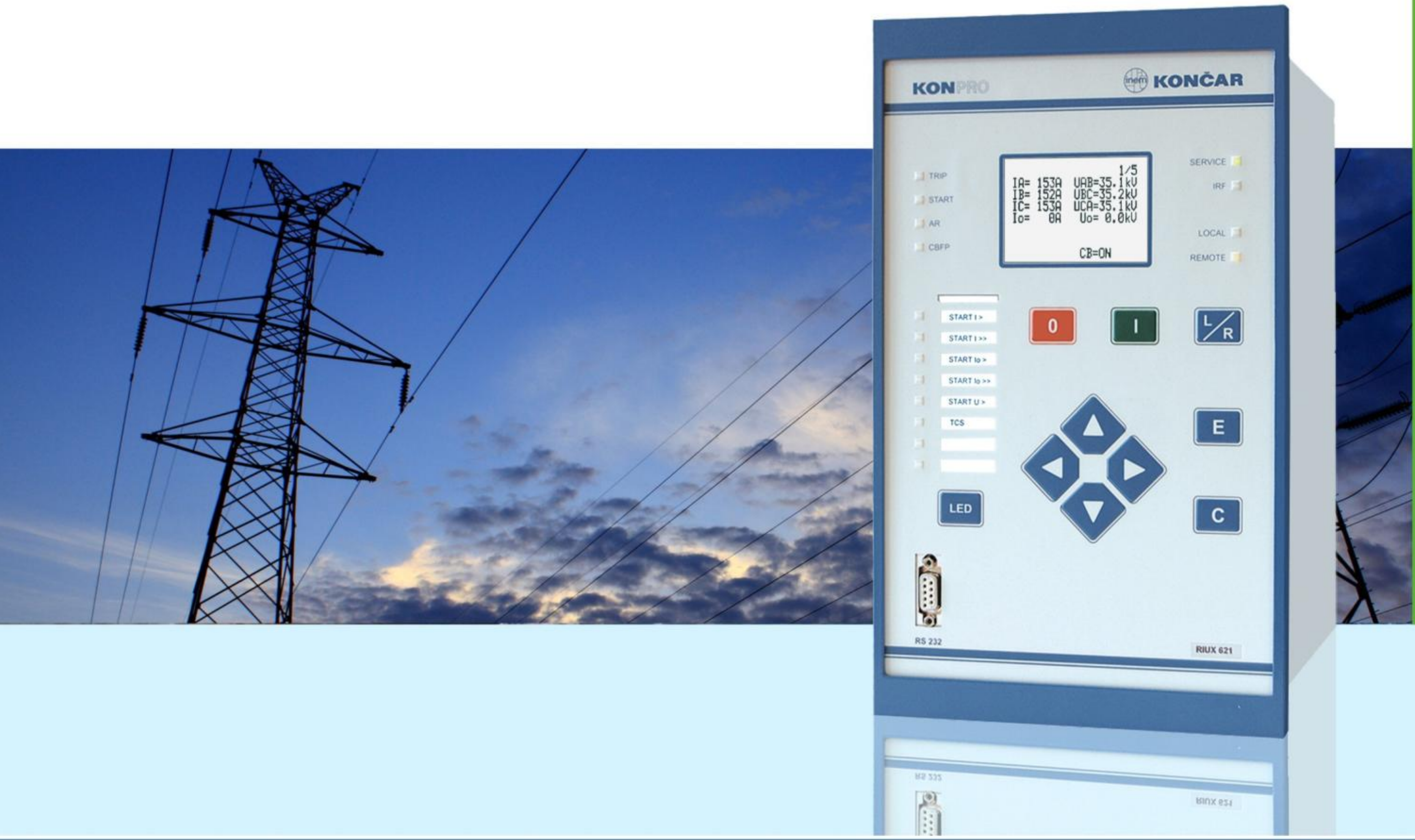
Končar Electronics and Informatics, Inc

Secondary equipment



TECHNICAL DESCRIPTION

KONPRO

RIUX

Numerical protection relay

MULTIFUNCTION PROTECTION RELAY FOR MEDIUM VOLTAGE BUSBAR FEEDERS

Description

Thanks to our rich experience in development and application of protection relays, the research and development team of the company KONCAR – Electronics and informatics, Inc., has developed a series of devices, which answers all requests set for this sort of equipment. The protection relay type RIUX is at the forefront of KONPRO generation of protection relays, built for protection of distribution and industrial medium voltage electrical power installations. RIUX offers the complete range of protection functions necessary for reliable protection of medium voltage busbar feeders and ability of oversight and control of circuit breakers. Thanks to its circuit architecture and modular software support, it is applicable for protection of power grids with all types of grounding. Integrated directional protection with energy flow supervision allows swift protection of radial and looped grids.

Aside from its primary protective role, relays enable several other options required from present-day protection relays, allowing reduction of devices needed in the field, which in turn reduces equipment maintenance costs. Key options include local and remote display of all current measured values, supervision of circuit breaker, and fault record of electric values during the time of failure, energy measurement, THD measurement, fault locator and transfer of data to the SCADA system.

Delayed operation time characteristics in accordance with IEC and IEEE standards, allow simple integration of the relay into existing protection systems, while retaining time selectivity applied in the system. Three levels of protection functions parameters allow quick protection adaptation to changes in the system. High level of programmability using the integrated program matrix allows simple signal interconnection to binary inputs and relay outputs of the device.

Modular design of the circuits and software architecture of the relay allow implementation of additional protection functions along with implementation of basic protection functions, which are part of the common programming package of the device, in accordance with customer needs. Integrated software support allows change of most parameters of protection functions using the control panel. Complete parameterization and parameter read-out is achieved using a computer.

Protective functions

Quick adaptation of the relay with regards to facility conditions is enabled using three levels of settings. The change of settings group is possible using communication means or via binary input. All three groups have the following protection functions on disposal:

- Overcurrent protection
  (ANSI No. 50, 51),
- Directional overcurrent protection
  (ANSI No. 67-DT, 67-IT),
- Earthfault protection
  (ANSI No. 50N-DT, 50N-IT),
- Directional earthfault protection
  (ANSI No. 67N-DT, 67N-IT),
- Sensitive directional earthfault protection
  (ANSI No. 67Ns-DT),
- Overvoltage protection
  (ANSI No. 59),
- Undervoltage protection
  (ANSI No. 27),
- Earthfault (U0) protection
  (ANSI No. 59N),
- Frequency protection (over/under frequency)
  (ANSI No. 81),
- Negative sequence overcurrent protection
  (ANSI No. 46-DT, 46-IT),
- Phase unbalance protection
  (ANSI No. 46DP) **,
- Cable thermal overload protection
  (ANSI No. 49F) **,
- Circuit breaker failure protection
  (ANSI No. 50BF),
- Inrush Restraint,
- Cold load pickup,
- Automated reclosing
  (ANSI No. 79),
- Fault locator
  (ANSI No. 21FL) **,
- Trip circuit supervision
  (ANSI No. 74TCS).

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Secondary equipment

RIUX

Management/supervision functions

- Predefined binary inputs for switch state supervision (BI1 & BI2),
- Predefined relay outputs for switch energization (RO1 & RO4),
- Programmable binary inputs for signal acquisition,
- Programmable signalization output relays,
- Management of relay outputs for switch energization, local and remote.

Measurement functions

- Voltage: I_{L1}, I_{L2}, I_{L3}, I_{E},
- Current: U_{L1N}, U_{L2N}, U_{L3N}, U_{E},
  U_{L1L2}, U_{L2L3}, U_{L3L1},
- Symmetric components: I_1, U_1 , I_2, U_2,
- Current P, Q, S, current factor cos φ,
- Energy W_{p+}, W_{p-}, W_{q+}, W_{q-}, W_s **,
- Total harmonic distortion: THD **,
- Frequency,

Failure analysis functions

- Event registration:
  - Event recorder,
  - Trip recorder,
  - Overview on device display and using PC software support.

- Disturbance registration:
  - Disturbance recorder,
  - Overview using PC software support,
  - Tripping possibility using binary input.

- Fault locator.

Communications

- Local:
  - Front panel (foil keypad, LCD),
  - Front user interface COM1 (RS232)

- Remote:
  Back optical interfaces:
  - COM0 (system/service interface)
  - COM2 (system/service interface)

- Supported communication protocol:
  - IEC 60870-5-103,
  - IEC 61850 (RIUX 623)

Other functions

- Time synchronization,
  IRIG B, front panel, software support,
- Continuous self-supervision,
- Testing capability using PC software support.

User interface

- Graphic LCD – 128x64 pixels,
- Possibility of adding new schemes,
- 8 predefined and 8 programmable LED's,
- Separate password protected parameter setting and switch management.

Measurement inputs

- Four current inputs – 1A, 5A (0.2A)**
- Four voltage inputs – 100V (200V)**.

Binary inputs and outputs

- 8 binary inputs
  (5 programmable, 52a, 52b, IRIG),
- 8 relay outputs
  (5 programmable, CB TRIP, CB CLOSE, IRF),
- Possible addition up to two BI/BO outputs type A, B or C,
- Type A – 8 binary inputs and 8 relay outputs,
- Type B – 16 binary inputs,
- Type C – 16 relay outputs.

Modular hardware and software architecture allows the optimization of relay function to the place of use (protecting).

(A detailed description of the differences can be seen from the ordering tags and tables with a list of functions)

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Device enclosure & connectivity

The device enclosure is specified for mounting plate installation, with foil keypad on front and connectivity clamps on the rear side.

- Size (dimensions):
(H x W x D = 296.5 x 176.8 x 222.9 mm).

The mounting plate opening dimensions are 268x174mm. Navigation keys on the front panel allow simple browsing of relay menus, while local parameters and measured value data readout is displayed on a graphic LCD and additional 16 LED diodes.

- The relay connects to the facility using connectivity clamps for lead reception with a cross section of 10 mm^2 (on measurement inputs), 4mm^2 (on relay outputs) and 2.5mm^2 (on binary inputs). The embedded analogue input unit allows reception of current and voltage signals with 1A, 5A & 0.2A** rated current for all device types.

- A USB interface is used for local communication with a computer. Remote communication is realized using a fibre-optic interface for reception of an optic plastic conduit with a V-Pin connector, on the rear side of the device. It is possible to deliver a special relay on demand, allowing connectivity of an optic-optic glass conduit with ST connector.

- The device circuit architecture is modular, allowing exchange of hardware modules, which as a result allows cheaper maintenance, and simple customization of the device to almost any facility needs.

- Thanks to such configuration the relay RIUX can be installed for protection of almost any insulated and earthed grid. Additional current input for ground current measurement, as well as the voltage input for measurement of ground voltage allow earthfault detection on various failure types.

- If the facility (installation) has no open delta voltage transformer installed, the ground voltage is calculated from measured values of phase voltage. Thus the calculated value of ground voltage is used for all necessary signal generations, associated with earthfault events.

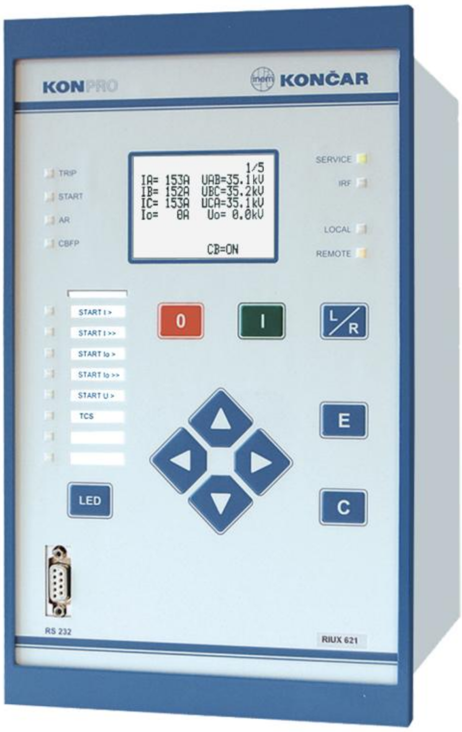

Fig. 1: Front panel of the RIUX relay

Fig. 2: Rear side of the RIUX relay

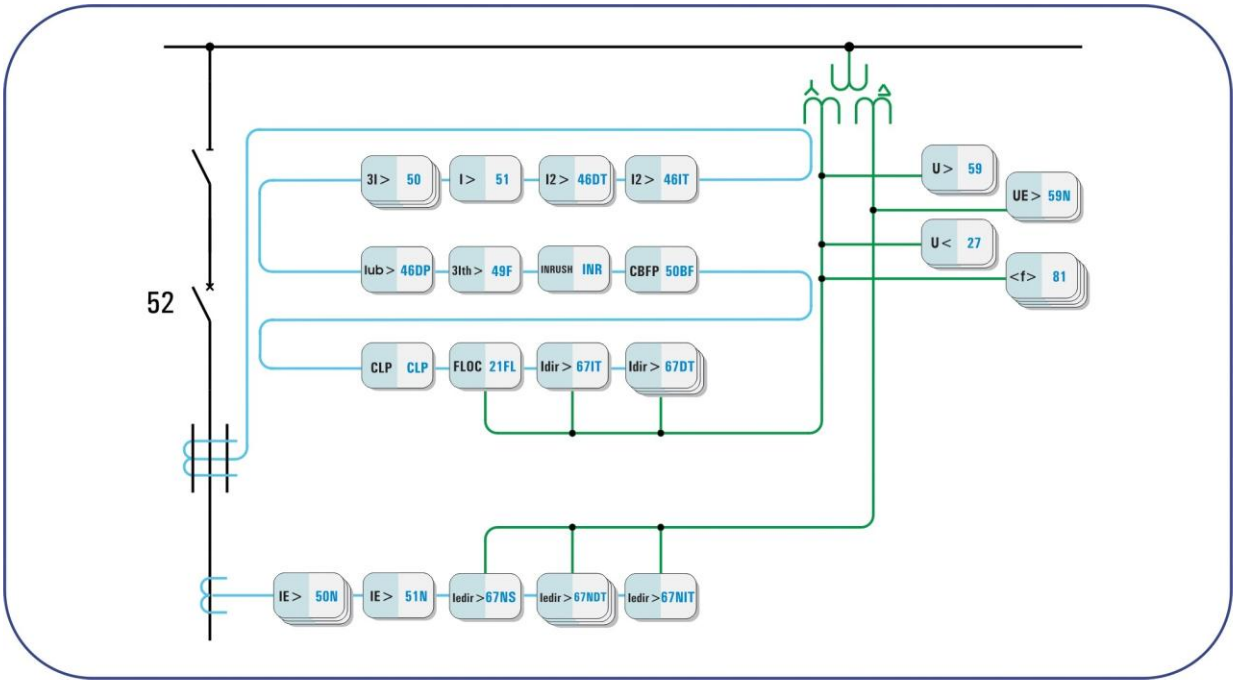

Fig. 3: Block diagram of the RIUX relay

- By simply changing parameters describing the connection of the relay to the power transformers, the relay adapts to the set of power transformers in the facility. It is permissible to connect linear or phase voltages to the power measurement inputs. If linear voltage is connected to the relay, phase voltages are calculated using an appropriate algorithm based on symmetric voltage components.

