Končar Electronics and Informatics, Inc

Secondary equipment

TECHNICAL DESCRIPTION

KONPRO

RFD

Numerical protection relay

Secondary equipment

RFD

MULTIFUNCIONAL TRANSFORMER DIFFERENCIAL PROTECTION RELAY

Description

Guided by years of experience in the development and application of protective relays, the development team at KONČAR - Electronics and Informatics Inc. has developed a device that can respond to all the demands that are presently facing this type of equipment. As a part of the present generation KONPRO RFD is added to the group of devices that offer a complete range of protective functions required for reliable protection of two winding power transformers and the ability to view and control for multiple devices. Thanks to its architecture and modular software solution it is applicable for the protection of all two winding transformers.

Apart from the basic protective role, relays provide a number of other features that are currently required for protection relays, which allows reducing the number of devices in the field, which results in reducing the cost of maintenance of equipment. The most important options that should be noted are local and remote display of all currently measured values, control of all switchgear in the field, their management, recording of faults, transformer temperature monitoring, controlling switchgear wear and transmission of data to the SCADA system.

Time characteristics for trip delay according to IEC and IEEE standards allow easy integration into existing relay protection systems, while maintaining time selectivity applied in the system. Three groups of settings of protective functions enable rapid adaptation to changes in the system of protection.

The high degree of programmability derived from using the program matrix makes it easy to connect signals to digital inputs and relay outputs of the device.

The ability to create your own control scheme makes it easy to configure the relay. Modular hardware and software architecture allows the relay, with the use of basic safety features contained in the basic program package devices, adding additional safety features, according to user needs. Integrated software allows you to change most of the parameters of protective functions via the front panel. Full adjustment and readout of the parameters of the relay is performed via computer.

Protection functions

Quick adjustment of the relay to the conditions in the plant is allowed by three groups of settings variable via communication or via binary input. In all three groups, there are the following protective functions:

- Stabilized three-phase differential protection
  (ANSI No. 87T)
- Stabilized, limited, low-impedance earth-fault protection of transformer primary
  (ANSI No. 87TN-A)
- Stabilized, limited, low-impedance earth-fault protection of transformer secondary
  (ANSI No. 87TN-B)
- Limited, high impedance earth-fault protection of transformers
  (ANSI No. 87N)
- Overcurrent protection of transformer primary
  (ANSI No. 50-A, 51-A)
- Ground current protection of transformer primary
  (ANSI No. 50N-A, 51N-A)
- Ground current protection of transformer secondary
  (ANSI No. 50N-B, 51N-B)
- Primary transformer unbalance current protection
  (ANSI No. 46DT-A, 46IT-A)
- Primary transformer loss of phase protection
  (ANSI No. 46DP-A)
- Transformer thermal overload protection
  (ANSI No. 49T)
- Primary circuit breaker failure protection
  (ANSI No. 50BF)
- Inrush protection (based on 2. harmonic)
- Trip circuit supervision of primary and secondary
  (ANSI No. 74TCS)
- Thermic supervision by temperature measurement
  (ANSI No. 23)

Secondary equipment

RFD

KONČAR

Control / monitoring functions

- Predefined binary inputs for circuit breaker supervision (BI1, BI2, BI3 and BI4)
- Predefined relay outputs for circuit breaker control (RO1, RO2, RO3 and RO4)
- Programmable binary inputs and relay outputs for signalization and control of other switchgear
- Programmable binary inputs for other signals
- Programmable relay outputs for signalization
- Control of relay outputs for switching of apparatus locally and remotely

Measurement functions

- Currents: I_{AA}, I_{BA}, I_{CA}, I_{EA}, I_{AB}, I_{BB}, I_{CB}, I_{EB}
- Symmetrical components: I_{1A}, I_{2A} , I_{1B}, I_{2B}
- Differential values: dI_A, dI_B , dI_C, dI_E

Fault analysis functions

- Event recorder:

  - *Event recorder*
  - *Trip recorder*
  - view on the relay screen and with the PC software

- Disturbance recorder:

  - *Disturbance recorder*
  - view with the PC software
  - can be triggered by binary input

Communication

- Locally:

  - Front human-machine interface (membrane keyboards, LCD)
  - front communication interface: COM1 (USB)

- Remotely:
  Rear optic interfaces:
  - COM0 (service / system)
  - COM2 (service / system)

- Communication protocols:
  - IEC 60870-5-103
  - IEC 61850

Other functions

- Time synchronization
  IRIG B, front panel, software
- Constant self-supervision
- Test option trough PC software

User interface

- Graphic LCD – 160x128 points
- Possibility of defining schematics
- 4 predefined and 12 programmable LEDs
- Setting of parameters and control of apparatus separated by different passwords

Measurement inputs

- 8 current inputs – 1A, 5A

Binary inputs and relay outputs

- 8 binary inputs
  (3 programmable, 52AA, 52BA, 52AB, 52BB, IRIG)
- 8 relay outputs
  (3 programmable, CBA TRIP, CBA CLOSE, CBB TRIP, CBB CLOSE, IRF)
- Possibility of adding up to two BI/BO units of A, B, C or D type
- A type – 8 binary inputs and 8 relay outputs
- B type – 16 binary inputs
- C type – 16 relay outputs
- D type – 7 RTD inputs and 2 analog inputs**

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

(a detailed description of the types of relays is visible from the ordering codes and tables with a list of functions)

*** on demand*

The unit housing and connection

The housing of the device is planned for installation on the mounting plate with a membrane keyboard on the front side and the connection terminals on the back.

