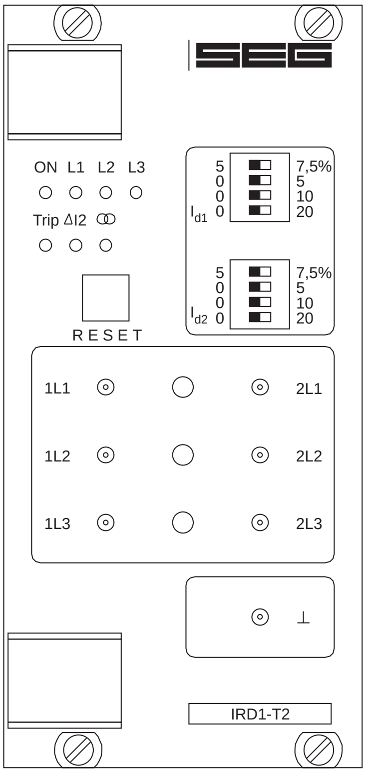
IRD1-T2 - Transformer differential protection relay



Contents

1. Summary

The application of powerful microprocessors 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 analog 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 microprocessor-based protective relays and their introduction into the market are stimulated by the trend nowadays to replace analog with digital protective equipment.

The superiority of digital protective relays to the traditional systems is enhanced by *MR* and *IR* relay family which have 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 fine setting steps
- User-friendly setting procedure by means of DIP-switches
- Operation reliability due to continuous self-supervision

All *MR* protection relays are based on microprocessor technics, whereas some of the *IR* relays are in analog design. Relay of the *IR* series are very suitable for all basic protection applications and have a clear price advantage over relays of the *MR* series. For all applicati-ons of a more complex nature, e.g. directional earth fault recognition and where convenience, fault analysis and communication ability is required, *MR* relays are used.

All relays of the *HIGH TECH LINE* are available for through panel mounting and 19" rack mounting. Connection terminals are of plug-in type.

2. Application

Power transformers are classified as one of the most valuable equipments in a power system, hence their protection is of very high importance. The transformer differential protection provides fast tripping in case of a fault - before severe damage arises.

The *IRD1-T2* relay is a strict selective object protection for two-winding transformers. Within a very short time this relay detects faults occuring within the zone to be protected and which require immediate tripping and isolation of the transformer. Such faults are:

- short circuits between turns, windings and cables inside the transformer housing
- earth faults inside the housing
- short circuits and earth faults outside the housing but within the protected zone (e.g. at bushings or supply lines).

The *IRD1-T2* is also able to detect other operational conditions (e.g. faults outside the protected zone, circuit closing etc.) i.e. it does not issue tripping commands for faults or any other transient phenomena outside the protected zone.

Additional to the transformer differential protection an overcurrent relay as backup protection is recommended. For this application we offer the relays *MRI1* or *IRI1*.

3. Characteristics

- Static protection relay
- Very low C.T. burden
- Adjustment to transformation ratio and connection groups without external interposing C.T.s
- Dual slope characteristic
- Galvanic isolation between all independent inputs
- Additional printed circuits "Saturation Detection" can be retrofitted at a later time
- Self-supervision of stabilization circuits
- Wide setting ranges
- Wide-ranging supply voltage (AC/DC)

4. Design

4.1 Connections

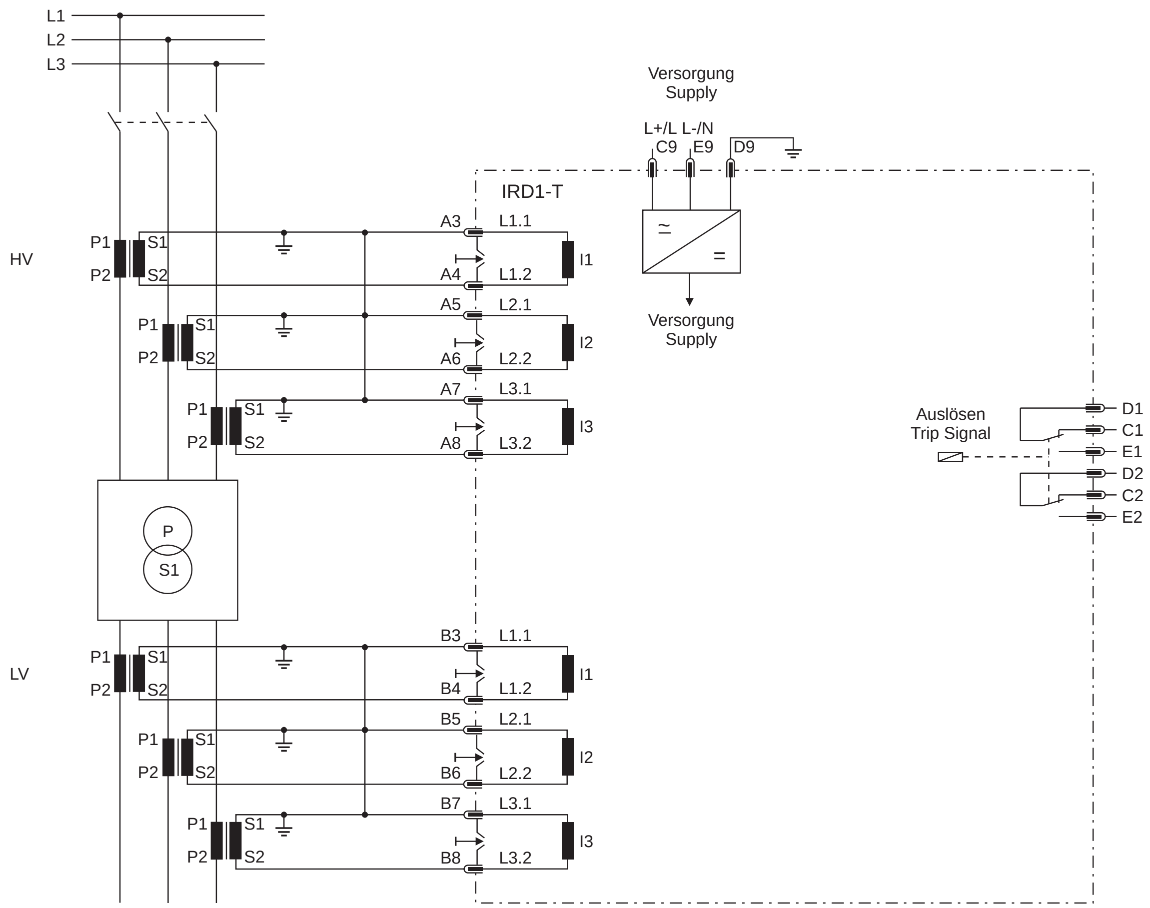


Fig. 4.1: Connection diagram IRD1-T2

4.1.1 Current measuring inputs

The analog secondary currents of the HV side are fed to the protection relay via terminals A3 - A8 and the secondary currents of the LV side via terminals B3 - B8.