- While setting voltage protection for pickup value it is possible to choose the effect on size of linear voltage, and direct or inverse voltage component. Common relay connection options are shown on fig. 4 and 5.

Protection of torodial and radial networks

- Directional protection functions for radial network protection are realized for protection from short-circuit and earthfault events. Setting of distinctive angle of -90° to +90°, as well as direction of operation parameters (forward/reverse), cover all four quadrants of directional protection operation.

Transformer energization detection

- When energizing the power transformer, the energizing currents can surpass nominal values by ten times. As this is a brief transition event, this state is not considered a failure. The typical attribute of this state is the emersion of second harmonic inrush current in energization current.

- The Inrush function for such event detection measures the size of second harmonic and uses it to block overcurrent protections, which could in cases like these, result in unwanted trip.

Cold load pickup

- Function used for grid protection in which a greater number of devices, which demand great energization power after a longer zero voltage period (e.g. air-conditioning units), is located. This protection function registers the duration of zero voltage state, and the size of set overcurrent protection is elevated to required values. Thus unwanted action of the protection system on trip circuit switching is disabled.

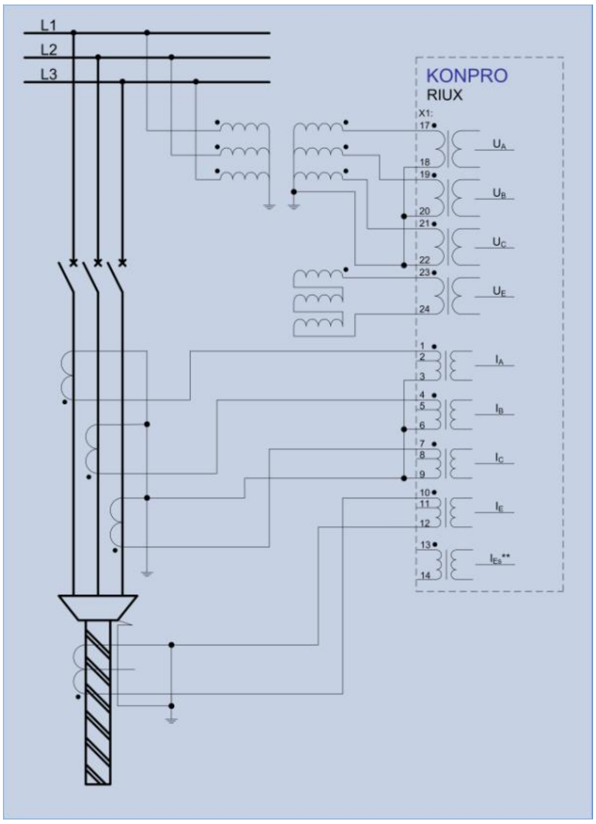

Fig. 4: Relay connection schematic RIUX with ground voltage transformer

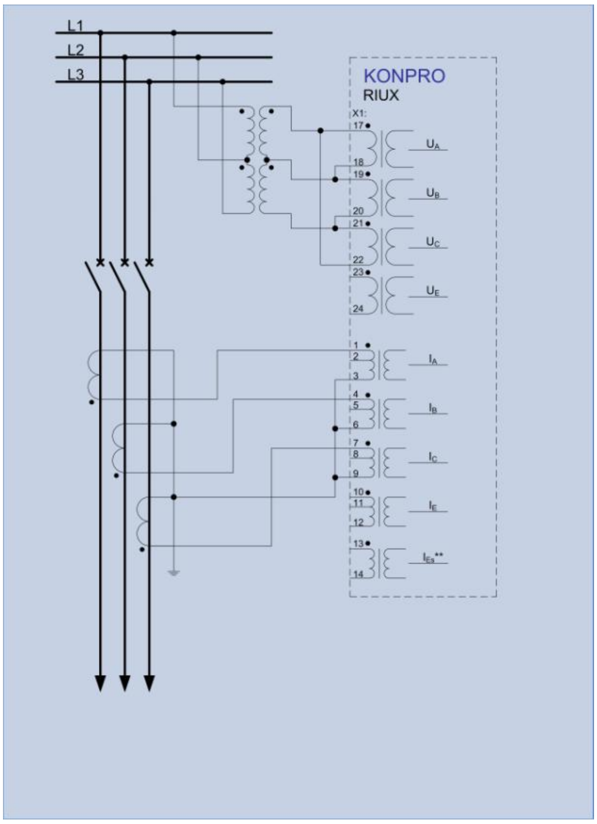

Fig. 5: Relay connection schematic RIUX without ground voltage transformer

Overview of protection functions for RIUX

ANSI relay indication	IEC indication	Function
50 – Phase OC	I>/>>/>>>	Overcurrent protection with *definite time* characteristic
51 – Phase OC	I>	Overcurrent protection with *inverse time* characteristic
50N – Earth OC	I_E>/>>/>>>	Earthfault protection with *definite time* characteristic
51N – Earth OC	I_E>	Earthfault protection with *inverse time* characteristic
67DT – Dir. OC	I_{dir}>/>>/>>>	Directional overcurrent protection with *definite time* char.
67IT – Dir. OC	I_{dir}>	Directional overcurrent protection with *inverse time* char.
67NDT – Dir. OC	I_{Edir}>/>>/>>>	Directional earthfault protection with *definite time* char.
67NIT – Dir. OC	I_{Edir}>	Directional earthfault protection with *inverse time* char.
67Ns – Dir. OC	I_{EE}>/>>	Sensitive earthfault protection
59 – Phase OV	U>	Overvoltage protection
59N – Earth OV	U_E>	Earthfault (voltage) protection
27 – Phase UV	U<	Undervoltage protection
46DT – Neg. Seq.	I_2>/>>	Negative sequence overcurrent protection with *definite time* characteristic
46IT – Neg. Seq.	I_2>	Negative sequence overcurrent protection with *inverse time* characteristic
** 46DP – Unbalance	I_{ub}>	Current unbalance protection
** 49F – Thermal Ov.	$3I_{th}$>	Cable thermal overload protection
81 - Freq. O/U	f>, f<	Over/Under-frequency protection
50BF	CBFP	Circuit breaker failure protection
79 - Auto recl.	AR	Automated reclosing

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- **Overcurrent protection with *definite time* characteristic (50 – Phase OC)**

The function is derived by measuring the current in all three phases, and comparing measured values with preset ones. Inter-independent algorithms for each phase enable shortest failure detection time. Three levels of settings for pickup current and time threshold allow selective protection settings. In order to enable proper protection start-up in case of intermitting failure, the *t-drop* parameter is added, keeping the function in start-up during set period of time after pickup disappearance. Thus protection start-up is enabled in case of brief consecutive short-circuits. The start-up time delay is independent towards current size.

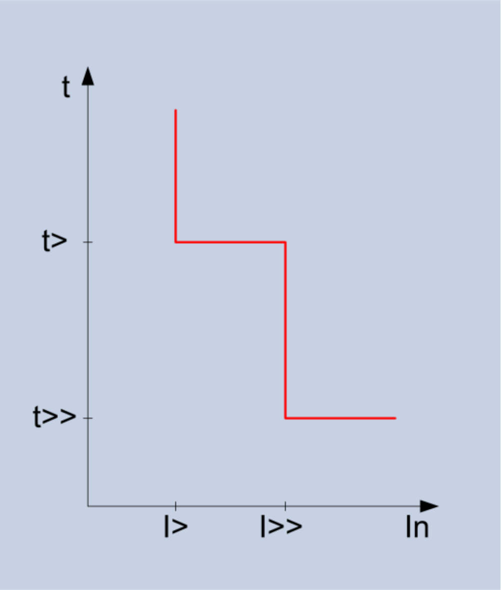


Fig. 6: Pickup characteristics of overcurrent protection with definite time

- **Overcurrent protection with *inverse time* characteristic (51 – Phase OC)**

Inter-Independent algorithms supervise current values in all three phases. Implemented characteristics enable delayed pickup time depending on current size or in regard to characteristics set by IEC or ANSI standards. The protection function is enabled in case when the current surpasses the set value by 10%. The pickup releases after current drops under value 1.05 I>. The derived pickup characteristics are shown in Table 1.

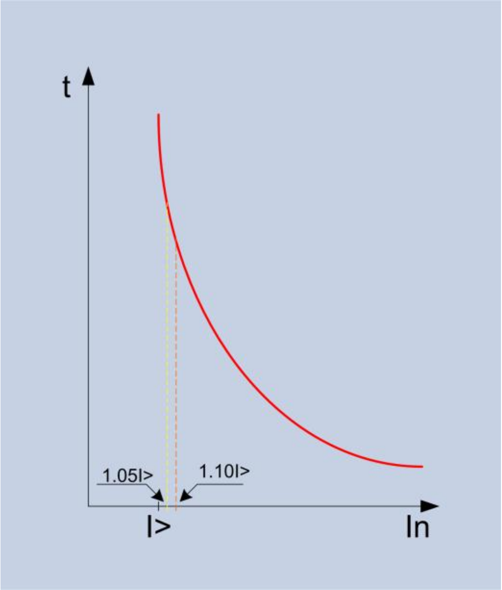


Fig. 7: Pickup characteristics of overcurrent protection with inverse time

IEC		α	β	
Normal inverse	$t = k \cdot \dfrac{\beta}{\left(\dfrac{I}{I>}\right)^{\alpha} - 1}$	0.02	0.14	
Very inverse		1	13.5	
Extremely inverse		2	80	
Long time inverse		1	120	
ANSI		α	β	γ
Normal inverse	$t = TD \cdot \left(\dfrac{\beta}{\left(\dfrac{I}{I>}\right)^{\alpha} - 1} + \gamma \right)$	2.0938	8.9341	0.17966
Short inverse		1.2969	0.2663	0.03393
Long inverse		1	5.6143	2.18592
Moderately inverse		0.02	0.0103	0.0228
Very inverse		2	3.922	0.0982
Extremely inverse		2	5.64	0.02434
Definite inverse		1.5625	0.4797	0.21359

Table 1. Implemented pickup characteristics of overcurrent protection

- **Earthfault protection with *definite time* characteristic (50N – Earth OC)**

  Value measured on current input for earthing current measurement is used as the pickup value. Three group settings for protection are available. The pickup characteristic is equal to the one of overcurrent protection with *definite time* characteristic. The protection function is realized in a way that it can register earthfaults with very small currents. Parameterization, as well as pickup of the protection is possible for just 1% of nominal current value.

- **Earthfault protection with *inverse time* characteristic (51N – Earth OC)**

  Current measured on current input for earthfault measure is used as the pickup value. Pickup time delay characteristic is equal to that of overcurrent protection with *inverse time* characteristic. Protection function is realized in a way that it can register earthfaults with very small current. Parameterization, as well as pickup of the protection is possible for just 1% of nominal current value.

- **Directional overcurrent protection with *definite time* characteristic (67DT – Dir. OC)**

  Aforementioned function is activated when two conditions are met. First – measured current exceeds preset value, and second – the direction of the current matches the direction of the protection. The direction of protection system is set using direction parameters, i.e. the Relay Characteristic Angle. Setting of said parameter is possible within limits of -90°÷90°, enabling coverage in all four quadrants with *forward/reverse* direction change capability. Three groups of settings, with three direction parameters, meet the demands of even the most complex protection cases in both directions and with different current and time settings. The direction is set using the faulted phase current and line voltage of two healthy phases. If said voltage amount is too small to determine failure current direction (three phase fault) with certainty, the appropriate voltage is used, stored in device memory before failure. Pickup characteristic of this protection, for failure in phase A, is shown on Fig. 8.

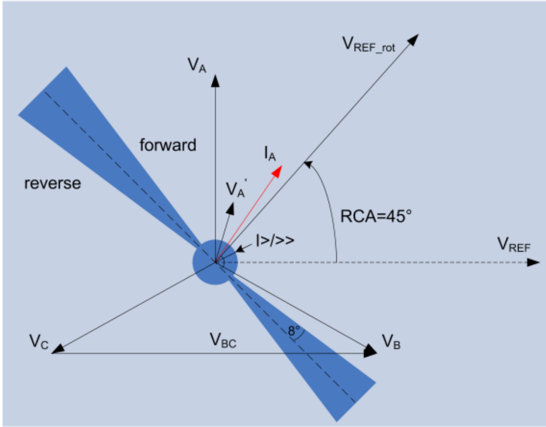


Fig. 8: Pickup characteristic of directional overcurrent protection

- **Directional overcurrent protection with *inverse time* characteristic (67IT – Dir. OC)**

  Directional overcurrent protection with *inverse time* characteristic is also activated when terms of direction and conditions of current, described in function 67DT – Dir. OC. are met. Current condition will be satisfied when the current value surpasses the set value by 10%. Time delay for pickup is set using characteristics determined by IEC and ANSI standards, equal to those of non-directional overcurrent protection.