- Dimensions:
  (HxWxD = 296.5 x 176.8 x 222.9 mm).

  Dimensions of the hole on the mounting plate are 267.9 X174, 2mm. The navigation keys on the front panel allow easy navigation through menus of the relay, while for the local display of parameters and measured values we are using a graphical display and 16 additional LED.

- Connecting the relay to the PowerStation is done through connection terminals for wires of crossection 10mm2 (for measuring inputs), 4mm2 (for relay outputs) and 2.5mm2 (the binary inputs). Built in analog inputs card is adapted for current inputs of 1A, 5A and 0.2A ** for all device types. For local communication with a computer we are using the standard USB interface. For the realization of remote communication two optical interfaces with an optical plastic line with V-pin connector located on the rear of the device are used. At request of the relay can be supplied with a glass optical interface for receiving an optical ST connector.

- Set-architecture of the device has a modular structure, which through the change of hardware modules enables cheaper maintenance and simple adjustment of the device almost all the requirements of the plant.

- Thanks to this performance relays can be set to protect nearly all two winding transformers. Additional power inputs for measuring ground current of primary and secondary enables fault detection in different types of failures and prevent unwanted trips of differential protection.

Figure 1 Front side of the relay

Figure 2 Back side of the relay

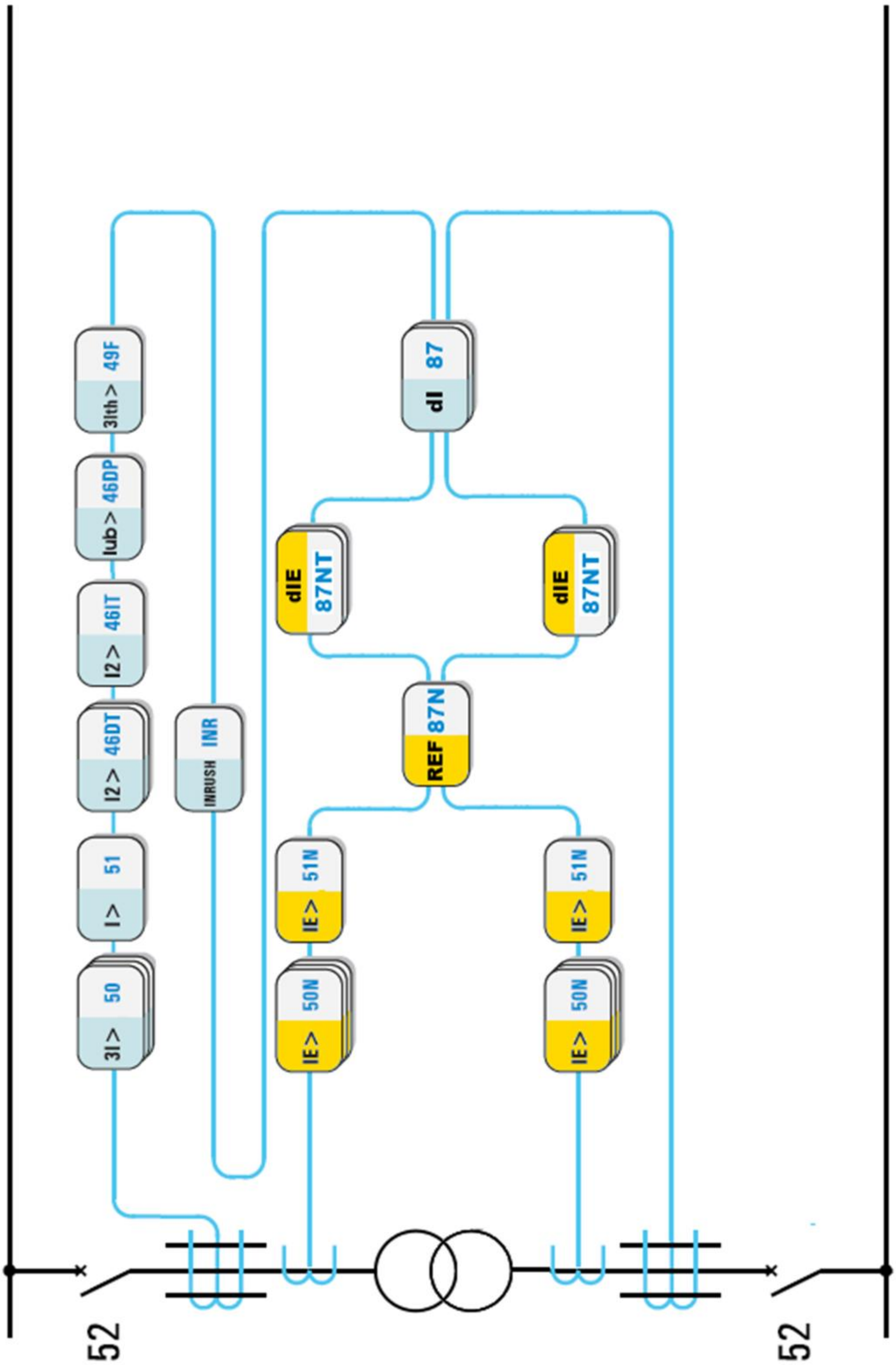


Figure 3 Block scheme of the RFD relay

Collective review of RFD protective relay functions

ANSI marking	IEC marking	Function
87T – Differential	dI>/>>	Stabilized differential protection
87TN-A Earth fault differential	dI_{EA}>/>>	Stabilized, limited, low impendant earth-fault protection of transformer primary
87TN-B Earth fault differential	dI_{EB}>/>>	Stabilized, limited, low impendant earth-fault protection of transformer secondary
87N Restricted earth fault	dI_{REF}>	Limited, high impendant earth protection
50-A – Phase OC	I>/>>/>>>	Overcurrent protection with *definite time* characteristic
51-A – Phase OC	I>	Overcurrent protection with *inverse time* characteristic
50N-A – Earth OC	I_{EA}>/>>/>>>	Primary ground current protection with *definite time* characteristic
51N-A – Earth OC	I_{EA}>	Primary ground current protection with *inverse time* characteristic
50N-B – Earth OC	I_{EB}>/>>/>>>	Secondary ground current protection with *definite time* characteristic
51N-B – Earth OC	I_{EB}>	Secondary ground current protection with *inverse time* characteristic
46DT-A – Neg. Seq.	I_2>/>>	Primary negative sequence protection with *definite time* characteristic
46IT-A – Neg. Seq.	I_2>	Primary negative sequence protection with *inverse time* characteristic
46DP-A – Unbalance	I_{ub}>	Primary loss of phase protection
49T – Thermal Ov.	$3I_{th}$>	Transformer thermal overload protection