4.1.2 Output relay

The *IRD1-T2* is provided with a tripping relay with two changeover contacts:

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

4.2 Front plate

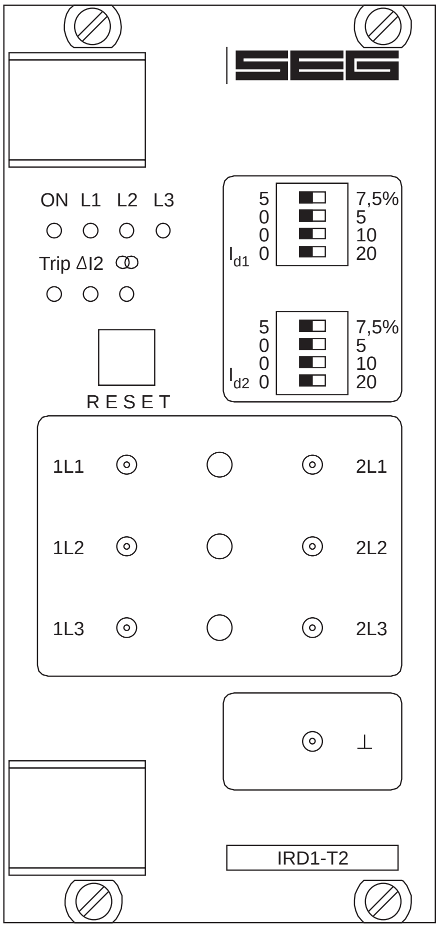


Fig. 4.2: Front plate

At the front of the relay *IRD1-T2* the following operating and indicating elements are arranged:

- 2 DIP-switches for the set values of the normal tripping characteristic
- 7 LEDs for indicating faults and readiness to operate
- 1 RESET push button
- 7 connecting sockets for fine adjustment of C.T.s and service measurements
- 3 potentiometers for balancing the interposing C.T. current transformer

4.2.1 LEDs

There are 7 LEDs on the front plate of the *IRD1-T2*.
LED "ON" indicates that the relay is in service. LEDs L1, L2, L3 and "TRIP" are fault indications. With LED ꝏ stabilization against magnetizing inrush is indicated. When changing over to coarse tripping characteristic, LED ΔI2 lights up (with extended version SAT only).

4.2.2 DIP-switches

The two DIP-switches at the front are for adjusting the tripping values (see 9.6 Tripping Characteristic).

4.2.3 RESET push button

The push button <RESET> is normally used to acknowledge and reset the TRIP LED (E-relay type). For SP-relay type the push button <RESET> is used to acknowledge and reset the TRIP LED and the trip relay after a tripping.

5. Working Principle

5.1 Operating principle of the differential protection

The fundamental operating principle of transformer differential protection is based on comparison of the transformer primary and secondary winding currents. For an ideal transformer, having a 1:1 ratio and neglecting magnetizing current, the currents entering and leaving the transformer must be equal.

During normal operation or when a short circuit has occured outside the protected zone, the C.T. secondary currents in the differential circuit neutralize each other. In case that a differential current I_d occurs, a fault in the transformer is detected.

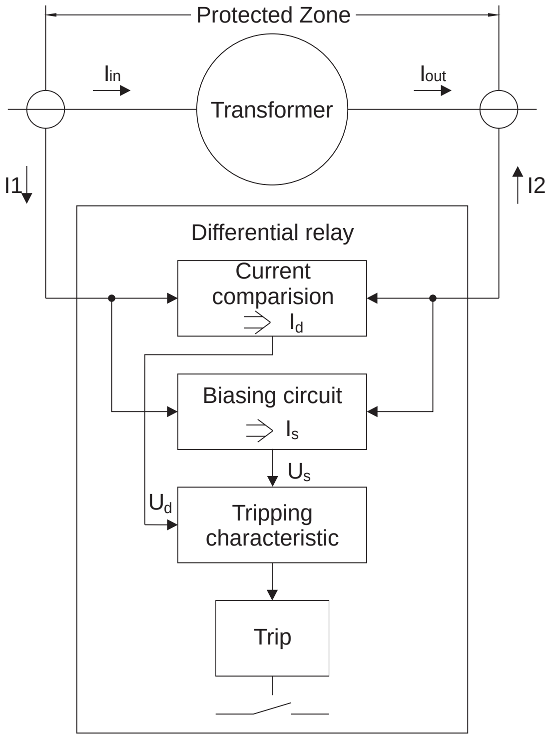


Fig. 5.1: General arrangement of differential protection:
I_d = differential (tripping) current
I_s = stabilizing current

Because of different problems, however, in practice measures for adaption and stabilization have to be taken to ensure trouble-free function of the transformer differential protection:

- due to possible mismatch of ratios among different current transformers
- Phase differences between primary and secondary side, caused by transformer vector groups, have to be duly considered
- Switching operations in the grid have to be recognized as such
- Inrush currents of the transformer must not result in maloperation.

5.2 Balancing of phases and current amplitudes

First of all the phase difference between primary and secondary side, which is caused by transformer vector groups, has to be compensated and the current amplitudes to be balanced. Unlike most other differential protection relays available, this scheme includes interposing C.T.s integrated in the differential relay, extra interposing C.T.s are not required.

Connection of interposing C.T.s is dependent on the vector group of the power transformer. For instance, for transformers with star (Y) windings the interposing C.T.s are connected in delta (Δ) to reject residual currents (i.e. currents flowing to the transformer due to an earth fault outside the protected zone and which would produce a differential current I_d) and to prevent maloperation of the differential protection.

5.3 Transformer regulation steps

The *IRD1-T2* can universally be used i.e. also for regulating transformers with an adjustable transformation ratio to stabilize voltage fluctuations of the supplying systems. Since, however, as a result of vector group balance and transformation ratio balance the differential protection is adjusted to the nominal transformation ratio of the transformer, an apparent differential current I_d arises proportionally to the flowing load current. Maloperation of the protection is prevented by the load-proportional stabilizing current I_S.