- **Directional earthfault protection with *definite time* characteristic (67NDT – Dir. OC)**

  Directional earthfault protection is needed in systems where a possibility of earthfault current flow is possible in both directions. In order for the protection to work selectively, i.e. to trip circuit just the part of the grid affected by the failure, it is necessary to determine the direction of the failure. The direction of the failure is determined on basis of the mutual position of voltage and current ground component vectors, or on basis of the mutual position of inverse component of voltage and current. In practice, the more common is the method of determining direction with ground component, while the method of inverse components gives better results in cases where ground impedance, i.e. ground voltage is small.

The protective function begins operation when conditions of current and direction are met. The pickup setting is permissible from 1% of nominal current value, which guarantees detection of even the smallest earthfault currents. In case when inverse components are used for fault direction detection, the setting of pickup value and characteristic angle are related to the inverse current and voltage component. In order to accurately detect the fault direction in all cases by the protection algorithm, the ground voltage setting threshold can be set up to 2% of nominal voltage.

- **Directional earthfault protection with *inverse time* characteristic (67NIT – Dir. OC)**

Directional earthfault protection with *inverse time* characteristic determines direction using same principals as the directional earthfault protection with *definite time* characteristic, described in the paragraph before. Pickup time delay is also described in cases of other *inverse time* protections. The protection will generate the pickup signal after the current surpasses value 10% greater than set value, with valid fault direction.

- **Directional sensitive earthfault protection (67Ns – Dir. OC)**

Voltage and current ground components are used as input measure values of protection. Depending on network type, two modes of protection can be used (sin and cos). The *sin-mode* is used for protection of insulated networks, where the value of relation I_0*sin φ is used as the pickup value.

Cos-mode is used for protection of earthed networks, and the value of I_0*cos φ is used as the pickup value.

When the value of corresponding relation exceeds set parameter values IEs>/>> with fulfilled direction conditions, the protection system generates associated pickup signals. The parameter *C.Angle* adjustable in range of ±45° is used to compensate for phase variance of power transformer for the measurement of current I_E. In order to prevent wrong direction determination with large currents, the pickup characteristic is stabilized in border area with an 8° pitch for all currents larger than 14*IEs>/>>.

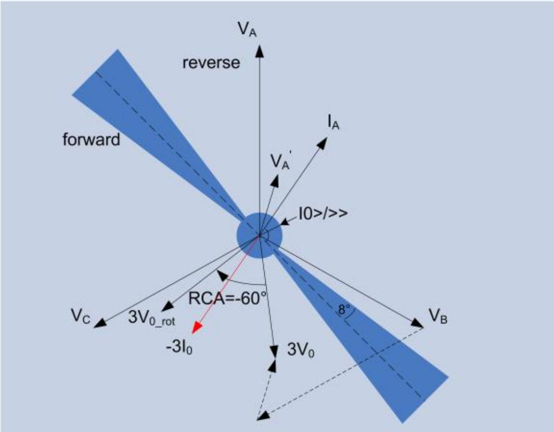


Fig. 9: Pickup characteristic of directional earthfault protection

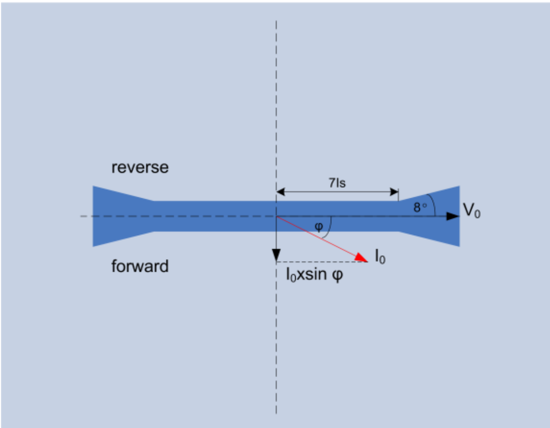


Fig. 10: Pickup characteristic directional earthfault protection in sin-mode

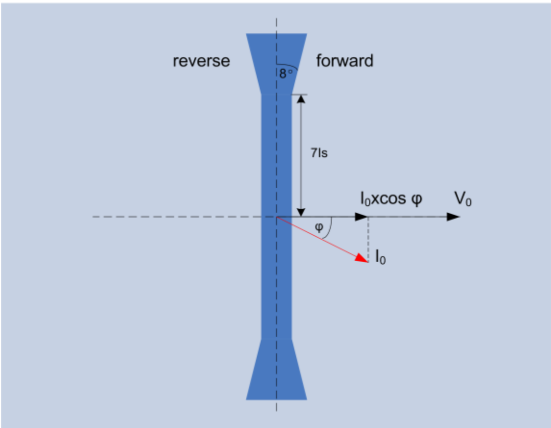


Fig. 11: Pickup characteristic directional earthfault protection in cos-mode

- **Overvoltage protection (59)**
  Overvoltage protection is realized in two degrees with the *definite time* characteristic. Three inter-independent algorithms process the measured voltage on each measurement input. It is possible to use linear voltages or inverse voltage component U_2 as pickup value.

  The calculated value of voltage U_2 will be accurate only in case when the relay is connected to three phase voltages. If the relay is connected to linear voltages, the value of calculated voltage U_2 will differ from real voltage value for the ground component. Wide latitude of settings for voltage and time, as well as setting of pickup/release (*R-drop*) ratios, allow adequate protection in almost all installation conditions.

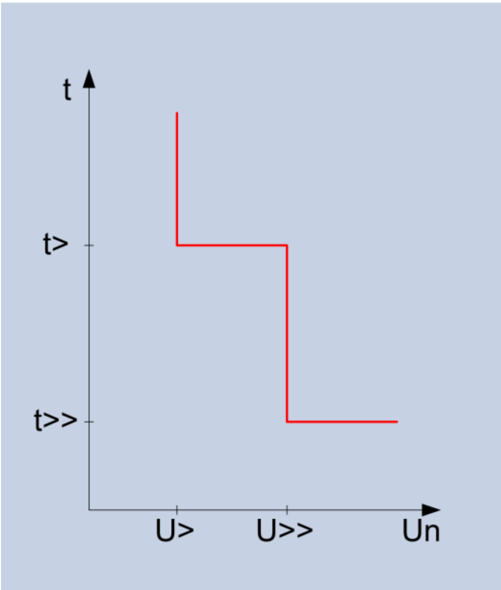


Fig. 12: Pickup characteristic of overvoltage protection

- **Earthfault protection (59N)**

  Earthfault protection with ground voltage measurement is common in insulated networks/grids, in which small currents are the result of earthfault cases. The protection algorithm uses voltage U_E as the pickup value, measured on voltage input provided for measurement. Protection is realized using two degrees of pickup settings, with the parameterization of appropriate time delay.

- **Undervoltage protection (27-Phase UV)**

  Undervoltage protection is implemented in two degrees with the *definite time* characteristic. Linear voltages or direct voltage component can be used as measured values. In order to avoid unnecessary pickup caused by trip circuit activation or any other reason, the protection algorithm supervises current through the switch. If current through the switch is smaller than set value, the *Current threshold* function concludes that the protected field is out of commission and does not generate any signals connected to the protection pickup. If the undervoltage protection has to be active regardless of the trip circuit state or current, the current supervision through the trip circuit can be turned off.

- **Negative sequence overcurrent protection with *definite time* characteristic (46DT-NEG. SEQ.)**

  In order to allow desired operation of protection in all failure conditions, the protection is realized in two degrees with *definite time* characteristic. Said protection is used to detect failure conditions that can lead to damage of equipment powered by electric energy. Those states can arise from e.g. phase interruption, unsymmetrical phase load, or absence of switching in all three poles of the trip switch. Based on measured phase currents, the function algorithm calculates the inverse component I_2 value, and compares it to preset value. The pickup in case of intermittent current I_2 occurrence is realized through the prolongation of pickup, set by the t-drop parameter.

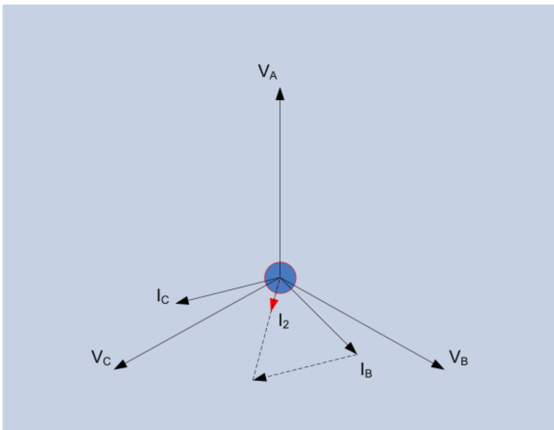


Fig 13: The calculation of current I_2 with one phase missing

- **Negative sequence overcurrent protection with *inverse time* characteristic (46IT-NEG. SEQ.)**

Said protection for inverse component I_2 calculation uses the same algorithm as the protection described before. The difference being in time delay of trip, which depends on the current (*inverse time*) in this case, in accordance with IEC standard characteristics. The protection will generate adequate pickup signals, when the inverse current component exceeds 10% above preset value.

- **Current unbalance protection (46DP-UNBALANCE)**

Current unbalance protection is used in transfer and distribution grids. It is useful in fault cases with low load that are hard to detect with inverse current protection. As input values of the function we are using effective values of all three phase currents. Using the measured values we are calculating minimal and maximal values, i.e. unbalance current.

$$\Delta I = \frac{I_{L\max} - I_{L\min}}{I_{L\max}} \cdot 100\%$$

- **Cable thermal overload protection (49F-Thermal Ov.)**

Cable thermal overload protection is used for thermal protection of three-phase energy cables and overhead power lines. The operating principle of the protection is based on a thermal model with one time characteristics that is being used at heating and cooling of the cable. In both cases for calculating temperature the protection algorithm is using an exponential curve. The expression that is being used is:

$$Temp = \left[\left(\frac{I}{I_{CABLE}}\right)^2 \cdot \left(Temp_{MAX} - Temp_{REF}\right)\right] \cdot \left(1 - e^{\frac{-t}{\tau}}\right) + Temp_{AMB}$$

When the calculated current value gets higher or equal to the pickup value the function will generate the adequate signals.

- **Frequency protection (81-Freq. O/U)**

Frequency is being measured based on the voltage measurement signal. The protection is realized in four stages. Each of those can play the role of overfrequency and underfrequency protection, depending on its setting. If the threshold setting is greater than nominal frequency (50Hz), the stage will operate as overfrequency protection, and if it is smaller, the stage will work as underfrequency protection.
In order to prevent unwanted operation of underfrequency protection in case of tripping protected field, the *U-block* parameter is used to set measured voltage parameters for which the protection is active. If the measured voltage drops below preset value, the function will deactivate

- **Automated reclosing (79-Auto recl.)**

The automated reclosing function is required most commonly in case of transient short circuits. It is very useful because it allows reduction of zero voltage pause to the bare minimum. If a transient failure occurs on the power line, e.g. a tree branch leans on the line, the overcurrent protection will trip the field breaker. After preset waiting time, the automated reclosing will give the signal for reclosure. If the failure is no longer present, the line will remain operational, and if it is still present, the overcurrent protection will disconnect the line again. If the failure is caused by a fallen branch pressed on the line, it is possible that it will be burned after several closing attempts, thus removing the cause of the failure. Integrated automated reclosing function allows setting of five automated reclosing attempts, after five different time delays. The embedded software allows interconnection of operation between automated reclosure and protective functions, thus allowing the user to select which functions will set off the automated reclosure cycle. The automated reclosure cycle can be started and blocked using the binary input. A controlled automated reclosure cycle activation is stipulated, depending on the time delay of certain function pickup, as well as starting restriction of the automated reclosure in case of three-phase short circuit (parameter *Blk.KS3*.)

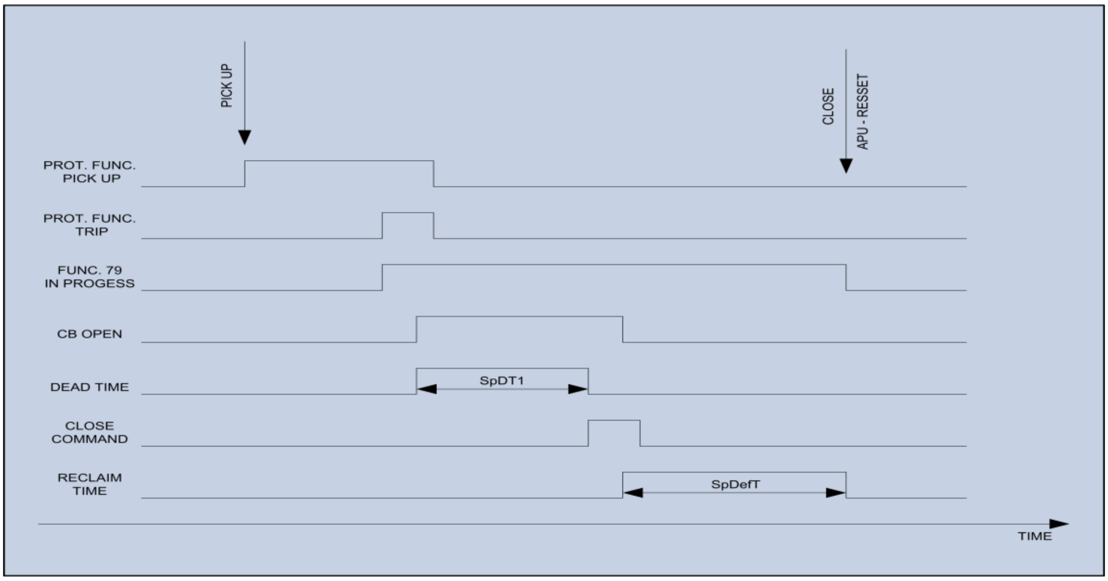


Fig. 15: Successful automated reclosing with one attempt

- ## Trip circuit failure protection (50BF-CBFP)

After the general trip warrant generation, it is possible that the trip circuit does not trip for some reason. Circuit failure reasons can be various, from line braking towards tripping coil, to a fault in the circuit itself. In order to cut power supply to the failed area, the trip circuit failure protection is activated, whose task is to control whether the trip based on warrant is realized, and if not to either trip the breaker trough the second tripping circuit, or to trip corresponding next trip circuit that supplies power to the failure. The trip circuit supervision is also possible based on signal contact, and current size through the switch. If the value ON is chosen for parameter *CB-contact*, the switch state function deduces based on the state of the signal switch. If the chosen value is OFF, the function deduces the state of the switch based on measured current through the switch. After the expiration of time function set by parameter *t-BF*, the function will generate the trip signal on the corresponding relay output.