50BF		Primary breaker failure protection

- **Stabilized differential protection (87T)**

Differential protection is a basic protection of power transformers. It works without any time delay. It protects them in relation to the intermediate short circuits, as well as in relation to the earthing at HV side of the transformer, and in the case of fault in the compounds of the transformer. Protecting the power transformer with differential protection is complex, because its rated current for HV and LV side are different amounts. In addition, in various groups of connections (Triangle - star) currents on the HV and LV side of the transformer are not the same in magnitude and phase angle that depends on the hour number of the transformers. Simply by changing the parameters that describe the type of transformer and ratios of current transformers, relay adjusts the angle and the amount of current in the primary and the secondary. By entering the correction coefficient it further stabilizes the protection. To eliminate unwanted tripping of faults outside of protection zones there is the possibility of eliminating ground currents.

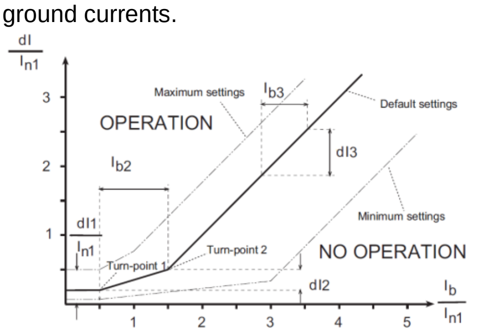


Figure 4 The tripping curve of differential protection

The function consists of one stabilized level and of one standard level. How at the start of the transformer seldom occur large surge currents that may cause undesired operation of differential protection a block of the stabilized stage of differential protection can be performed. The blockade is performed by detecting the second or fifth or both harmonic in the current.

- **Stabilized, limited, low impedance ground current protection of the transformer (87TN-A/B)**

Restricted earth-fault protection of transformer is used for sensitive detection of fault of one of the windings of the transformer. This type of transformer fault detection in general is much more sensitive than the differential protection fault in the transformer. Restricted earth-fault protection as well as differential protection works by comparing the current.
The protection is comprised of one degree. This level is stabilized with respect to the amount of current through the transformer and is subject to the blockade in the detection of energization.

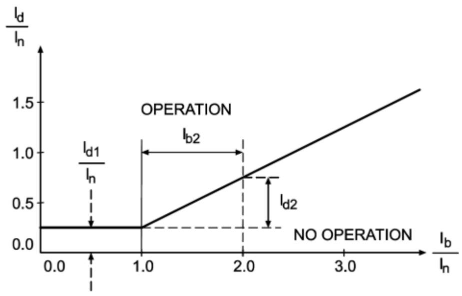


Figure 5 Tripping curve for 87TN

- **Limited, high impedance ground current protection of the transformer (87N)**

Restricted earth-fault protection of transformer is used for sensitive detection of fault of one of the windings of the transformer. This type of transformer fault detection in general is much more sensitive than the differential protection fault in the transformer. Differential fault current can be measured using the circuit in Figure 6 Outdoor unit is shown in Figure 6 consists of four current transformers which measure the phase currents and earth current and stabilization resistor Rs and a variable resistor Ru.