5.4 Working principle of the C.T. saturation detector SAT

With many transformer differential protection systems, relay instability may occur on heavy through faults if the main current transformers saturate. In the transient condition of saturation the C.T.s on both ends of the protected zones do not produce the correct secondary current according to the primary current. The differential relay measures a differential current on the secondary C.T. side which is not present on the primary side. Hence a nuisance tripping might occure.

Such transient phenomenons causing C.T. saturation may occur due to:
- Heavy through faults (external short circuit)
- Starting of big motors
- Magnetizing inrush currents of transformers
- Internal faults

The figure 5.2 explains the saturation of the C.T. core due to a short circuit current. In the instant of a short circuit often a DC-component is present in the current. The high primary current induces a flux in the C.T. core, reaching the saturation level. The iron-core retains the high flux level even after the primary current falls to zero. In the time periods of saturation the C.T. does not transform the primary current to the secondary side but the secondary current equals zero.

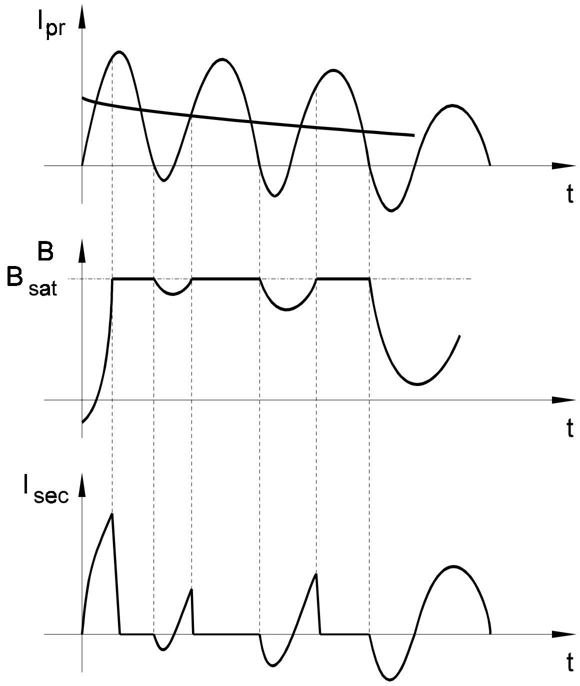


Fig. 5.2: Current transformer saturation
a) Primary current with DC offset
b) Core flux density
c) Secondary current

Dissimilar saturation in any differential scheme will produce operating current.

Figure 5.3 shows the differential measurement on the example of extremely dissimilar saturation of C.T.s in a differential scheme. Fig. 5.3a shows the secondary current due to C.T. saturation during an transformer fault (internal fault). The differential current i_d represents the fault current. The differential relay must trip instantanously.

Fig. 5.3b shows the two secondary currents in the instant of an heavy external fault, with current i_1 supposed to C.T. saturation, current i_2 without C.T. saturation.
The differential current i_d represents the measured differential current, which is an operating current. As this differential current is caused by an external fault and dissimilar saturation of the two C.T.s, the differential relay should not trip.

Fig. 5.3 Current comparison with C.T.s saturated by DC offset in fault current wave from
5.3a: Internal fault,
Single end fed: i_1 = secondary output current from saturated C.T. (theroretical)
i_2 = 0; Internal fault fed from side 1 only.
i_d = measured differential current
5.3b: External fault: i_1 as in fig. 3a for an internal fault.
i_2 normal current from C.T. secondary on side 2.
The wave forms for the differential current Id for internal and external faults are seen to be different for the two cases considered.

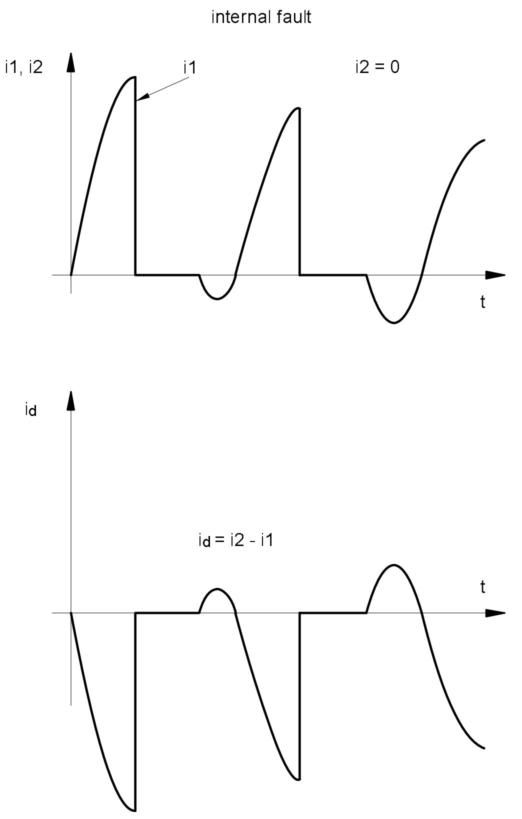


Fig. 5.3a: Internal fault

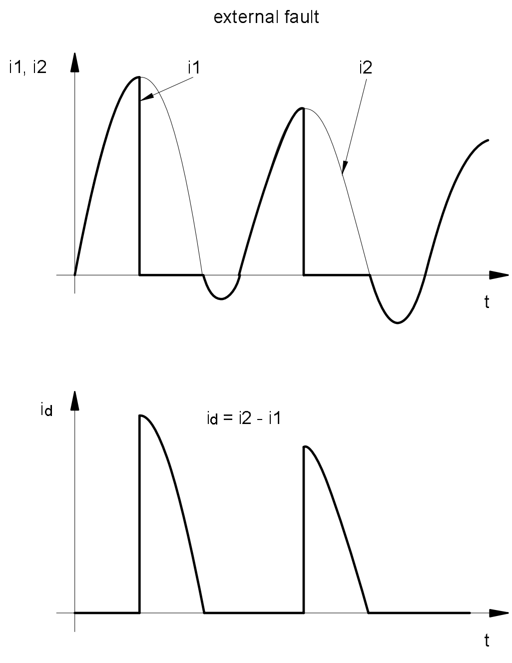


Fig 5.3b: External fault

The saturation detector **SAT** analyses the differential current of each phase separately. The SAT module differentiates the differential current and detects:

- Rate of change of differential current $d(i_d)/dt$
- Sign of $d(i_d)/dt$
- Internal / external fault
- Time period of saturation, within one cycle
- DC or AC saturation

The instant of an extreme rate of change of differential current $d(i_d)/dt$ clearly marks the begin of a C.T. saturation.
The sign of this $d(i_d)/dt$ value distinguishes the internal fault from an external fault.
One detected extreme $d(i_d)/dt$ value per cycle indicates a saturation due to DC-current contents.
Whereas two extreme $d(i_d)/dt$ values per cycle indicate a C.T. saturation caused by a high alternating current.