- ## Trip circuit supervision (74TC-Trip C.S.)

In case of trip circuit failure, the trip command will not cause breaker tripping. Such a state is extremely dangerous; therefore trip circuit supervision is used in order to alert personnel to failure as soon as possible. Trip circuit control is realized using adequate binary inputs. Depending on binary input state, the function deduces whether the trip circuit is in sound or erroneous state. Two connectivity schemes are possible – with one or two binary inputs. When supervising the trip circuit with one binary input (TCS2), the binary input shall be in lead state, with a working trip circuit with the breaker on and off, required that the TRIP contact is not closed. In order to avoid trip circuit signal failure on protection pickup, a *definite time* characteristic time delay is integrated. TC failure signal will be generated after expiration of the time delay. It is necessary to set the time delay so it is longer than the duration of TRIP relay closure. Such connectivity keeps the TC failure signal even in case the TRIP relay contacts remain permanently closed after tripping.

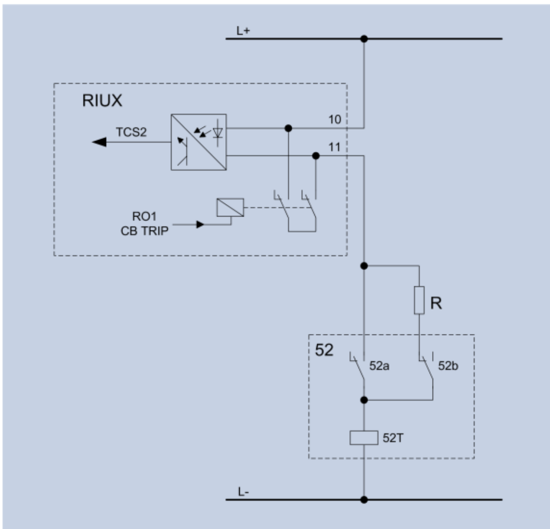


Fig. 16: Trip circuit supervision with TCS2

Oper. selectivity is achieved using two binary inputs and the *Meas. mode* parameter. When monitoring via two binary inputs (TCS1 & TCS2), the function deduces that the TC is sound if at least one binary input operates in lead state. In addition, a request in case of TC failure is the need to block breaker closing next to the failed TC. Breaker closing blockade, on given command and with TCS function, is achieved by setting *TC fail blk.* to state ON.

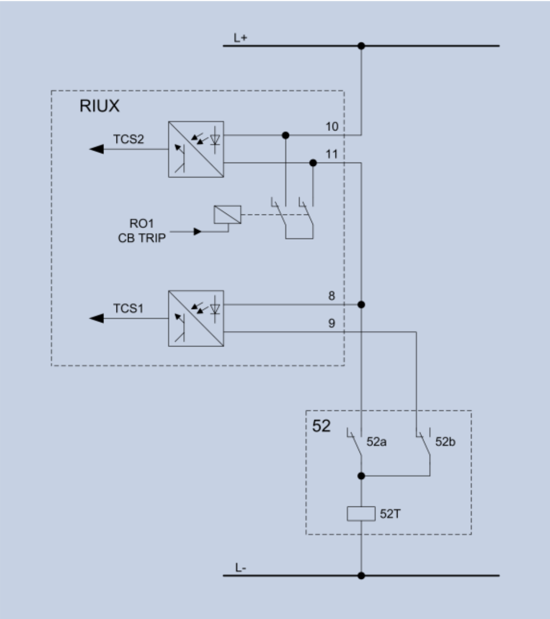


Fig. 17: Trip circuit supervision w/TCS1 & TCS2

- **Complete adjustment to facility equipment**

The circuit and software architecture of the protective relay RIUX allow adjustment of protection to implemented measurement transformers and switches in the facility. With regards to the power transformers in the facility, the relay can be connected to a set of two pole isolated power transformers, and a set of one pole isolated power transformers, i.e. three wire and four wire. Selection of connectivity modes is performed using *VT conn.* parameter. If the relay is connected to a set of one pole isolated power transformers, and voltage measurement UE is unavailable, said voltage can be calculated from measured phase voltage using *VT conn. = 3P-UE-C*. All relay types from RIUX series are equipped with analogue current inputs for rated current 1A and 5A (0.2A on demand), as well as voltage inputs for rated voltage 100V (200V on demand). Circuit breaker tripping/closing is often realized using auxiliary relays, therefore it is sometimes necessary to ensure a sufficient time interval for trip/close command impulse. Close command impulse duration can be adjusted. The factory settings for trip/close impulse duration is 250ms.

- **Advanced failure analysis**

In order to enable quality event analysis in case of disturbances or failures in the facility, the device has an implemented event log list, as well as a trip log. Each list can store a maximum of 512 events, with expansion capability according to the users' wishes. Events are stored on the lists in 2ms intervals. The choice of events that are to be stored is selected via software support. The integrated battery allows storing of all events even after auxiliary device power supply failure or disappearance.

- **Fault locator**

The exact fault location speeds up the return of line to power reducing losses caused by undelivered electricity. Unilateral fault locator is implemented with the possibility of data entry of up to three sections of the line. Activation of the calculation is made on the trip or on start depending on your settings.

- **THD metering**

Quality of electricity is an increasingly important factor in the functioning of the power system. Measurement of THD can be done continuously or on an order. Having completed one set of measurements it is checked whether it meets the set conditions.

- **Energy metering**

The function of electrical energy measurement is increasingly being used in devices of this type. The purpose of the function is the ability to track active and reactive energy at a measurement point. Energy is obtained by integrating measured values of power in the time period and summing the obtained values. Energy is measured in all four quadrants.

- **Time synchronization**

In order to keep internal relay time synchronized with the time of other relays in the facility, remote synchronization using communications (SCADA) or the provided binary input prepared for IRIG-B time code is enabled. Time setting is possible using software support or using the front panel. The integrated battery allows undisturbed work of the clock mechanism even after auxiliary power failure or disappearance.

- **Communications capabilities**

The layout and markings of keys on the front panel allow intuitive usage of the local communications interface. The USB interface on front panel, and optical interface on the rear, allow local and remote communications using IEC 60870-5-103 (61850 optional) protocol. This protocol is accepted as the international standard for protection parameter transfer and failure recording.

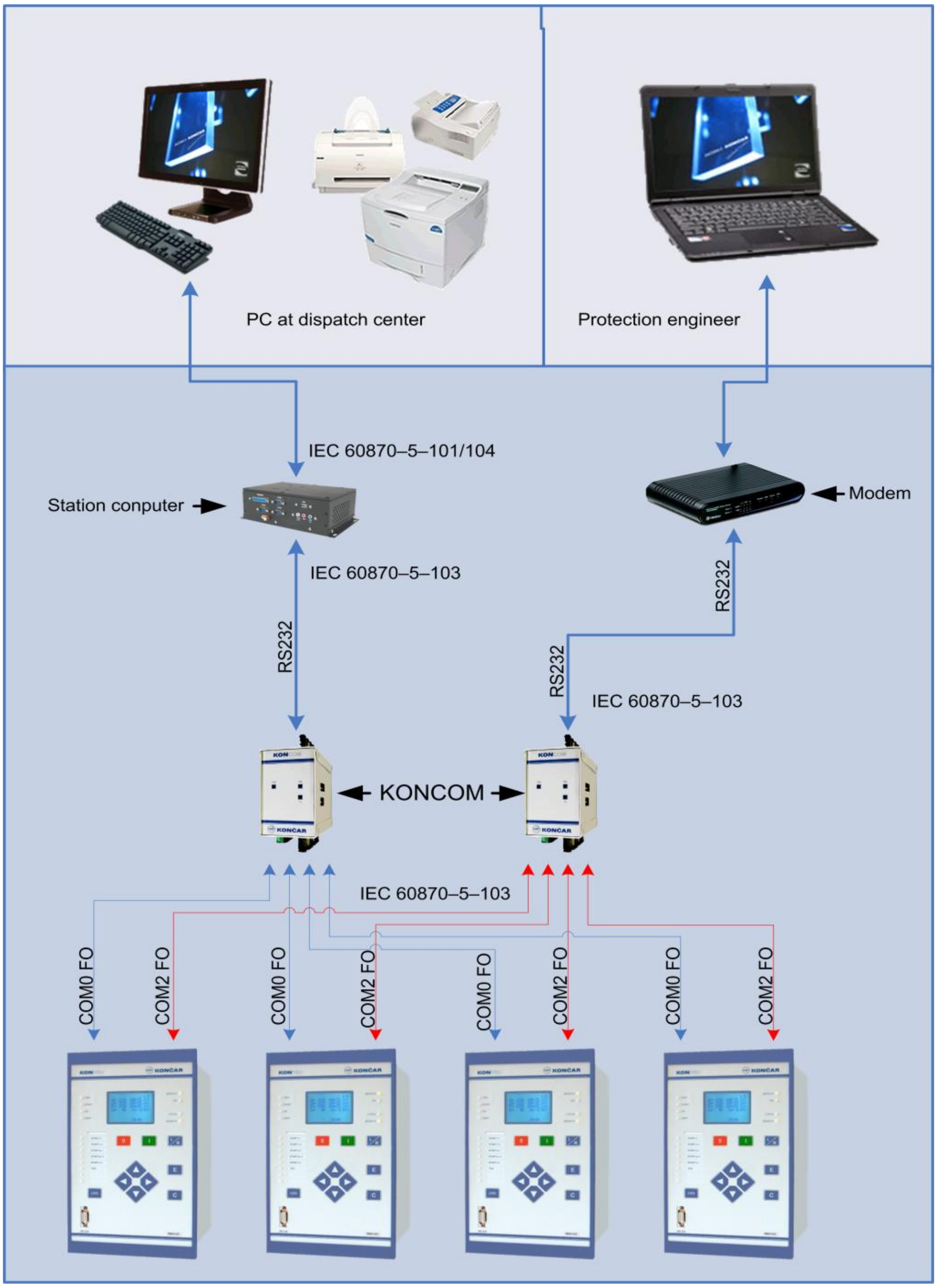


Fig. 18: Communications connection schematic for facilities

The figure 18 shows one kind of relay interconnection using the communications inverter. In order to achieve optimal characteristics, we recommend usage of communications converters from the KONCOM series. The image illustrates the device RIUX 622, which is equipped with two optical ports (service and system port), allowing relays to be connected to the SCADA system and to a remote PC used by protection engineer.