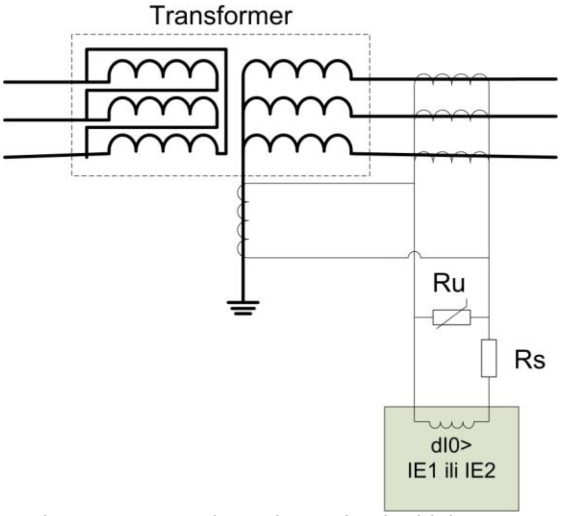


Figure 6 Connection scheme for the high impedance ground current transformer protection

The function can be used on the primary or secondary winding. The variable resistor is required in the case of large overvoltages.

- **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.

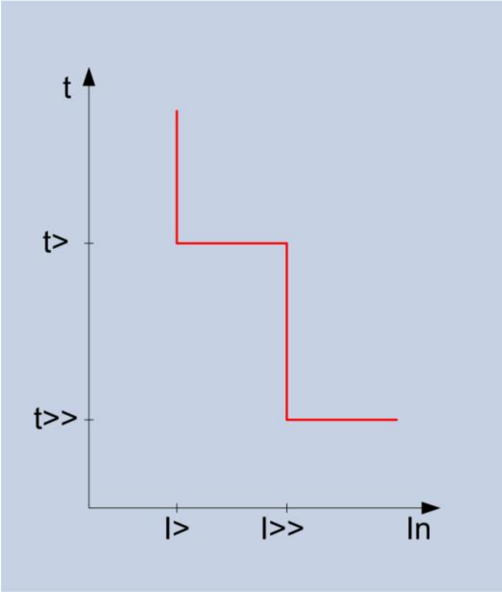


Figure 7 Pickup characteristics of overcurrent protection with definite time

- **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.

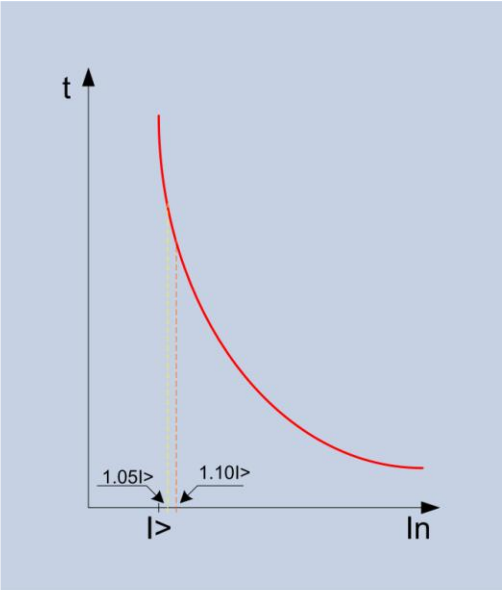


Figure 8 Pickup characteristics of overcurrent protection with inverse time

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

- **Earth fault 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 a very small current. Parameterization, as well as pickup of the protection is possible for just 1% of nominal current value.

- **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.

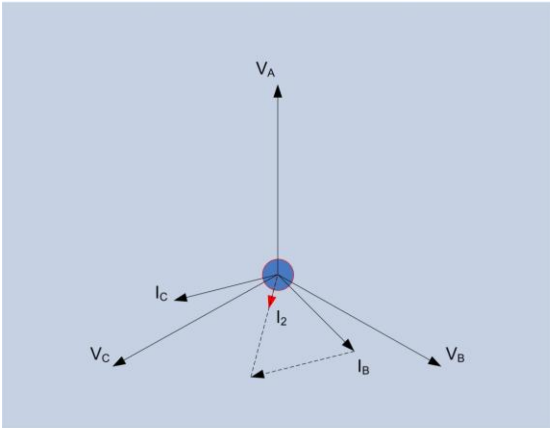


Figure 9: The calculation of current I_2 with one phase missing

- **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 is 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 calculate minimal and maximal values i.e. the unbalance current.

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

- **Transformer thermal overload protection (49T-Thermal Ov.)**

Protection against thermal overload of transformers is intended for thermal protection of the transformer. The principle of operation is based on the function of the thermal model with two time constants, which are used for heating and cooling the transformer. In both cases, the protection algorithm is used to calculate the temperature of the exponential curve. The term used for this is:

$$Temp = \left[p \cdot \left(\frac{I}{I_{n1}}\right)^2 \cdot \Delta\Theta_n\right] \cdot \left(1 - e^{-\frac{t}{\tau_1}}\right) + \left[(1-p) \cdot \left(\frac{I}{I_{n1}}\right)^2 \cdot \Delta\Theta_n\right] \cdot \left(1 - e^{-\frac{t}{\tau_2}}\right) + Tamb$$

When the calculated value of the current assumes a value greater than or equal to the set value it will generate the predefined signals.

- **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 through the second tripping circuit, or to trip the 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. If that current exceeds the parameter set by function *Current threshold* (0,05In=default), the function deduces that the switch remains closed. After the expiration of time function set by parameter *t-BF*, the function will generate the trip signal on the corresponding relay output. Given that at RFD devices we have two trip circuits only the primary one is monitored and if he is not tripped function generates a trip signal.

- **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.