The logic control evaluating above informations derives:

- Only external faults lead to blocking of the trip circuit.
- In case of detected DC-current saturation the differential current measurement is blocked completely until:the transient condition ends, or an internal fault is detected (instantanously), or AC-current saturation is detected.
- In case of detected AC-current saturation only the time periods of saturation are blocked during one cycle. This means that even under severe saturation the differential relay evaluates the differential current in „sound" time periods. This is a major advantage to relays solely applying harmonic filters for saturation detecting.
- All detected transient phenomenons change the tripping characteristic to the "coarse tripping characteristic" (pl. ref. to Technical Data).

This logic control circuit provides a continuous self diagnostic, limiting any blocking function to maximum of 1.7 seconds.

This approach has several advantages. For example, if a C.T. saturated as a result of an external fault, the relay remains stable because the measuring system recognizes the differential current is due to C.T. saturation arising from a fault outside the protected zone. However, if an internal fault occurs, this is immediately recognized, blocking is overridden and the relay trips immediately.

Similarly, if a fault occurs during magnetizing inrush of a transformer this is immediately detected and the differential relay operates correctly tripping the transformer.

Please refer to block diagram, fig. 5.4, para. 5.6.

5.5 Transformer inrush

When a transformer is first energized, a transient inrush current flows. This inrush current occurs only in the energized winding and has no equivalent on the other side of the transformer. The full amount of inrush current appears as differential current and would cause the differential relay to trip if there is no stabilisation against the inrush phenomenon.
Typically the inrush current contains three components that distinguish it from other fault currents:

The DC-component:
The DC-component is present at least in one phase of the inrush current, depending on the instant of energizing.

The second harmonic:
The second harmonic is present in all inrush currents due to uni-directional flux in the transformer core.

The fifth harmonic:
The fifth harmonic is present when the transformer is subjected to a temporary overvoltage.

The filter module "SAT" detects not only C.T. saturation due to external faults but also the inrush current of the transformer to be protected.

The differential current id of each phase is analysed separately. The signal of id passes a filter arrangement detecting transient conditions due to the DC-component, the second harmonic and the fifth harmonic.

Thus all three components are used for detecting an inrush current. The limits for blocking of the differential protection are:

DC-component:	20%...60% of i_d
2nd harmonic:	20%...50% of i_d
5th harmonic:	10%...25% of i_d

The restraining influence, resp. the blocking depends on the combination of the three components. If only a single component is present, the highest value applies. If a mixture of all three components is present, the lowest values apply.
With this combined measurement of the three restraining components *IRD1-T2* achieves:

Reliable inrush stabilisation
Fast tripping if the incoming transformer is defective
restraining feature against C.T.-saturation.

Whereas a complete blocking of the protection is only performed during the first energizing of the transformer, the harmonic content supervision **restrains** during normal operation against phenomenons like C.T. saturation. This means that internal faults will be detected instantaneously (ms range), whereas external faults do not cause tripping.

The inrush blocking is stopped when:

- The differential current falls below the tripping characteristic, or
- the differential current shows an internal fault, according to the harmonic content, or
- the differential current exceeds 15 x nominal current, or
- a fixed period of time has elapsed.

The basic relay version without module "SAT" does not provide the harmonic restrain feature.
For applications on bigger transformers or for generator-transformer protection we recommend the use of module "SAT".