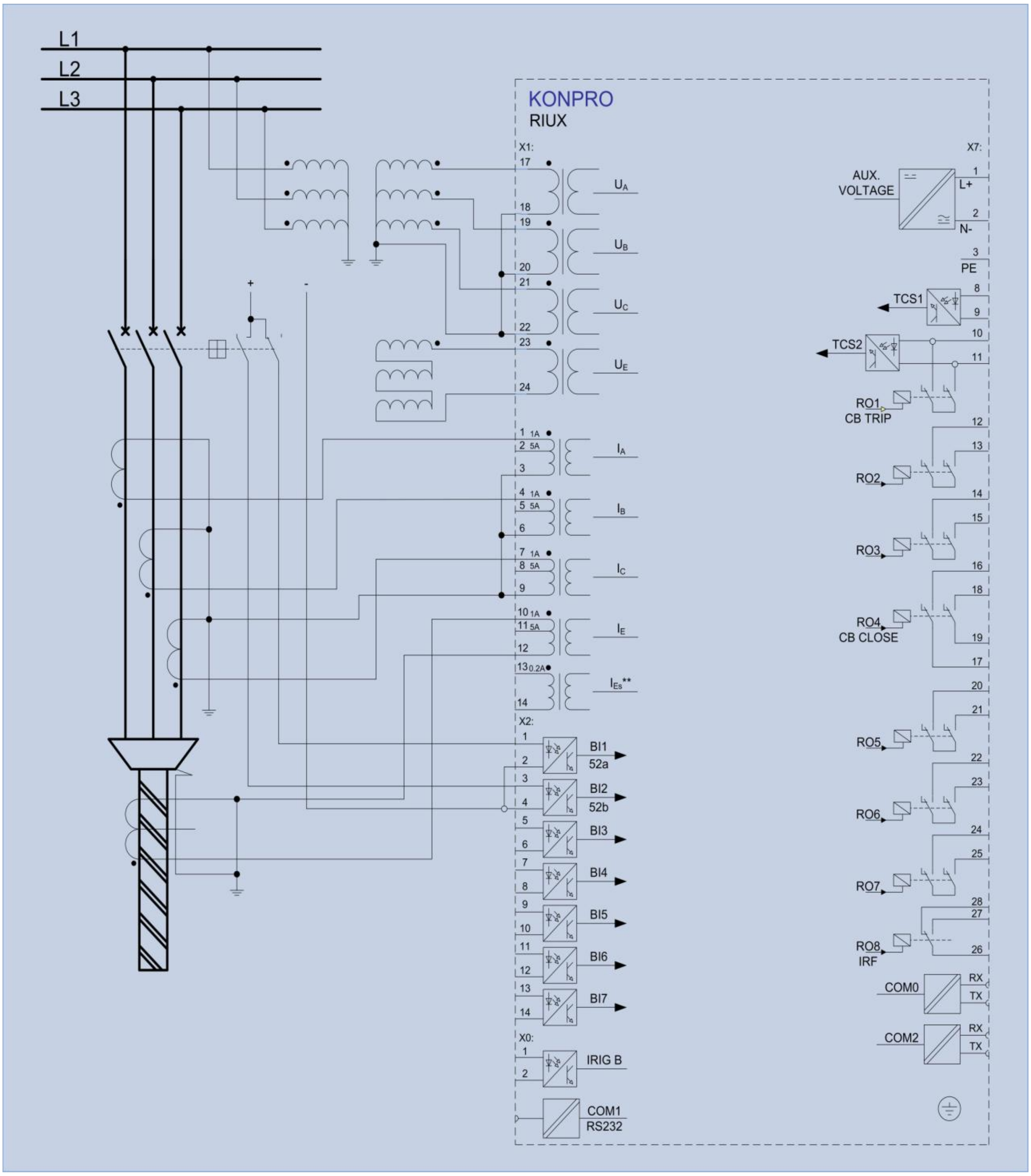


Fig. 19: Common connectivity schematic of basic relay types to measurement transformers, with breaker state monitoring

- ## Expansion of binary input and relay output number

The figure above shows the schematic of basic relay type, without additional expansion boards with binary inputs and outputs. Present-day power facilities demand relays to receive and compute a large number of signals, as well as send a lot of signals. In order to fulfil all potential demands, relays type RIUX allow expansion of circuitry with additional binary input and relay output expansion boards.

We offer three types of units, as shown on figure 21. Basic circuit and software architecture are adapted to receive up to two additional expansion boards of same or different type, depending on demand shown on order description. The next two pictures show all the basic and additional relay modules.

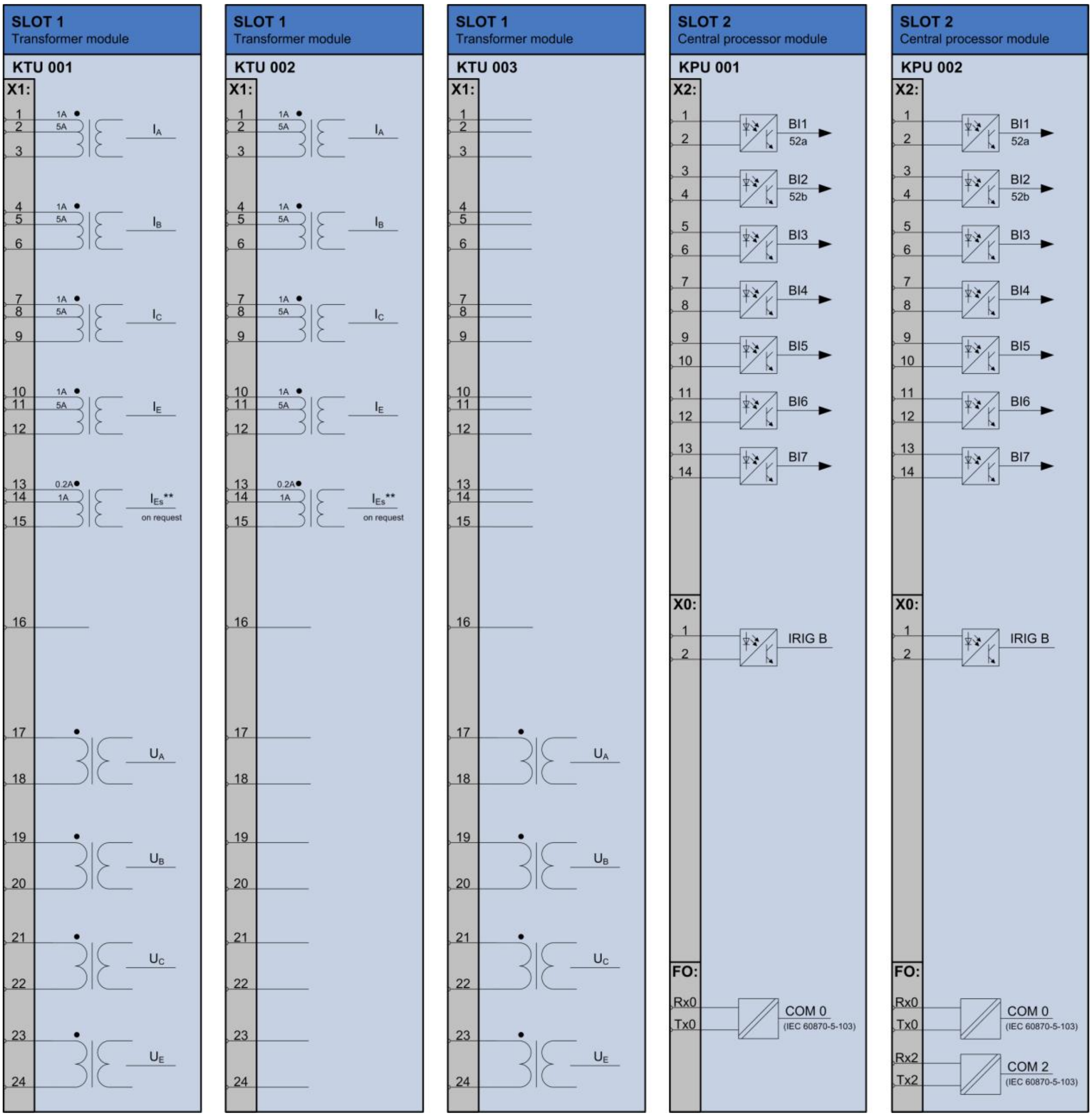


Fig. 20: Schematic of basic and additional relay modules

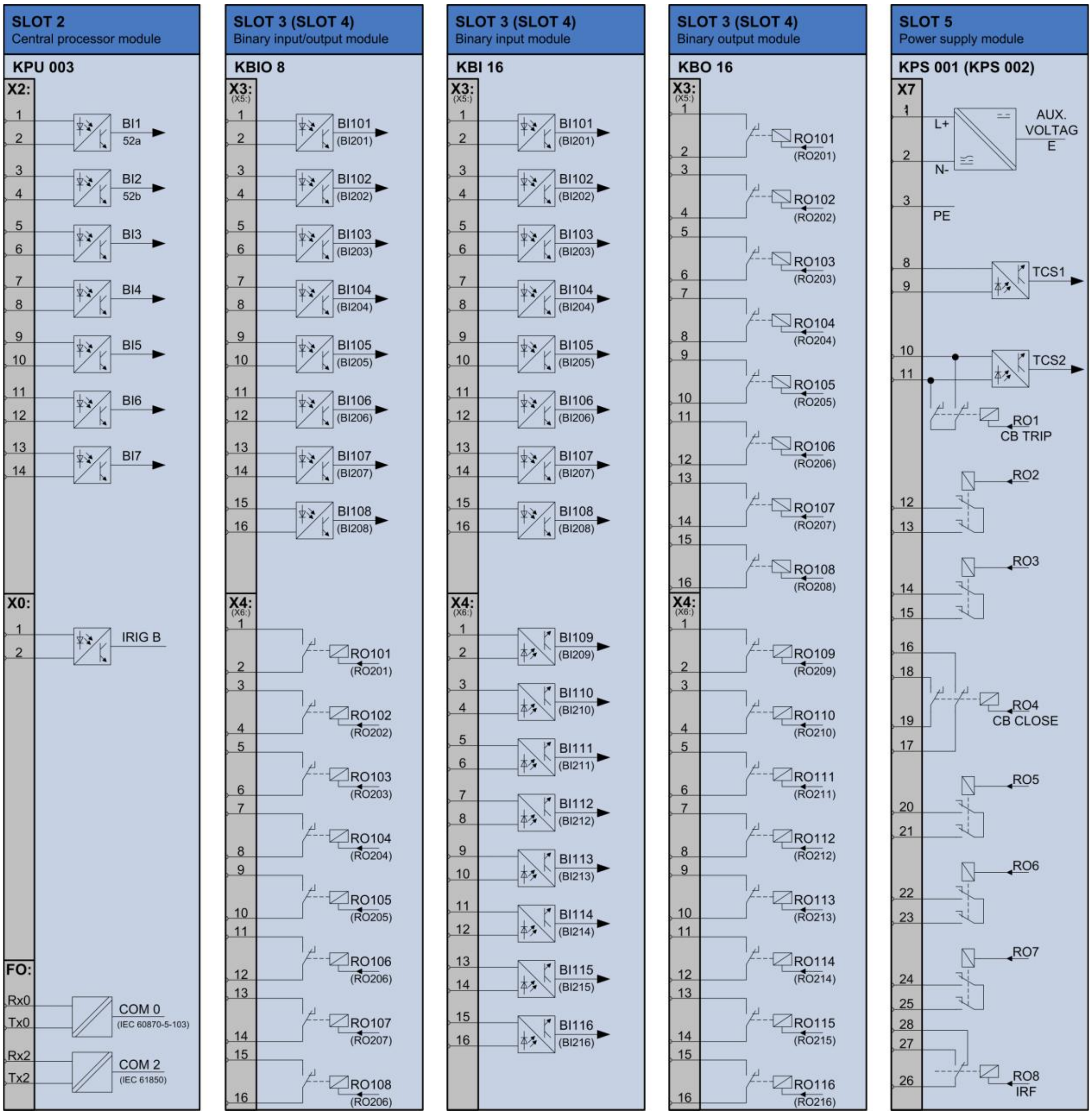


Fig. 21: Schematic of basic and additional relay modules

TECHNICAL DATA

MEASUREMENT INPUTS

Current inputs

- Number of inputs	4
- Rated current	1A, 5A (0.2A)**
- Rated frequency	50/60 Hz
- Number of connectors per input	3 (1 A, 5 A and mutual)
- Consumption	< 0.5 VA
- Load Capacity	
- Thermal	4 In constant, 100 In per one second
- Dynamic	250 In for one half-period

Voltage inputs

- Number of inputs	4
- Rated voltage	100 V (200V)**
- Rated frequency	50/60 Hz
- Number of connectors per input	2
- Consumption	< 0.5 VA
- Load Capacity	4 U_n constant

Binary inputs

	Number of binary inputs:
- Standard variant (on CPU unit)	8 (52a, 52b, IRIG, 5 programmable)
- Additional card A-type O/I units	8 (programmable)
- Additional card B-type O/I units	16 (programmable)
- Additional card C-type O/I units	0
Voltage setting for binary inputs	18-80 Vdc
	80-265 Vdc

Relay outputs

	Number of relay outputs:	
- Standard variant (on power supply unit)	8 (CBtrip, CBclose, IRF, 5 programmable)	
- Additional card A-type O/I units	8(programmable)	
- Additional card C-type O/I units	16(programmable)	
Number of rear relay outputs (for tripping/closing)	7 (2 predefined TRIP and CLOSE)	
Circuit voltage	≤ 400 Vac/dc	
Continuous current	8 A	
Admissible current (close and hold) – 0.5 s	28 A	
Admissible current per contact	Signal relays (I/O unit)	triping relays (on power unit)
- For 48 Vdc	2.5 A	8A
- For 110 Vdc	0.5 A	2A
- For 220 Vdc	0.25 A	0,6 A

Local and remote communications

Local communication (on front panel)	
- Operating interface – COM 1	USB, IEC 60807-5-103
Remote communication (on rear panel)	
- System/Service interface – COM 0	V-Pin connector, IEC 60870-5-103
- System/Service interface – COM 2	V-Pin connector, IEC 60870-5-103 or 61850

Auxiliary power supply

Auxiliary voltage	80-265 Vdc ; 18-80 Vdc
	220 -230V, 50Hz
Consumption	
- Stand-by	Approx. 10 W
- Operation	Approx. 15 W

Device enclosure

Installation	Using installation plate
Weight	Approx. 7.0 kg

*** on demand*

Secondary equipment

RIUX

KONČAR inem

GENERAL INFORMATION

C/CE Conformity

HRN EN 61000-6-2:2001.	EMC directive
HRN EN 61000-6-4:2003.	EMC directive
HRN EN 60950-1: 2005+A11:2005	LVD directive

Electrical testing

Insulation testing

- According to standard: IEC 60255-5	
- Measurement inputs, binary inputs, relay outputs	2.5kV rms, 50/60Hz
- Class III impact voltage test: Measurement inputs, binary inputs, relay outputs, auxiliary power supply	5kV peak value 1.2/50µs, 0.5J, 3 pos. and 3 neg. impulses in 5s interval