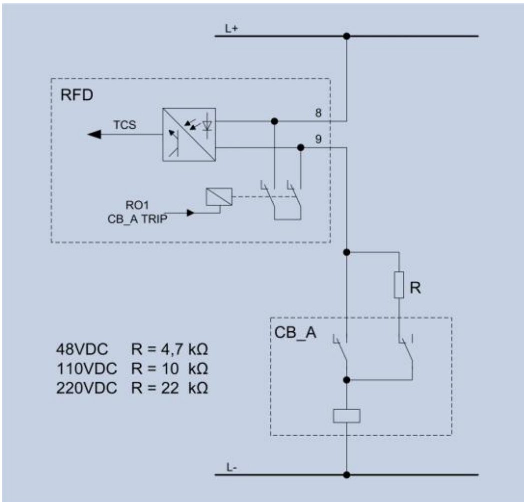


Figure 10. Primary trip circuit failure supervision

As with the device RFD there is a switch at primary and secondary side of the transformer so there are two control tripping circuit which can be activated separately. In addition, a request in case of TC failure is the need to block the 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.

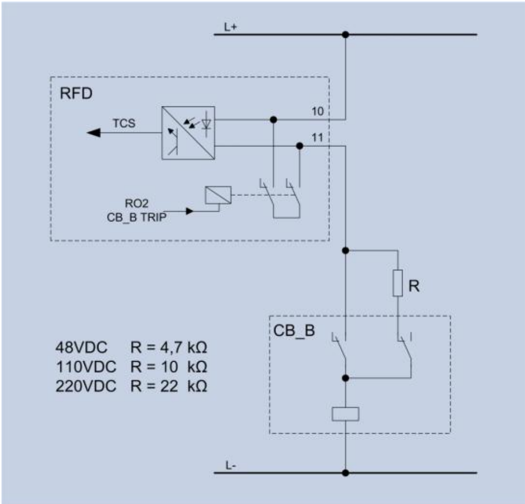


Figure 11. Secondary trip circuit failure supervision

- **Transformer thermal supervision by temperature measurement (23 Therm. sup.)**

The function of thermal supervision of the transformer temperature by measurement allows continuous monitoring of the temperature in seven points using RTD elements. The measured resistance values from each of the connected RTD elements are processed in seven equal mutually independent algorithms. The choice of two levels of settings for each element enabling applications in various plants. Measured temperature values are available to users via the HMI interface and via serial communication interfaces. Detecting errors in one of the connected RTD elements generates information errors and blocking the issuance of the signal pickup.

- **Apparatus wear monitoring**

Circuit breaker wear monitoring function, which is usually performed as an additional function in the relay protection, gives a good enough insight into the MV circuit breaker, and as such allows the rationalization of maintenance costs. Circuit breaker wear usually depends on the tripping current and therefore tripping currents in all three phases are taken as measuring inputs of the specified function. With circuit wear monitoring over current an overview of the number of trips, operating time and number of manipulations for all other apparatus is given.

- **Transformer energization detection (InRush)**

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, ground current protection and limited low impedance ground current protection which could in cases like these, result in unwanted trip.

- **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 backup allows undisturbed work of the clock mechanism even after auxiliary power failure or disappearance.

- **Complete adjustment to facility equipment**

The circuit and software architecture of protective relays allows adjustment of protection to implemented measurement transformers and switches in the facility. 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 setting 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 lists in 2ms intervals. The selection of events that are to be stored is chosen via software support.

The integrated battery allows storing of all events even after auxiliary device power supply 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.