5.6 Block diagram

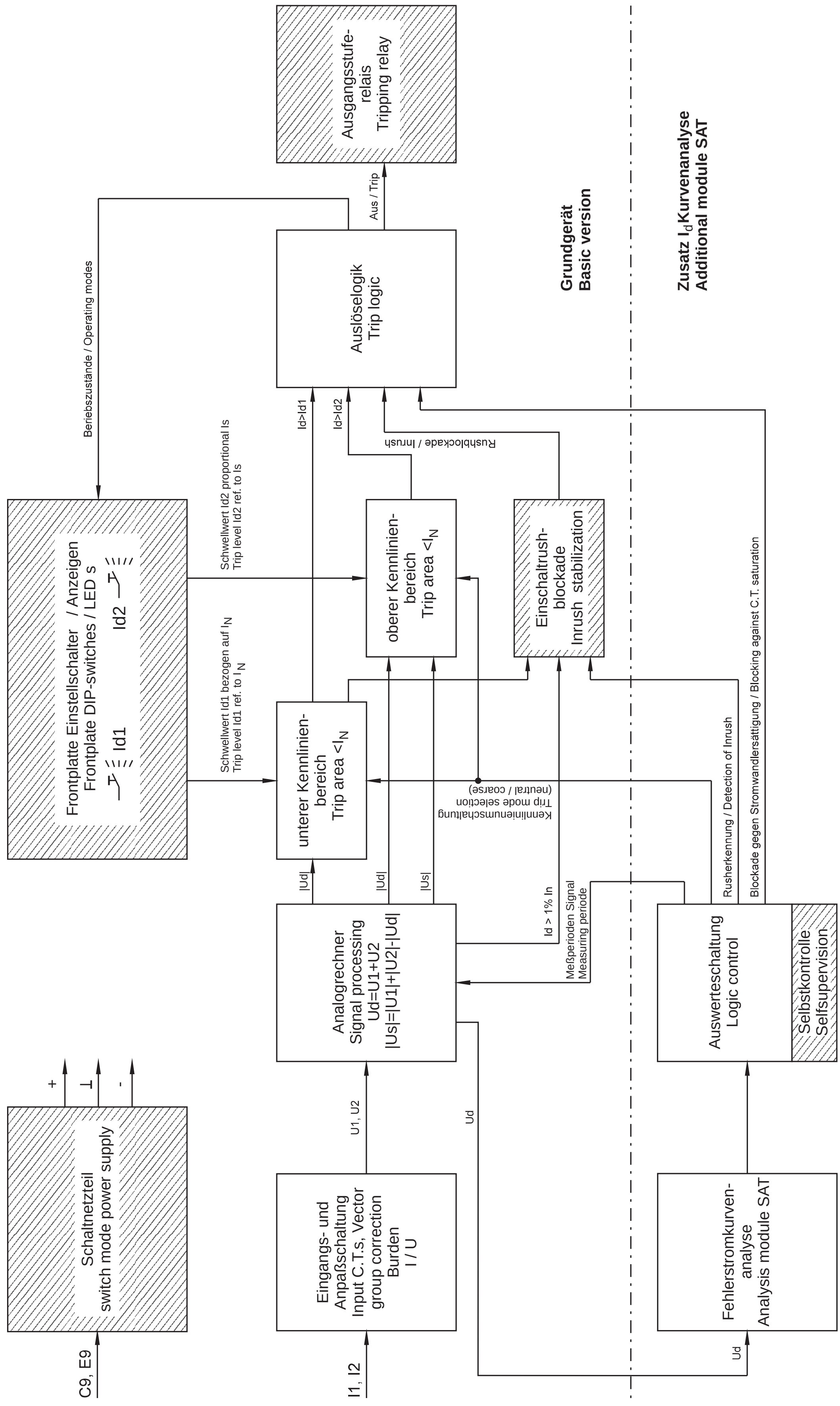


Figure 5.4: Signal structure of the differential relay in a logic diagram.

6. Operation and Settings

The basic relay version without SAT provides two DIP-switches for the adjustment of the tripping characteristic:

I_{d1} represents the setting for the tripping area below nominal current. The I_{d1} setting relates to the nominal current of the relay and is independent of the through current.

I_{d2} represents the setting for the tripping area above nominal current. The I_{d2} setting relates to the "stabilizing current Is". Whereas Is is the current flowing through the protected zone. This biasing area is important for external faults. The higher the current due to an external fault, the higher is the biasing influence.
On through faults, large differential currents may be produced by the transformer tap changer or due to mismatching of the current transformers. The biased slope characteristic prevents incorrent operation of the relay under these conditions.

With the additional module SAT the tripping characteristic changes to "coarse" in case of detected transient phenomenons, as explained above. The fixed tripping values for the coarse measurement are:

I_{d1} = 100 % I_N
I_{d2} = 60 % Is

6.1 Setting recommendations

The tripping characteristic should be selected according to the known mismatch of the secondary currents fed to the relay plus a safety margin of 10 to 15 %. This setting avoids maloperation caused by normal load conditions.
Mismatch of the currents may be produced by:

- Ratio error and phase shifting of the C.T.s. E.g.: For protection C.T.s of 10P20 rating the ratio error at nominal current is 3 %. At 20 times nominal current the ratio error reaches 10 %.
- Load tap changer (LTC). The automatic LTC may vary the ratio of the protected transformer as much as +/- 10%. This causes a current mismatch of the same amount.
- The ratio mismatch caused by the transformer ratio should be compensated by the internal matching C.T.s and the burden adjustment.

Considering the example above, both settings I_{d1} and I_{d2} should be set to:

3% + 3% for C.T. errors
10% for LTC range
15% safety margin

Arrives to a setting of 31%. The nearest possible setting is 30%. Hence both DIP-switches should be set to 30%. The pictures below show the DIP-switch setting as well as the actual tripping characteristic.

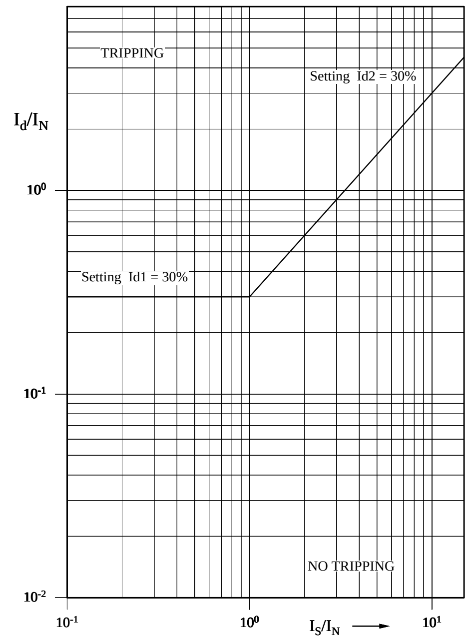


Fig. 6.1: Characteristic example

For this DIP-switches for I_{d1} and I_{d2} have to be in the following positions:

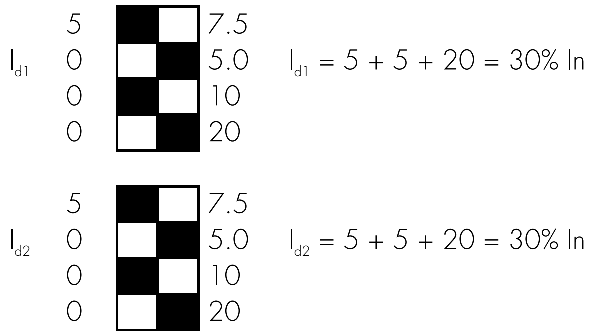


Fig. 6.2: DIP-switches

6.2 Reset

6.2.1 Manual Reset

By pressing the RESET push-button, the trip relay is reset and the LED indication extinguishes.

6.2.2 Automatic Reset

As soon as the circuit breaker is switched on and current flows again after a tripping condition, the trip relay as well as the existing LED indication are reset automatically.

7. Housing

The *IRD1-T2* 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 *IRD1-T2* is constructed for flush-mounting. The dimensions of the mounting frame correspond to the requirements of DIN 43700 (72 - 144 mm). The cut-out for panel mounting is 68 x 138 mm.

The front plate of the *IRD1-T2* 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 *IRD1-T2* is in general suitable for installation in a modular carrier according to DIN 41494. The installation dimensions are: 12TE; 3HE.

According to requirements, the *IRD1-T2* 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 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 *IRD1-T2* module can be unplugged even with current flowing, without endangering the current transformers connected.