EMC testing

- According to standard: IEC 60255-22, IEC 61000-4, IEC 61000-6-2, IEC 61000-6-4	
- Resistance to short signals at frequency of1MHz, IEC 60255-22-1, class III	2.5kV peak value1MHz 400 waves at sec, for 2s
- Electrostatic discharge, IEC 60255-22-2	±6kV by contact, ±8kV trough air
IEC 61000-4-2 + A1 + A2	±4kV by contact, ±8kV trough air
- Resistance to electromagnetic field radiation IEC 60255-22-3	10V/m, 27-500MHz, 80-1000MHz
IEC 61000-4-3 + A1 + A2	10V/m, 80-1000MHz
- Resistance to electric quick transient / brief signal, IEC 60255-22-4 IEC 61000-4-4	±4kV dc port, ±2kV sig. port, 5/50ns, 5kHz, 60s
- Resistance to high-energy wave signal, IEC 60255-22-5 IEC 61000-4-5	1.2/50µs, dc clamps: ±1kV dif, ±2kV comm. 1.2/50µs voltage OK, 8/20µs short circuit current, 0.5kV
- Resistance to disturbances induced by RF field IEC 60255-22-6 IEC 61000-4-6 + A1	150kHz-80MHz, Modulation 80%AM at 1KHz, 10Vef
- Resistance to PF magnetic field IEC 61000-4-8 + A1	30A/m, 50Hz, 60s, xyz axis
- Resistance to impulse magnetic field IEC 61000-4-9 + A1	300A/m, 50Hz, 60s, 5 pos. + 5 neg. imp. 10s
- Permanent voltage interference at main clamps IEC 61000-6-4, EN 55011 + A1 + A2	150kHz-30MHz
- Radio emission IEC 61000-6-4, EN 55011 + A1 + A2	30MHz-1000MHz

Mechanical testing

Resistance testing for vibration, shock, strikes and earthquakes

- According to standard: IEC 60255-21	
- Resistance to vibration (sinusoidal) IEC 60255-21-1	10-60Hz, Amp. ±0.035mm 60-150Hz, acceleration 0.5g, class 1 xyz axis 20 cycles, 1octave/min.
- Shock and strikes resistance IEC 60255-21-2	Shock test: acceleration 5g, duration11ms, Strike test: acceleration 10g, duration 16ms, class1
- Earthquake resistance IEC 60255-21-3	1-8Hz, 3.5mm x axis, 1.5mm y axis 8-35Hz 1g x axis, 0.5g y axis, class 1

Ambient/climate testing

Thermal resilience testing

- According to standard: IEC 60068-2, IEC 60255-6	
- Resilience to thermal influence in duration of 16 hrs IEC 60068-2-1, IEC 60068-2-2	-25°C to +70°C
- Temporarily allowed installation temperature in duration of 96 hrs	-10°C to +55°C
- Recommended constant installation temperature IEC 60255-6	-5°C to +55°C
- Recommended constant storage temperature IEC 60255-6	-10°C to +55°C

Humidity resilience testing

- According to standard: IEC 60068-2-30	
- Resilience to elevated temperature with elevated humidity IEC 60068-2-30	+55°C at 95%rel.humidity, duration of 96hrs

Degree of enclosure mechanical protection

- According to IEC 60529	Front: IP50 Rear: IP20

Additional testing

Testing of permissible thermal load of measurement current inputs

- Permanent	4In, effectively
- In interval of 5s	40In, effectively
- In interval of 1s	100In, effectively

Measurement accuracy

Currents	In range of 10-200% In 0,5% In or 1% current value
Voltages	In range of 10-120% Un 0,5% Un or 1% current value
Powers	In range of 10-120% rated power U>0,5Un, I>0,5In, f=50Hz, |cosf|>0,7 2% rated value

Protection functions

Overcurrent protection with definite time characteristic (ANSI No. 50)

- Measurement inputs		IA, IB, IC	
- Function activation	Func.	OFF I> I>, I>> *I>, I>>, I>>>	
- First/second/third stage - Pickup value - Pickup time characteristic *Definite time*	 I>, I>>, I>>> t>, t>>, t>>>	 0.00 – 30.00 In 0.05 – 300.00 s	 step: 0.01 In step: 0.01 s
- Allowed dropdown time	t-drop	0.00 – 60.00 s	step: 0.01 s
Cold Load Pickup - CLP first/second/third stage - Pickup value - Pickup time characteristic *Definite time*	 Ic>, Ic>>, Ic>>> tc>, tc>>, tc>>>	 0.00 – 30.00 In 0.00 – 300.00 s	 step: 0.01 In step: 0.01 s
- Start time		< 30 ms (at 2Ip)	
- Release time		< 35 ms (at 2Ip)	
- Pickup/release ratio		0.95 (Ip/In ≥ 0,5)	
- Time accuracy		2% pickup value or 10 ms	
- Pickup current accuracy		2% pickup value or 0.01 In	

Overcurrent protection with inverse time characteristic (ANSI No. 51)

- Measurement inputs		IA, IB, IC	
- Function activation	Func.	OFF ON	
- Pickup value	I>	0.10 – 5.00 In	step: 0.01 In
- Pickup time characteristic *IEC-Normal inverse* *IEC-Very inverse* *IEC-Extremely inverse* *IEC-Long inverse* *ANSI-Inverse* *ANSI-Short inverse* *ANSI-Long inverse* *ANSI-Moderately inverse* *ANSI-Very inverse* *ANSI-Extremely inverse* *ANSI-Definite inverse*	 k TD	 0.05 – 1.00 0.50 – 15.00	 step: 0.01 step: 0.01
Cold Load Pickup - CLP pickup value - CLP pickup time characteristic *IEC-…* *ANSI-…*	 Ic> kc TD	 0.10 – 5.00 In 0.05 – 1.00 0.50 – 15.00	 step: 0.01 In step: 0.01 step: 0.01
- Drop-out characteristic	Drop-out	Instant.	
- Working area		1.10 Ip	
- Release value		1.05 Ip (Ip/In ≥ 0,5)	
- Pickup current accuracy		2% set value or 0.01 In (1A)	
- Time accuracy		5% set value ± 2% curr tol, min 30 ms	

Earthfault protection with definite time characteristic (ANSI No. 50N)

- Measurement input		IE	
- Function activation	Func.	OFF IE> IE>, IE>> *IE>, IE>>, IE>>>	
- First/second/third stage			
- Pickup value	IE>, IE>>, IE>>>	0.01 – 10.00 In	step: 0.01 In
- Pickup time characteristic			
Definite time	tE>, tE>>, tE>>>	0.00 – 300.00 s	step: 0.01 s
- Allowed dropdown time	t-drop	0.00 – 60.00 s	step: 0.01 s
Cold Load Pickup			
- CLP first/second/third stage			
- Pickup value	IEc>, IEc>>, IEc>>>	0.10 – 10.00 In	step: 0.01 In
- Pickup time characteristic			
Definite time	tEc>, tEc>>, tEc>>>	0.00 – 300.00 s	step: 0.01 s
- Start time		< 35 ms	
- Release time		< 35 ms	
- Pickup/release ratio		0.95 (Ip/In ≥ 0,5)	
- Time accuracy		2% pickup value or 10 ms	
- Pickup current accuracy		2% pickup value or 0.01 In	

Earthfault protection with inverse time characteristic (ANSI No. 51N)

- Measurement input		IE	
- Function activation	Func.	OFF ON	
- Pickup value	IE>	0.01 – 5.00 In	step: 0.01 In
- Pickup time characteristic			
IEC-Normal inverse	kE	0.05 – 1.00	step: 0.01
IEC-Very inverse			
IEC-Extremely inverse			
IEC-Long inverse			
ANSI-Inverse	TDE	0.50 – 15.00	step: 0.01
ANSI-Short inverse			
ANSI-Long inverse			
ANSI-Moderately inverse			
ANSI-Very inverse			
ANSI-Extremely inverse			
ANSI-Definite inverse			
Cold Load Pickup			
- CLP pickup value	IEc>	0.01 – 5.00 In	step: 0.01 In
- CLP pickup time characteristic			
IEC-…	kEc	0.05 – 1.00	step: 0.01
ANSI-…	TDEc	0.50 – 15.00	step: 0.01
- Drop-out characteristic	Drop-out	Instant.	
- Working area		1.10 Ip	
- Pickup/release ratio		1.05 (Ip/In ≥ 0,5)	
- Pickup current accuracy		5% pickup value. ± 2% current tolerance, 30 ms	
- Time accuracy		2% pickup value or 0.01 In	

Directional overcurrent protection with definite time characteristic (ANSI No. 67-DT)

- Current inputs		IA, IB, IC	
- Voltage inputs		UA, UB, UC	
- Referred voltage		UAB, UBC, UCA *If the voltage is too small for measurement it is taken from memory (2P)*	
- Function activation	Func.	OFF Iφ> Iφ>, Iφ>> *Iφ>, Iφ>>, Iφ>>>	
- Characteristic angle	RCA	± 90°	step: 1°
- Pickup direction	Dir>, Dir>>, Dir>>>	forward / reverse	
- Stabilization angle (pickup/release)		8^0 / 3^0	
- First/second/third stage - Pickup value - Pickup time characteristic *Definite time*	 Iφ>, Iφ>>, Iφ>>> tφ>, tφ>>, tφ>>>	 0.10 – 30.00 In 0.05 – 300.00 s	 step: 0.01 In step: 0.01 s
- Allowed dropdown time	t-drop	0.00 – 60.00 s	step: 0.01 s
Cold Load Pickup - CLP first/second/third stage - Pickup value - Pickup time characteristic *Definite time*	 Iφc>, Iφc>>, Iφc>>> tφc>, tφc>>, tφc>>>	 0.10 – 30.00 In 0.05 – 300.00 s	 step: 0.01 In step: 0.01 s
- Start time		< 45 ms	
- Release time		< 40 ms	
- Pickup/release ratio		0.95 (Ip/In ≥ 1)	
- Time accuracy		2% pickup value or 10 ms	
- Pickup current accuracy		2% pickup value or 0.01 In	
- Angle accuracy		±3°	

Directional overcurrent protection with inverse time characteristic (ANSI No. 67-IT)

- Current inputs		IA, IB, IC	
- Voltage inputs		UA, UB, UC	
- Referred voltage		UAB, UBC, UCA *If the voltage is too small for measurement it is taken from memory (2P)*	
- Function activation	Func.	OFF ON	
- Characteristic angle	RCA	± 90°	step: 1°
- Pickup direction	Dir>	forward / reverse	
- Stabilization angle (pickup/release)		8^0 / 3^0	
- Pickup value	Iφ>	0.10 – 5.00 In	step: 0.01 In
- Pickup time characteristic *IEC-Normal inverse* *IEC-Very inverse* *IEC-Extremely inverse*	 kφ	 0.05 – 1.00	 step: 0.01

IEC-Long inverse *ANSI-Inverse* *ANSI-Short inverse* *ANSI-Long inverse* *ANSI-Moderately inverse* *ANSI-Very inverse* *ANSI-Extremely inverse* *ANSI-Definite inverse*	TDφ	0.50 – 15.00	step: 0.01
Cold Load Pickup - CLP pickup value - CLP pickup time characteristic *IEC-…* *ANSI-…*	Iφc> kφc TDφc	0.10 – 5.00 In 0.05 – 1.00 0.50 – 15.00	step: 0.01 In step: 0.01 step: 0.01
- Drop-out characteristic	Drop-out	Instant.	
- Working area		1.10 Ip	
- Pickup/release ratio		1.05 Ip (Ip/In ≥ 0,5)	
- Time accuracy		5% pickup value ± 2% current tolerance, 30 ms	
- Pickup current accuracy		2% pickup value or 0.01 In	
- Angle accuracy		±3°	

Directional earthfault protection with definite time characteristic (ANSI No. 67N-DT)

- Current input		IE	
- Voltage inputs		UA, UB, UC / UE	
- Function activation	Func.	OFF IEφ> IEφ>, IEφ>> *IEφ>, IEφ>>, IEφ>>>	
- Polarization (c- calculated, m- measured)	Pol.	32VT (UE-c / UE-m, IE) 32QT (U2, I2)	
- Characteristic angle	RCA-N	± 90°	step: 1°
- Pickup direction	Dir>, Dir>>, *Dir>>>	forward / reverse	
- Stabilization angle (pickup/release)		8^0 / 3^0	
- Minimal referred voltage	Umin	0.02 – 0.5 Un (32VT, UE-m) 0.05 – 0.5 Un (32QT/VT, Uc)	step: 0.01 Un
- First/second/third stage - Pickup value - Pickup time characteristic *Definite time*	 IEφ>, IEφ>>, IEφ>>> tEφ>, tEφ>>, tEφ>>>	 0.01 – 10.00 In (32VT,UE-m) 0.10 – 10.00 In (32QT/VT, Uc) 0.05 – 300.00 s	 step: 0.01 In step: 0.01 s
- Allowed dropdown time	t-drop	0.00 – 60.00 s	step: 0.01 s
Cold Load Pickup - CLP first/second/third stage - Pickup value - Pickup time characteristic *Definite time*	 IEφc>, IEφc>>, IEφc>>> tEφc>, tEφc>>, tEφc>>>	 0.01 – 10.00 In (32VT,UE-m) 0.10 – 10.00 In (32QT/VT, Uc) 0.05 – 300.00 s	 step: 0.01 In step: 0.01 s
- Start time		< 45 ms	
- Release time		< 40 ms	
- Pickup/release ratio		0.95 (Ip/In ≥ 0,5)	
- Time accuracy		2% pickup value or 10 ms	

- Angle accuracy		±3°	

Directional earthfault protection with inverse time characteristic (ANSI No. 67N-IT)