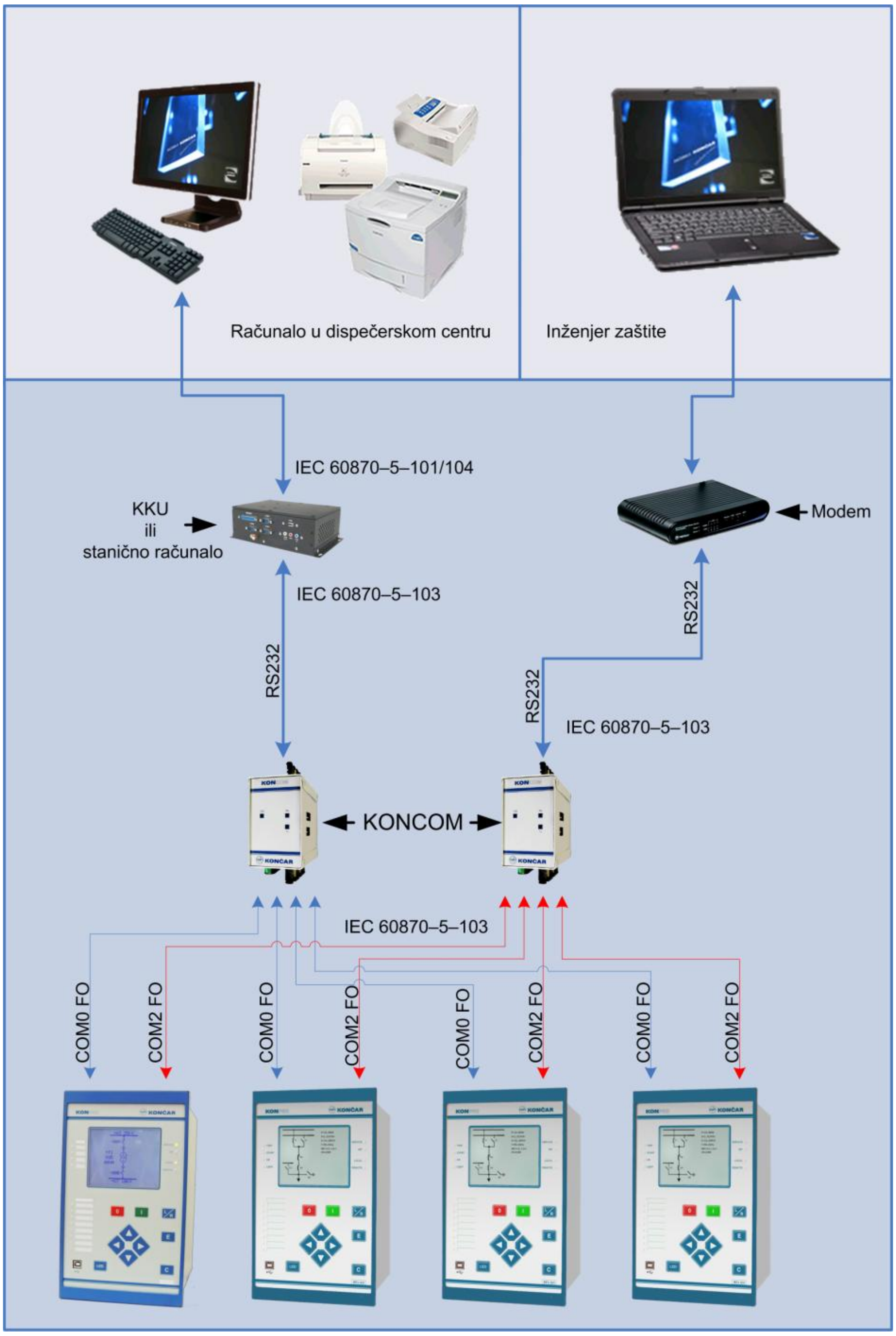


Figure 12. Communications connection schematic for facilities

The figure 12 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 a relay, 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.

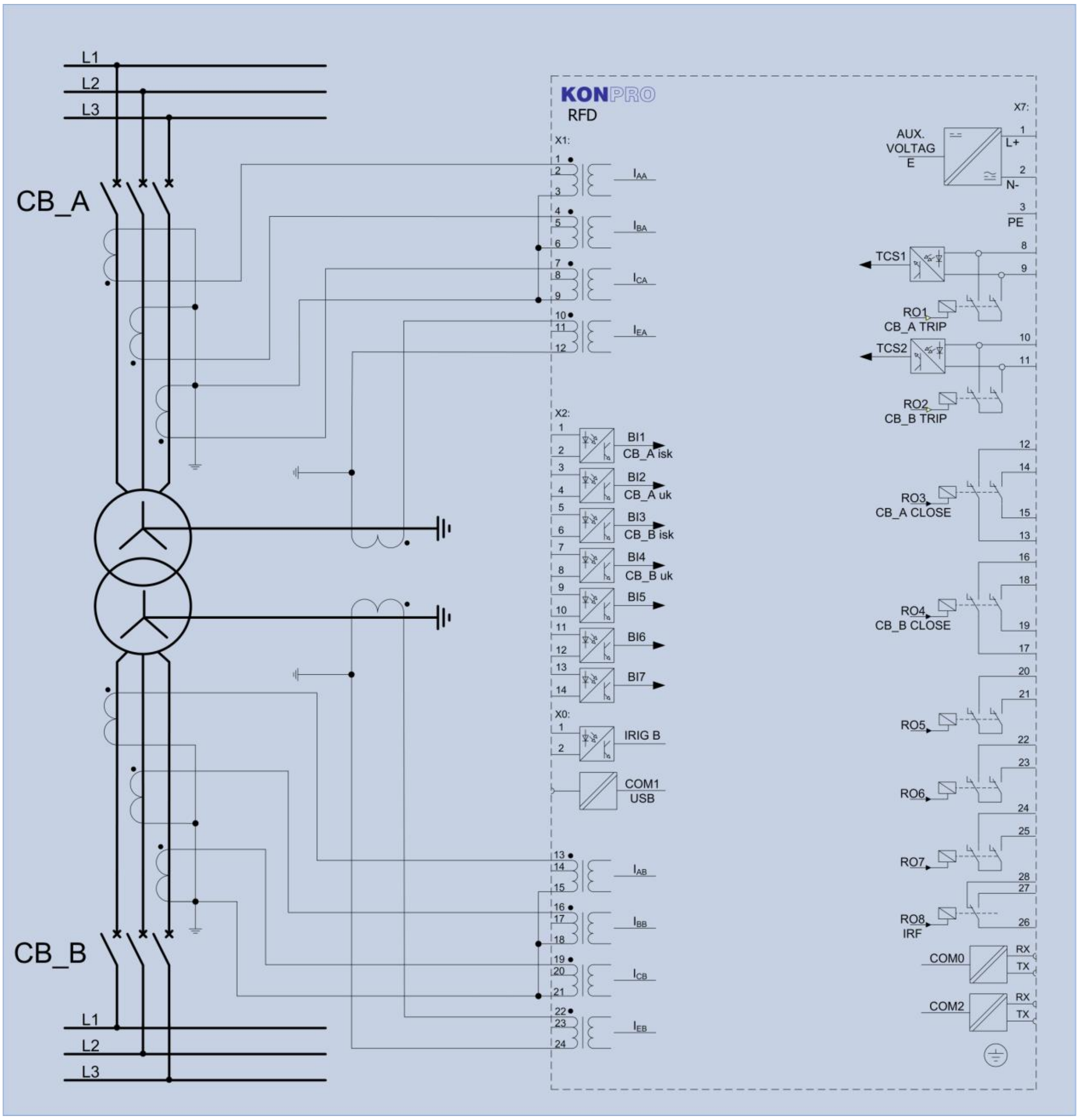


Figure 13. Common connectivity schematic of basic relay types to measurement transformers, with breaker state monitoring