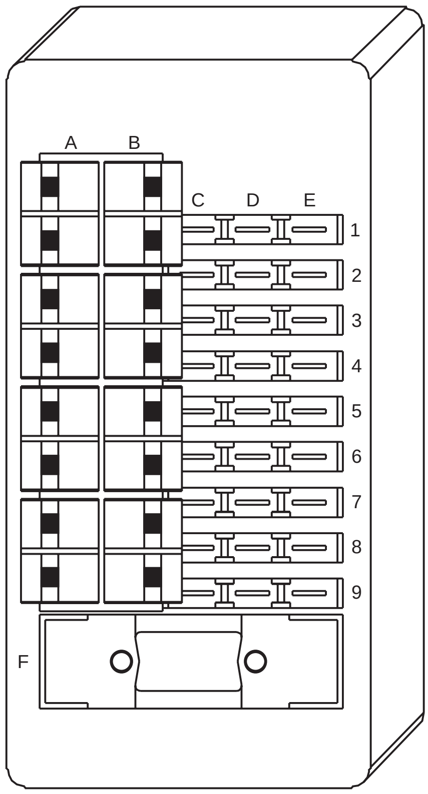


Fig. 7.1: Terminal block

8. Relay testing and commissioning

Correct connection of primary and secondary side of the C.T.s as well as the correct connection and adjustment of the internal matching C.T.s are the condition for a perfect service of the differential relay. Therefore please observe:

The order form should be filled with great care. The transformer differential relay will be pread justed at SEG according to the order form. When taking the relay into service the commis sioning checks explained below should be followed.

The test instructions following below 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 correspond to the plant data on site.
- the current transformer circuits are connected to the relay correctly. Please pay special attention also to the primary connections of the C.T.s.
- the 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.
When the auxiliary supply is switched on please observe that the LED "ON" is alight.

8.2 Secondary injection test

- Test equipment:
- One adjustable current source up to two times nominal current of the relay
- Ampere meter with class 1
- Auxiliary supply source corresponding with the rated supply range
- Power diode (10 A)
- Switching device
- Test leads and tools

NOTE! Before conducting secondary tests, assure that the relay does not cause unwanted tripping (danger of blackouts).

8.2.1 Trip level Id1

Inject a current into each current input according to the test circuit below and check the current value at which a trip occures. The tripping values should correspond to:

- For the relay side connected to the star-side of the transformer: 1.73 times the setting of I_{d1}.
- For the relay side connected to the delta side of the transformer: 1.0 times the setting of I_{d2}.

The difference of tripping levels is explained by the internal matching C.T.s. The star-side matching C.T.s are internally connected in delta and transform the current to a value 0.58 times the input current.
The delta side matching C.T.s are internally connected in star. Hence the transformation ratio is 1.

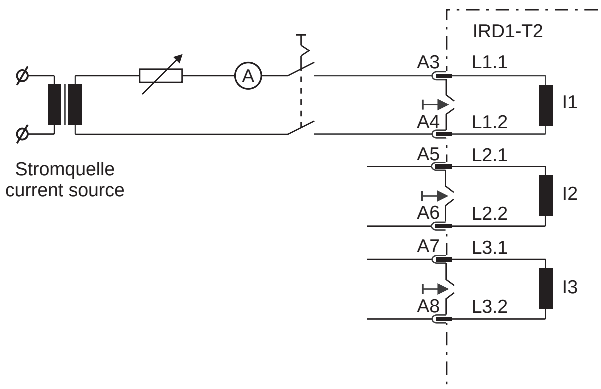


Fig. 8.1: Trip level test circuit

8.2.2 Inrush blocking

The inrush blocking may be tested with a simple test circuit, shown below:

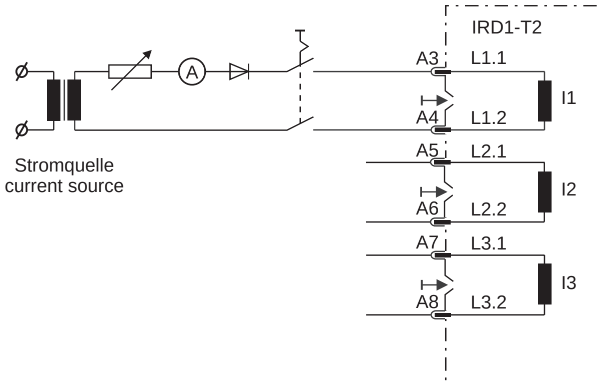


Fig. 8.2: Inrush blocking test circuit

Adjust the input current to app. 1.5 times nominal current. Switch off the current.
Switch the current on with the same adjustment. Observe that the inrush blocking LED lights up and no trip occurs. Observe that after 3.5 s the LED ↀ extinguishes and a trip occurs. This is caused by the maximum blocking time supervision. Switch the current off. If saturation detector SAT is used the maximum blocking time is reduced to 1.7 s.

8.3 Primary test

The test of the correct connection of the main C.T.s and the correct matching of the internal measuring values can only be done with the transformer in service. A minimum load of app. 50 % of the transformer load is recommended to avoid malinterpretation of measuring values. At low currents the magnetizing current of the transformer has a high influence on the test results. Make sure that the trip circuit of the differential relay is blocked and cannot cause unwanted tripping. On the other hand a backup protection, like an overcurrent relay, must protect the transformer in cause of failures!

8.3.1 Phase and ratio check

The *IRD1-T2* provides sockets for test leads on the front of the relay:

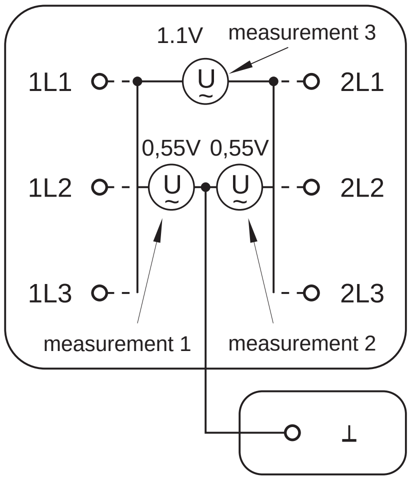


Fig. 8.3: Test sockets on the front plate

Connect lead 1 to	Connect lead 2 to	Reading at nominal current on the transformer star side	Reading at nominal current on the transformer delta side
1L1	⊥	550 mV	550 mV
2L1	⊥	550 mV	550 mV
1L2	⊥	550 mV	550 mV
2L2	⊥	550 mV	550 mV
1L3	⊥	550 mV	550 mV
2L3	⊥	550 mV	550 mV
1L1	2L1	1100 mV	1100 mV
1L2	2L2	1100 mV	1100 mV
1L3	2L3	1100 mV	1100 mV

Table 8.1: Measuring values for phase and ratio check

The internal measuring voltages proportional to the input currents may be measured as follows. The measuring instrument should be a digital multimeter set to AC-voltage measurement, range 2.0 V.