- Current input		IE	
- Voltage inputs		UA, UB, UC / UE	
- Function activation	Func.	OFF ON	
- Polarization (c- calculated, m- measured)	Pol.	32VT (UE-c / UE-m, IE) 32QT (U2, I2)	
- Characteristic angle	RCA-N	± 90°	step: 1°
- Pickup direction	Dir>	forward / reverse	
- Stabilization angle (pickup/release)		8^0 / 3^0	
- Minimal referred voltage	Umin	0.02 – 0.5 Un (32VT, UE-m) 0.05 – 0.5 Un (32QT/VT, Uc)	step: 0.01 Un
- Pickup value	IEφ>	0.01 – 5.00 In 0.10 – 5.00 In (32QT/VT, Uc)	step: 0.01 In
- Pickup time characteristic *IEC-Normal inverse* *IEC-Very inverse* *IEC-Extremely inverse* *IEC-Long inverse* *ANSI-Inverse* *ANSI-Short inverse* *ANSI-Long inverse* *ANSI-Moderately inverse* *ANSI-Very inverse* *ANSI-Extremely inverse* *ANSI-Definite inverse*	kEφ TDEφ	0.05 – 1.00 0.50 – 15.00	step: 0.01 step: 0.01
Cold Load Pickup - CLP pickup value	IEφc>	0.01 – 5.00 In 0.10 – 5.00 In (32QT/VT, Uc)	step: 0.01 In
- CLP pickup time characteristic *IEC-…* *ANSI-…*	kEφc TDEφc	0.05 – 1.00 0.50 – 15.00	step: 0.01 step: 0.01
- Drop-out characteristic	Drop-out	Instant.	
- Working area		1.10 Ip	
- Pickup/release ratio		1.05 Ip (Ip/In ≥ 0,5)	
- Time accuracy		5% pickup value ± 2% current tolerance, 30 ms	
- Pickup current accuracy		2% pickup value or 0.01 In	
- Angle accuracy		±3°	

Sensitive directional earthfault protection with definite time characteristic (ANSI No. 67Ns-DT)

- Current input		IE	
- Voltage inputs		UA, UB, UC / UE	
- Function activation	Func.	OFF IEs> IEs>, IEs>>	
- Polarization	Pol.	UE-c, IE UE-m , IE	
- Mode	Mode	sinφ cosφ	

- Pickup direction - Correction angle	Dir>, Dir>> C. Angle	forward / reverse ± 45°	 step: 1°
- Minimal referred voltage	Umin	0.02 – 0.5 Un 0.10 – 0.5 Un (UE-c)	step: 0.01 Un
- First/second stage - Pickup value	 IEs>, IEs>>	 0.01 – 5.00 In 0.05 – 5.00 In (UE-c)	 step: 0.01 In
- Pickup time characteristic *Definite time*	 tEs >, tEs>>	 0.05 – 300.00 s	 step: 0.01 s
- Reset time	t-reset	0.00 – 60.00 s	step: 0.01 s
Cold Load Pickup - CLP first/second stage - Pickup value	 IEsc>, IEsc>>	 0.01 – 5.00 In 0.05 – 5.00 In (UE-c)	 step: 0.01 In
- Pickup time characteristic *Definite time*	 tEsc>, tEsc>>	 0.05 – 300.00 s	 step: 0.01 s
- Start time		< 60 ms	
- Release time		< 60 ms	
- Pickup/release ratio		0.95 (Ip/In ≥ 0,5)	
- Time accuracy		2% pickup value or10 ms	
- Current accuracy		2% pickup value or 0.01 In	
- Angle accuracy		±3°	

Overvoltage protection (ANSI No. 59)

- Voltage inputs		UA, UB, UC	
- Function activation	Func.	OFF U> U>, U>>	
- Measurement type	Meas.	Uph-ph U2	
- First/second stage - Pickup value - Pickup time characteristic *Definite time*	 U>, U>> t>, t>>	 0.10 – 2.00 Un 0.05 – 300.00 s	 step: 0.01 Un step: 0.01 s
- Pickup/release ratio	R-drop	0,90 – 0,99	step: 0.01
- Pickup time (Uph-ph) - Pickup time (U_2)		< 40 ms < 45 ms	
- Release time(Uph-ph) - Release time (U2)		< 45 ms < 50 ms	
- Voltage accuracy (Uph-ph) - Voltage accuracy (U2)		2% pickup value or 1 V 3% pickup value or 2 V	
- Time accuracy		2% pickup value or 10 ms	

Undervoltage protection (ANSI No. 27)

- Voltage inputs		UA, UB, UC	
- Function activation	Func.	OFF U< U<, U<<	

- Measurement type	Meas.	Uph-ph U1	
- First/second stage - Pickup value - Pickup time characteristic *Definite time*	 U<, U<< t<, t<<	 0.10 – 1.20 Un 0.05 – 300.00 s	 step: 0.01 Un step: 0.01 s
- Pickup/release ratio	R-drop	1,01 – 3,00	step: 0.01
- Current supervision block	CS-block	ON OFF	
- Current threshold	Current thresh.	0.01 – 1.00 In	step: 0.01 In
- Pickup time		< 40 ms	
- Release time		< 45 ms	
- Voltage accuracy (Uph-ph) - Voltage accuracy (U1)		2% pickup value or 1 V 3% pickup value or 2 V	
- Time accuracy		2% pickup value or 10 ms	

Earthfault protection (ANSI No. 59N)

- Voltage inputs		UA, UB, UC / UE	
- Function activation	Func.	OFF UE> UE>, UE>>	
- First/second stage - Pickup value - Pickup time characteristic *Definite time*	 UE>, UE>> t>, t>>	 0.02 – 1.00 Un (3P-UE-m) 0.05 – 1.00 Un (3P-UE-c) 0.05 – 300.00 s	 step: 0.01 Un step: 0.01 s
- Pickup/release ratio	R-drop	0,95 (Ip/In ≥ 0,5)	
- Pickup time		< 45 ms	
- Release time		< 45 ms	
- Voltage accuracy		2% pickup value or 1 V	
- Time accuracy		2% pickup value or 10 ms	

Frequency protection (ANSI No. 81)

- Measurement inputs		UA, UB, UC	
- Function activation	Func.	OFF ON	
- Blocking voltage	Ublock	0.02 – 1.20 Un	step: 0.01 Un
- First/second/third/fourth stage - Pickup value - Pickup time characteristic *Definite time*	 f1/f2/f3/f4 t1/t2/t3/t4	 45.00 – 55.00 Hz 0.1 – 300.00 s	 step:0.01 Hz step: 0.01 s
- Pickup time		Approx. 300 ms	
- Release time		Approx. 300 ms	
- Pickup - release		20 MHz	
- Frequency accuracy		10 MHz	
- Time accuracy		2% pickup value or 10 ms	

Negative sequence overcurrent protection with *definite-time* characteristic (ANSI No. 46-DT)

- Measurement inputs		IA, IB, IC	
- Function activation	Func.	OFF I2> I2>, I2>>	
- First/second stage - Pickup value - Pickup time characteristic *Definite time*	 I2>, I2>> t2>, t2>>	 0.10 – 3.00 In 0.05 – 300.00 s	 step: 0.01 In step: 0.01 s
- Allowed dropdown time	t-drop	0.00 – 60.00 s	step: 0.01 s
- Pickup time		< 45 ms	
- Release time		< 45 ms	
- Pickup/release ratio		0.95 (Ip/In ≥ 0,5)	
- Time accuracy		2% pickup value or 10 ms	
- Current accuracy		3% pickup value or 0.02 In	
- Working area		all phase currents less than 4 In	

Negative sequence overcurrent protection with *inverse-time* characteristic (ANSI No. 46-IT)

- Function activation	Func.	OFF ON	
- Measurement inputs		IA, IB, IC	
- Pickup value	I2>	0.10 – 3.00 In	step: 0.01 In
- Pickup time characteristic *IEC*	 Tp2	 0.05 – 1.00 s	 step: 0.01 s
- Working area		1.10 Ip, phase currents less than 4 In	
- Pickup/release ratio		1.05 Ip (Ip/In ≥ 0,5)	
- Time accuracy		3% + 2% curr measurement error	
- Current accuracy		3% set value or 0.02 In	

** Current unbalance protection (ANSI No. 46DP)

- Measurement inputs		IA, IB, IC	
- Function activation	Func.	OFF ON	
- Pickup value	Iub>	10.0 – 100.0 %	step: 0.1 %
- Pickup time characteristic *Definite time*	 t>	 0.05 – 300.00 s	 step: 0.01 s
- Minimal pickup current	Imin	0.05 – 1.00 In	step: 0.01In
- Pickup time		< 100 ms	
- Release time		< 50 ms	

- Pickup/release ratio		0.95	
- Time accuracy		2% pickup value or 10 ms	

*** on demand*

** Cable thermal overload protection (ANSI No. 49F)

- Measurement inputs		IA, IB, IC	
- Function activation	Func.	OFF ON Alarm only	
- *Task* interval		100 ms	
- Time constant	Time const.	1 – 999 min	step: 1min
- Maximal permanent cable current	I_{CABLE}	1 – 5In	korak: 0,01In
- Ambient temperature	TempAMB	- 40 – 100 ºC	korak: 1ºC
- Referred temperature	TempREF	- 40 – 100 ºC	korak: 1ºC
- Maximal cable temperature	TempMAX	40 – 150 ºC	korak: 1ºC
- Alarm temperature	49F ALARM	50 – 100 % TempMAX	korak: 1%
- Allowed reclosing temperature	TempRECL	40 – 100 % TempMAX	korak: 1%

*** on demand*

Cold load pickup

- Function activation for: 50, 51, 50N, 51N, 67DT, 67IT, 67NDT, 67NIT	Func.	OFF ON	
- Start condition for CLP	Start	no current CB cont.	
- Maximum time of CB being open before CLP	CB t-open	0 – 36 000 s	step: 1 s
- Maximum time of CLP being active	t-active	0 – 36 000 s	step: 1 s

Inrush detection

- Function activation for: 50, 51, 50N, 51N, 67DT, 67IT, 67NDT, 67NIT	Func.	OFF ON	
- Start time prolongation		25 ms	
- Pickup value	2nd	10 – 50 %	step: 1 %
- Maximum inrush current	Imax	0.1 – 30.00 In	step: 0.01 In
- X-block function activation	X-block	OFF ON	
- Duration of X-block function	tx -block	0.00 – 180.00 s	step: 0.01 s

Automated reclosing (ANSI No. 79)

- Function activation	Func.	OFF ON	
- Activating function		50, 50N, 51, 51N, 67, 67N, 67IT, 67NIT, 46, 46IT, external TRIP	
- CB monitoring		- by 2 binary inputs	
- Number of CB closing	n	1 – 5	step: 1
- Block AR by 3 phase fault	Blk. KS3	ON	

		OFF	
- Active time	t active	0.10 – 300.00 s	step: 0.01 s
- First/second/third/fourth stage - *Dead time* - *Reclaim time* - *Definite time*	 td1,td2,td3, td4,td5 tr tdef	 0.10 – 300.00 s 0.10 – 300.00 s 0.10 – 300.00 s	 step: 0.01 s step: 0.01 s step: 0.01 s
- Block 79		- trip by breaker failure protection - trip by trip circuit supervision - local/remote close command	
- Time accuracy		2% pickup value or 10 ms	

Circuit breaker failure protection (ANSI No. 50BF)

- Measurement inputs		IA, IB, IC	
- Function activation	Func.	OFF ON	
- Minimal current for CB being considered closed	Current thresh.	0.01 – 1.00 A	
- Function start		- internal trip signal - local/remote trip	
- Time delay	t-BF	0.05 – 60.00 s	step: 0.01 s
- Time accuracy		2% pickup value or 10 ms	
- Start criteria	CB contact	ON, OFF	

Trip circuit supervision (ANSI No. 74TCS)

- Function activation	Func.	OFF ON	
- Measurement type	Meas.mode	2 bin 1 bin	
- Control current of trip circuit		5 mA	
- Time delay	t>	0.10 – 3.00 s	step: 0.01 s
- Time accuracy		2% pickup value or 10 ms	
- Block manual close and AR	TC fail blk.	ON OFF	

Other functions and parameters

Time synchronization

- Date	Date	[01 - 31] . [01 - 12] . [2000 - 2100]	Day. Month. Year
- Time	Time	[00 - 23] . [00 - 59] . [00 - 59]	Hour. Minute. Second.
- Synchronization manner	Sync.	Internal IRIG-B Comm-103 Bin. input	
- Time after synchronization termination	T-sync.	1 - 65535	min

Energy measurement

- Measurement inputs		IA, IB, IC, UA, UB, UC
- Function activation	Func.	OFF ON
- Register reset	Resetreg	ON
- Positive real energy register	Wp+	0 – 7999999kWh
- Negative real energy register	Wp-	0 – 7999999kWh
- Positive reactive energy register	Wq+	0 – 7999999kVArh
- Negative reactive energy register	Wq-	0 – 7999999kVArh
- Apparent energy register	Ws	0 – 7999999kVAh
- Power factor	PF	-1.00 – 1.00

Disturbance recorder

- Function activation	Func	OFF ON	
- Sampling frequency	Sampl.	1KHz 2KHz	
- *Prefault time*	t-pre	0.05 - 1.00 s	step: 0.01s
- *Postfault time*	t-post	0.05 - 1.00 s	step: 0.01s
- *Limit time*	t-limit	0.1 – 5.0 s	step: 0.1s
- Trigger	trigger:	TRIP PU	

THD Measurement

- Measurement inputs		UA, UB, UC	
- Function activation	Func.	OFF ON	
- Measured voltage	MeasVolt	U1, U2, U3,	
- Measurement mode	Mode	Continuous Demand	
- Measurement interval	MeasInterv	10 min. 3 s	
- Limit value THD factor	LimTHD	0.0 – 30.0%	default 8%
- Statistics period	Period	1h/12h/1d/2d/3d/4d/5d/6d/7d	
- Acceptance percentage	Acceptance	90.0 – 99.5%	

Relay characteristic angle

- Characteristic angle for 67DT and 67 IT	RCA 67	-90 – 90˚	step: 1˚
- Characteristic angle for 67NDT and 67N IT	RCA 67N	-90 – 90˚	step: 1˚

Change group

- Active group selection	Active group	1 – 3	step: 1

Circuit Breaker control

Control type LOCAL/REMOTE:	Control	Front pl. Bin.in.

Records and event logs

Event records and disturbance logging

Event log	Log of all events		500
Trip log	Log of all events related to trip		500
Disturbance log	log of disturbance recordings	2kHz 1kHz	12s / 8 24s / 8
Reset Event log	Delete event log	password	
Reset Trip log	Delete trip log	password	
Reset Disturbance log	Delete disturbance log	password	

System parameters

Transformer ratios

Current transformer primary	CT prim	1 – 2000 A	step: 1 A
Current transformer secondary	CT sec	1 A or 5 A	
Earth current transformer primary	CTE prim	1 – 2000 A	step: 1 A
Earth current transformer secondary	CTE sec	1 A or 5 A	
Voltage transformer primary	VT prim	0,1 - 99,99 kV	step: 0,01 kV
Voltage transformer secondary	VT sec	50,0 – 130,0 V	step: 0,1 V
Earth voltage transformer primary	VTE prim	0,1 - 99,99 kV	step: 0,01 kV
Earth Voltage transformer secondary	VTE sec	50,0 – 130,0 V	step: 0,1 V

Means of voltage connection

Choosing means of voltage connection	VT conn.	3L- UE-m (UE measured) 3P- UE-m (UE measured) 3P- UE-c (UE calculated)	

Circuit breaker

Minimal current to consider CB closed	Curr. thresh	0,01 – 1,00 A	step: 0,01 A

DISPLAY OF MEASUREMENTS ON FRONT PANEL SCREEN

PRIMARY VALUES

A:	Primary value of current IA (A)
B:	Primary value of current IB (A)
C:	Primary value of current IC (A)
E:	Primary value of current IE (A)
AB:	Primary value of line voltage UAB (kV)
BC:	Primary value of line voltage UBC (kV)
CA:	Primary value of line voltage UCA (kV)
E:	Primary value of voltage UE (kV)

SECONDARY VALUES

A:	Secondary value of current IA (A)
B:	Secondary value of current IB (A)
C:	Secondary value of current IC (A)
E:	Secondary value of current IE (A)
AB:	Secondary value of line voltage UAB (V)
BC:	Secondary value of line voltage UBC (V)
CA:	Secondary value of line voltage UCA (V)
E:	Secondary value of voltage UE (V)

NOMINAL VALUES

A x In:	Nominal value of current IA
B x In:	Nominal value of current IB
C x In:	Nominal value of current IC
A x Un (Uph):	Nominal value of phase voltage UA
B x Un (Uph):	Nominal value of phase voltage UB
C x Un (Uph):	Nominal value of phase voltage UC
A x Un (Ulin):	Nominal value of line voltage UAB
B x Un (Ulin):	Nominal value of line voltage UBC
C x Un (Ulin):	Nominal value of line voltage UCA
UE x Un:	Nominal value of ground voltage UE
IE x In:	Nominal value of ground current IE
IE x cosφ xIn :	Nominal value of cos component of IE
I2 x In:	Nominal value of inverse current
U2 x Un:	Nominal value of inverse voltage
I1 x In:	Nominal value of direct current
U1 x Un:	Nominal value of direct voltage

GENERAL VALUES

UBC:	Primary value of line voltage UAB (kV)
IA:	Primary current of current IA (A)
P:	Primary value of real power(MW)
Q:	Primary value of reactive power (MVar)
S:	Primary value of apparent power (MVA)
f:	Frequency (Hz)
cosφ :	Power factor
**** THD**	Total harmonic distortion

** ENERGY

Wp+	Value of positive real energy
Wp-	Value of negative real energy
Wq+	Value of positive reactive energy
Wq-	Value of negative reactive energy
Ws	Value of positive apparent energy

*** on demand*

TYPE CODE

When ordering the relay it is necessary to specify the type code. Detailed description of type capabilities is shown in the following table:

RIUX 6 2 1 - 0 0 A 1 E - 2 0

Function

Series

Variant
2 – Small display

Hardware package
1 – 1x FO (IEC 60870-5-103)
2 – 2x FO (IEC 60870-5-103)
3 – 1x FO (IEC 60870-5-103)
1x FO (IEC 61850)

BI/R0 units 1. slot
0 - No additional units
A - Binary unit A-type (8BI+8RO)
B - Binary unit B-type (16BI)
C - Binary unit C-type (16RO)

BI/R0 units 2. slot
0 - No additional units
A - Binary unit A-type (8BI+8RO)
B - Binary unit B-type (16BI)
C - Binary unit C-type (16RO)

Aux. power supply
A - 80-265Vdc, 230Vac
B - 18-80Vdc

Nominal voltage
1 - 100Vac
2 - 200Vac

Nominal frequency
E - 50Hz
F - 60Hz

Software package
1..9

Rear optical port
0 - Plastic
1 - Glass

LIST OF STANDARD FUNCTIONS FOR INDIVIDUAL RELAY TYPE

RIUX SW package 2 (SLOT1 of the device consists of a KTU 001 unit)

IEC	ANSI	FUNCTION DESCRIPTION/RELAY TYPE	RIUX 621	RIUX 622	RIUX 623
		Protection functions - current			
I>,>>	**50**	Overcurrent protection with DT characteristic	•	•	•
I>>>	**50**	Overcurrent protection with DT characteristic		•	•
I>	**51**	Overcurrent protection with IDMT characteristic	•	•	•
I_E>,>>	**50N**	Earthfault protection with DT characteristic	•	•	•
I_E>>>	**50N**	Earthfault protection with DT characteristic		•	•
I_E>	**51N**	Earthfault protection with IDMT characteristic	•	•	•
I_{dir}>,>>	**67DT**	Directional overcurrent protection with DT characteristic	•	•	•
I_{dir}>>>	**67DT**	Directional overcurrent protection with DT characteristic		•	•
I_{Edir}>	**67IT**	Directional overcurrent protection with IDMT characteristic	•	•	•
I_{Edir}>,>>	**67NDT**	Directional earthfault protection with DT characteristic	•	•	•
I_{Edir}>>>	**67NDT**	Directional earthfault protection with DT characteristic		•	•
I_{Edir}>	**67NIT**	Directional earthfault protection with IDMT characteristic	•	•	•
I_{EE}>,>>	**67Ns**	Sensitive directional earthfault protection	•	•	•
I_2>,>>	**46DT**	Negative sequence overcurrent protection with DT characteristic	•	•	•
I_2>	**46IT**	Negative sequence overcurrent protection with IDMT characteristic	•	•	•
	INR	Inrush Restraint	•	•	•
		Protection functions - voltage			
U>,>>	**59**	Overvoltage protection	•	•	•
U_E>,>>	**59N**	Earthfault (voltage) protection	•	•	•
U<,<<	**27**	Undervoltage protection	•	•	•
f> / f<	**81**	Over/under frequency protection	•	•	•
		Supervisory functions			
	50BF	Breaker faliure protection	•	•	•
$0 \rightarrow 1$	**79**	Auto reclosing	•	•	•
	74TC	Trip circuit supervision(TCS1, TCS2)	•	•	•
		Time sincronization	•	•	•
		Event logger(event recorder + trip logger)	•	•	•
		Disturbance recorder	•	•	•
		Managment level (local/remote)	•	•	•
		Measurment			
		3xI, IE, 3xUf, 3xUL, UE, sim. comp., I1, U1, I2, U2, P, Q, S, cos φ, f,	•	•	•
		Control			
		Breaker control	•	•	•

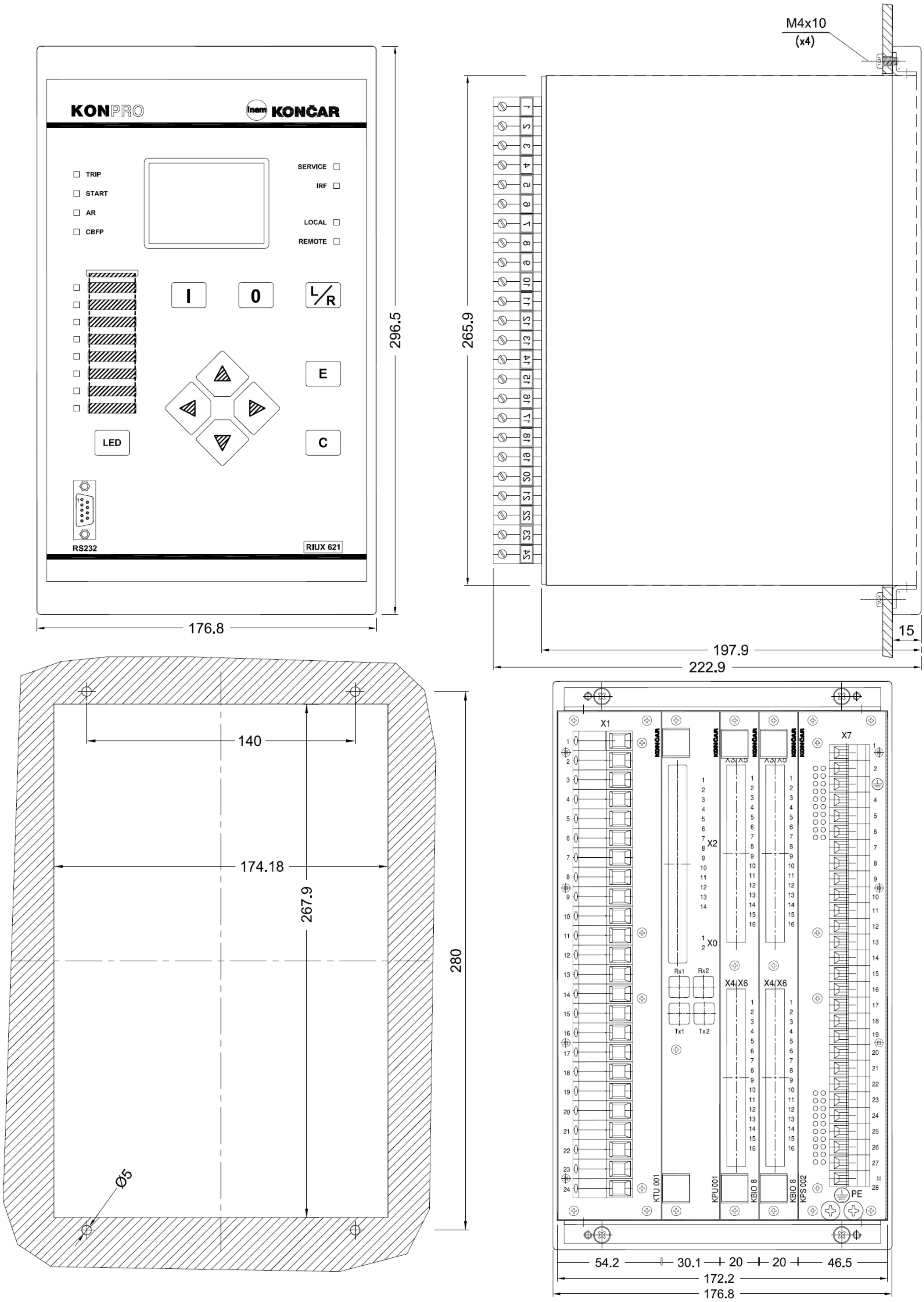
RIUX SW package 3 (SLOT1 of the device consists of a KTU 002 unit)

IEC	ANSI	FUNCTION DESCRIPTION/RELAY TYPE	RIUX 621	RIUX 622	RIUX 623
		Protection functions - current			
I>,>>	**50**	Overcurrent protection with DT characteristic	•	•	•
I>>>	**50**	Overcurrent protection with DT characteristic		•	•
I>	**51**	Overcurrent protection with IDMT characteristic	•	•	•
I_E>,>>	**50N**	Earthfault protection with DT characteristic	•	•	•
I_E>>>	**50N**	Earthfault protection with DT characteristic		•	•
I_E>	**51N**	Earthfault protection with IDMT characteristic	•	•	•
I_2>,>>	**46DT**	Negative sequence overcurrent protection with DT characteristic	•	•	•
I_2>	**46IT**	Negative sequence overcurrent protection with IDMT characteristic	•	•	•
	INR	Inrush Restraint	•	•	•
		Supervisory functions			
	50BF	Breaker faliure protection	•	•	•
0 → 1	**79**	Auto reclosing	•	•	•
	74TC	Trip circuit supervision(TCS1, TCS2)	•	•	•
		Time sincronization	•	•	•
		Event logger(event recorder + trip logger)	•	•	•
		Disturbance recorder	•	•	•
		Managment level (local/remote)	•	•	•
		Measurment			
		3xI, IE, sim. comp., I1, I2	•	•	•
		Control			
		Breaker control	•	•	•

RIUX SW package 4 (SLOT1 of the device consists of a KTU 003 unit)

IEC	ANSI	FUNCTION DESCRIPTION/RELAY TYPE	RIUX 621	RIUX 622	RIUX 623
		Protection functions - voltage			
U>,>>	**59**	Overvoltage protection	•	•	•
U_E>,>>	**59N**	Earthfault (voltage) protection	•	•	•
U<,<<	**27**	Undervoltage protection	•	•	•
f> / f<	**81**	Over/under frequency protection	•	•	•
		Supervisory functions			
	74TC	Trip circuit supervision(TCS1, TCS2)	•	•	•
		Time sincronization	•	•	•
		Event logger(event recorder + trip logger)	•	•	•
		Disturbance recorder	•	•	•
		Managment level (local/remote)	•	•	•
		Measurment			
		3xUf, 3xUL, UE, sim. comp. U1, U2	•	•	•
		Control			
		Breaker control	•	•	•

MEASURMENT SCHEMATIC AND RELAY DIMENSIONS



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