The readings stated below refer to nominal current of the transformer (refering to the order form). Any current value below may be calculated proportionally. Please also note that due to the C.T. errors and the transformer magnetizing current the measured values might deviate up to 10% from the theoretical values. The columns star and delta side are stated both. The appropriate column must be selected according to the actual connection.

Nominal load current of the transformer is generally transformed to the internal measuring voltage of 550 mV AC. Both amplitudes of the measuring voltages of one phase, e.g. 1L1 and 1L2, should be equal.The phase angle of the voltages of one phase, e.g. 1L1 and 1L2, must be 180 degrees. A slight deviation might be caused by the magnetizing current of the transformer.
In most cases a wrong connection of the C.T.s is the reason for maloperation of the differential protection. If all connections are correct and the internal measuring value still shows deviations from the expected values, please check if the transformer group given on the type plate corresponds to the transformer vector group.
If the single ended measurements (e.g. 1L1 - ⊥) differ within one phase, e.g.:
1L1 - ⊥: 400 mV
2L1 - ⊥: 600 mV
1L1 - 2L1: 1000 mV
but the differential measurement equals the sum of both the deviation may be balanced using the concerned potentiometer on the front plate.

a)	Measuring 1 (1L1 - 0) Measuring 2 (2L1 - 0) Measuring 3 (1L1 - 2L1)	550 mV 550 mV 1100 mV	Correct connection
b)	Measuring 1 (1L1 - 0) Measuring 2 (2L1 - 0) Measuring 3 (1L1 - 2L1)	550 mV 550 mV 0 mV	Current flow of a C.T. (S1 and S2) is reversed)
c)	Measuring 1 (1L1 - 0) Measuring 2 (2L1 - 0) Measuring 3 (1L1 - 2L1)	550 mV 550 mV 550 mV	Phase position mixed-up (e.g. one current from phase L1, the other one from phase L2)

Tabelle 8.2: Measuring results

Comments on the measuring results:

Measuring results are based on values at rated relay current. If the test is carried out at partial current, the values differ accordingly.

Minimal measuring value deviations, e.g. due to unequal transformer ratio of the C.T.s, can be rectified by balancing the corresponding potentiometer.

For phases L2 and L3 measurements a) - c) to be done in similar manner.

8.3.2 "Hot" primary test

Attention: Reconnect the trip circuit at the end of all commissioning tests and perform the following "hot" test:

Load the transformer with minimum 50% load. Assure that the tripping of the transformer C.B. does not cause unwanted damages (blackout).

To operate the differential relay use a shorting link between one of the phase measuring sockets and ⊥, e.g. connect 1L1 to ⊥. The relay should trip immediately. If no trip occurs, make sure that the load current exceeds the set value of I_{d1}.

9. Technical Data

9.1 Measuring input

Rated data:
Rated current I_N: 1 A / 5 A
Rated frequency f_N: 50 - 60 Hz

Power consumption in current circuit: at I_N = 1 A <0.1 VA
at I_N = 5 A <0.5 VA

Thermal withstand capability
in 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 voltages 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: at 24 V standby approx. 3 W operating approx. 6 W
at 110 V standby approx. 3 W operating approx. 6 W

9.3 General data

Returning time: 50 ms
Dropout to pickup ratio: >97 %
Time lag error class index E: 100 ms ± 10ms
Minimum operating time: 30 ms

9.4 Output relays

The output relay has the following characteristics:

Maximum breaking capacity 250 V AC / 1500 VA / continuous current 6 A

For DC-voltage:

	ohmic	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	0.2 A / 22 W
60 V DC	0.7 A / 42 W	0.5 A / 30 W	0.3 A / 17 W
24 V DC	6 A / 144 W	4.2 A / 100 W	2.5 A / 60 W

Max. rated making current: 64 A (VDE 0435/0972 and IEC 65/VDE 0860/8.86)
Mechanical life span: 30 x 10^6 operating cycles
Electrical life span: 2 x 10^5 operating cycles at 220 V AC / 6 A
Contact material: silver cadmium oxide (AgCdO)

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 as per DIN IEC 255 part 21-2
Vibration:	class 1 as per DIN IEC 255 part 21-1
Degree of protection:	IP54 by enclosure of the relay and front panel (only D-version single unit)
Weight:	ca. 1.5 kg
Mounting position:	any
Overvoltage class:	III

9.6 Tripping characteristics

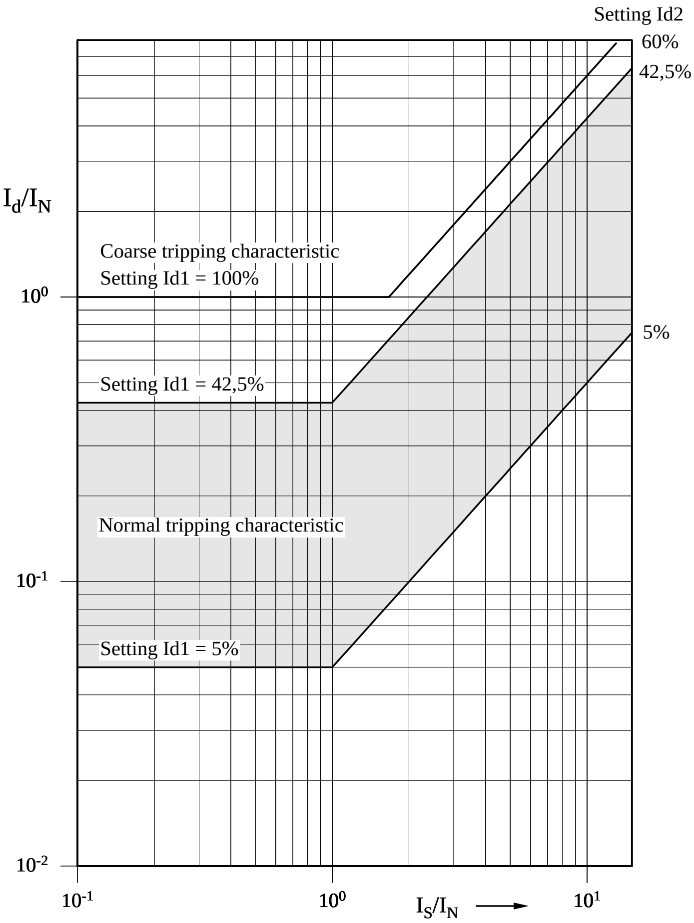


Fig. 9.1: Tripping range

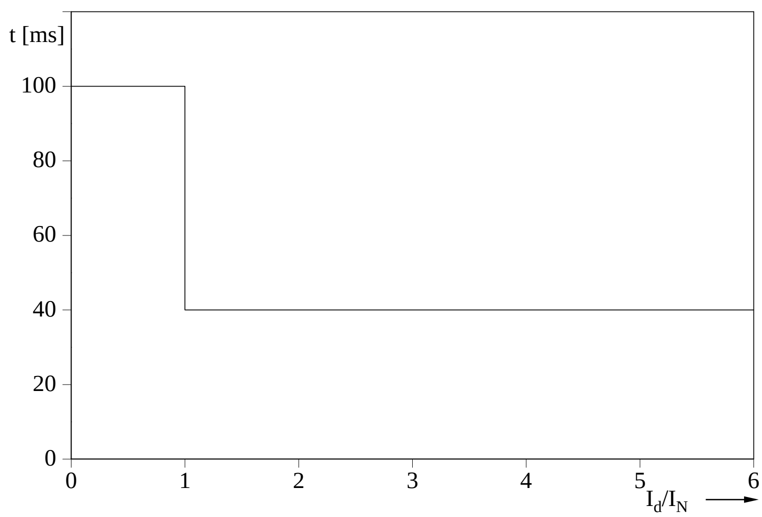


Fig. 9.2: Tripping time dependent from I_d

9.7 Dimensional drawing

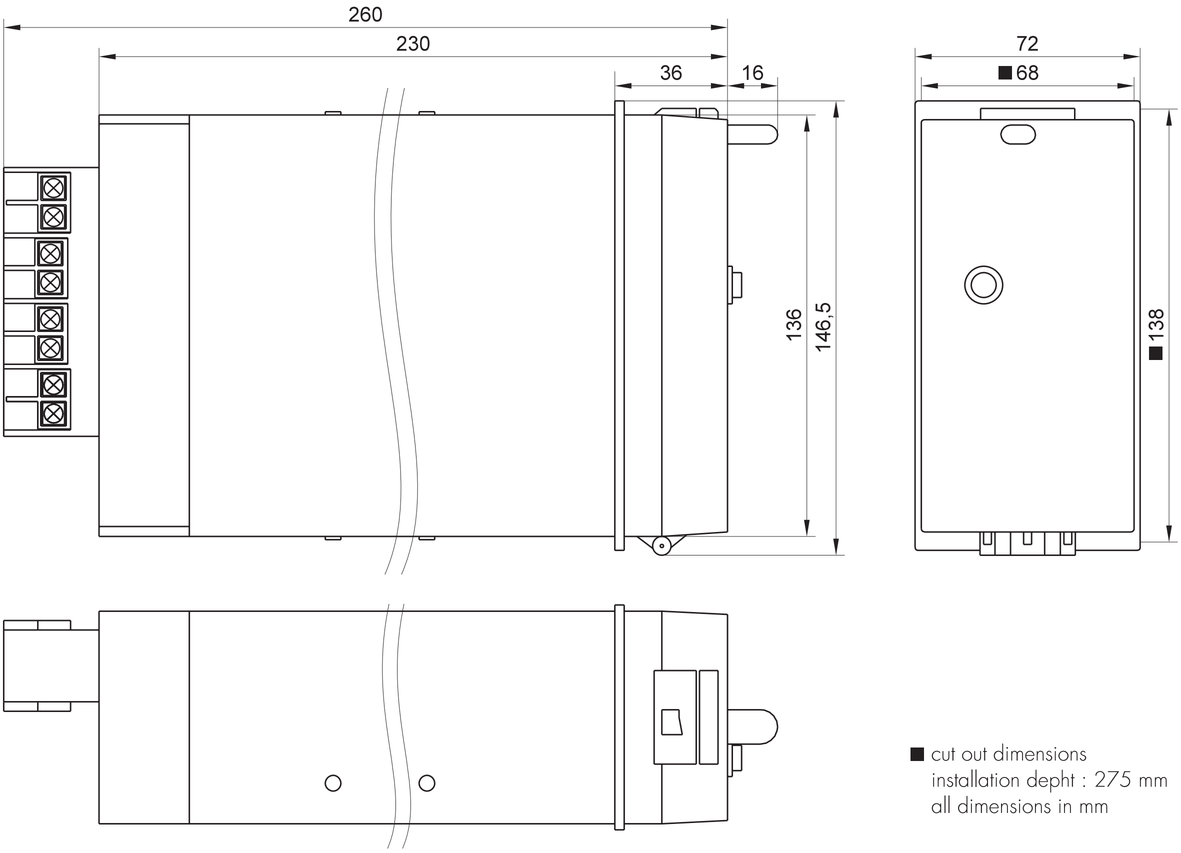


Fig. 9.3: Dimensional drawing

Please observe:

A distance of 50 mm is necessary when the units are mounted one below the other for the housing bonnet to be easily opened. The front cover can be opened downwards.

10. Order form

Transformer-differential protection relay ***IRD1-***	T	2					
Rated current 1 A 5 A			**1** **5**				
Tripping type relay without latching latching relay with hand reset				**E** **SP**			
Extra equipment for reliable functioning during CT saturation					**SAT**		
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**

Transformer rated capacity		**MVA**
Vector group		
Voltage	High voltage side	**kV** ± **%**
	Low voltage side	**kV**
Current transformer ratio	High voltage side	**/**
	Low voltage side	**/**
Rated current	High voltage side	**/**
	Low voltage side	**/**

Important instruction !
In order to ensure the balancing of the transformer differential circuit, the variation of the current refered to the current transformer secondary shall be in the range from 50 % (0.5 A for 1 A CT and 2.5 A for 5 A CT) up to a maximum of 110 % (1.1 A for 1 A CT and 5.5 A for 5 A CT). We request you to kindly consider this factor while choosing the layout of the transformer.

Please check by means of the following formula the correctness of your data: $S = U \cdot I \cdot \sqrt{3}$

Technical data subject to change without notice!

Setting list *IRD1-T2*

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

Project: ______________________________ SEG job.-no.: ______________________

Function group: =______________ Location: +__________ Relay code: -______________________

Relay functions: ______________________________

Setting of parameters

Parameter		Unit	Default settings	Actual settings
Id1	Differential current	% In	5	
Id2	Differential current	% In	5	

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