- **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, and send a lot of signals as well. In order to fulfil all potential demands, relays allow expansion of circuitry with additional binary input and relay output expansion boards.

We offer three types of units, as shown on figure 14. 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.

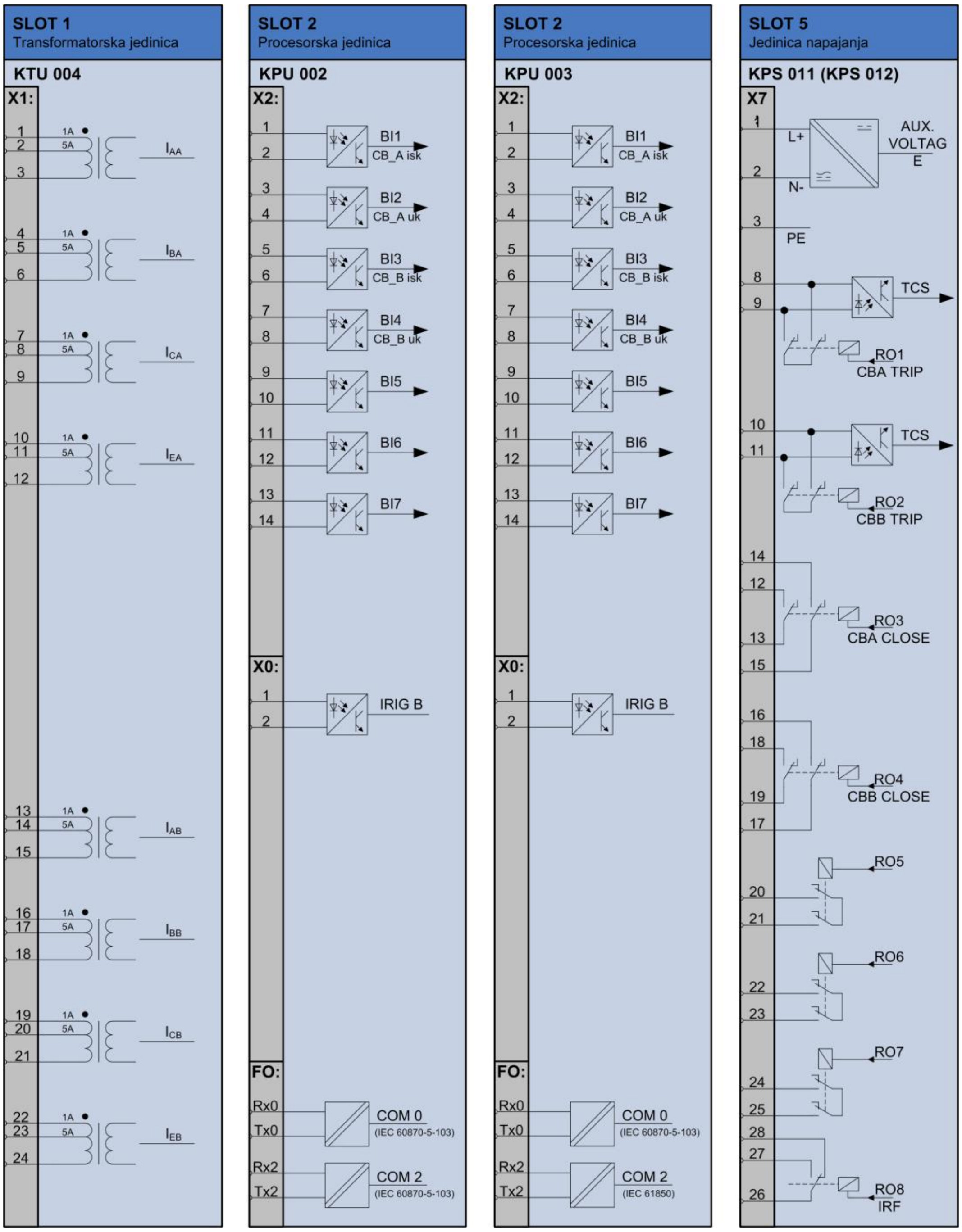


Figure 14. Schematic of basic and additional relay modules

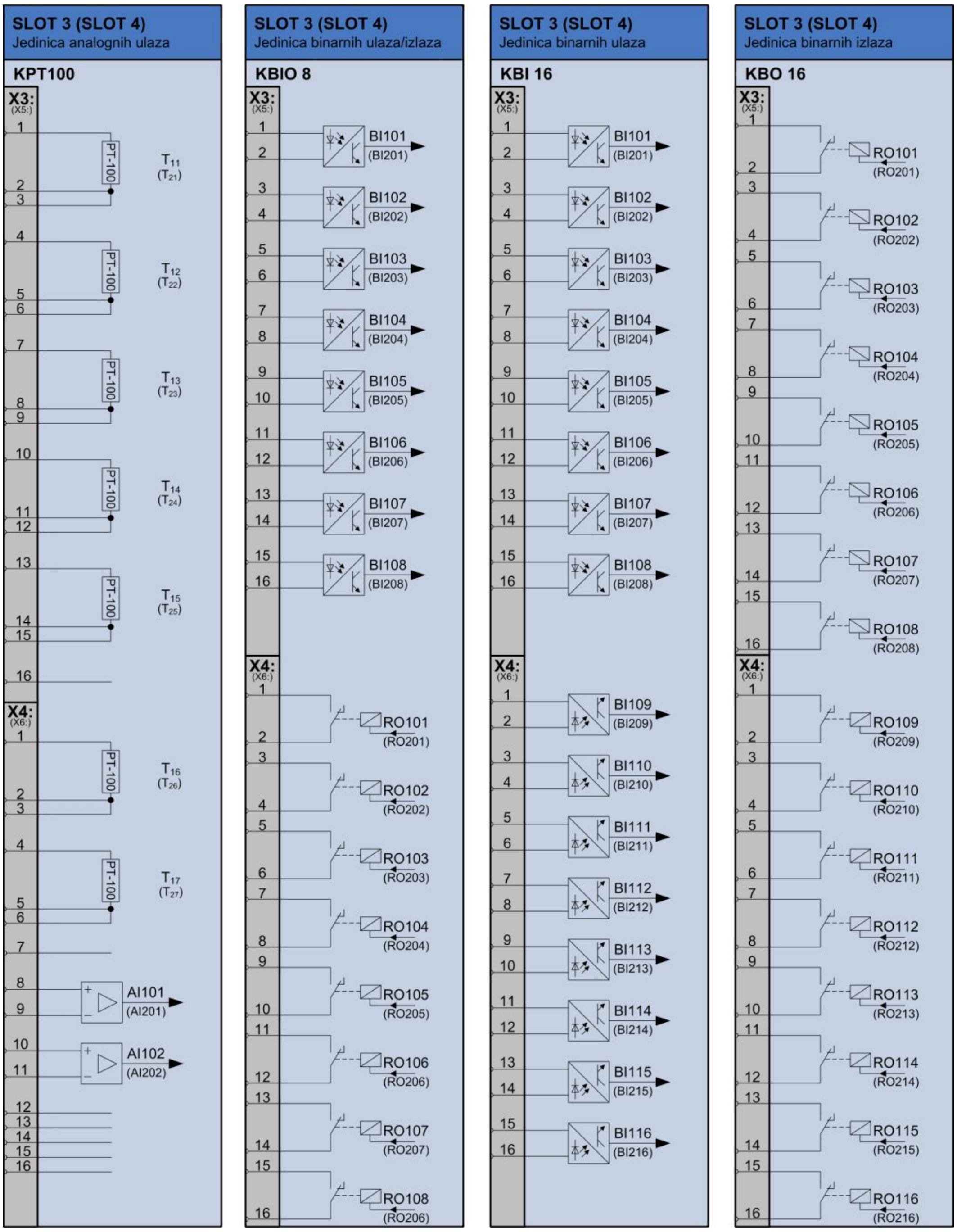


Figure 15. Schematic of basic and additional relay modules

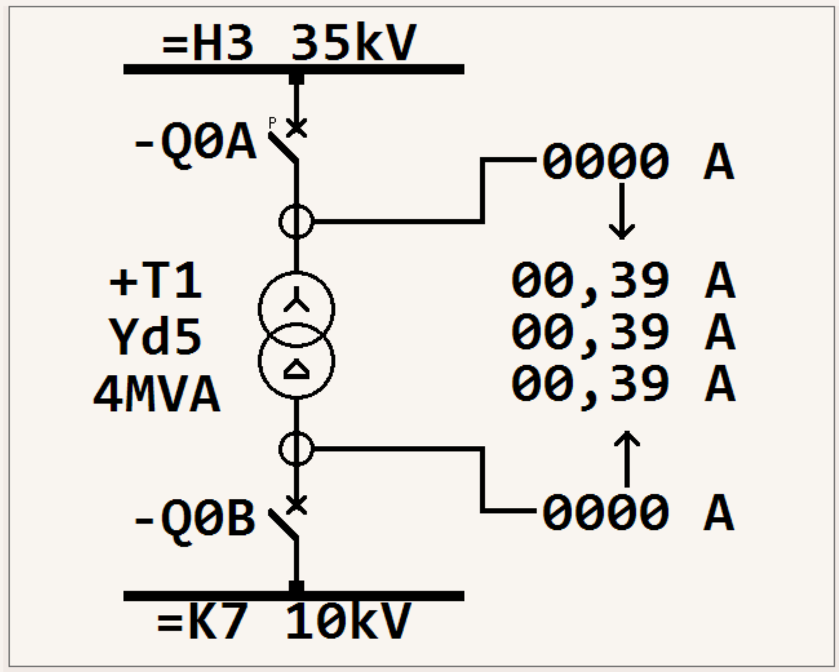
- **HMI interface**

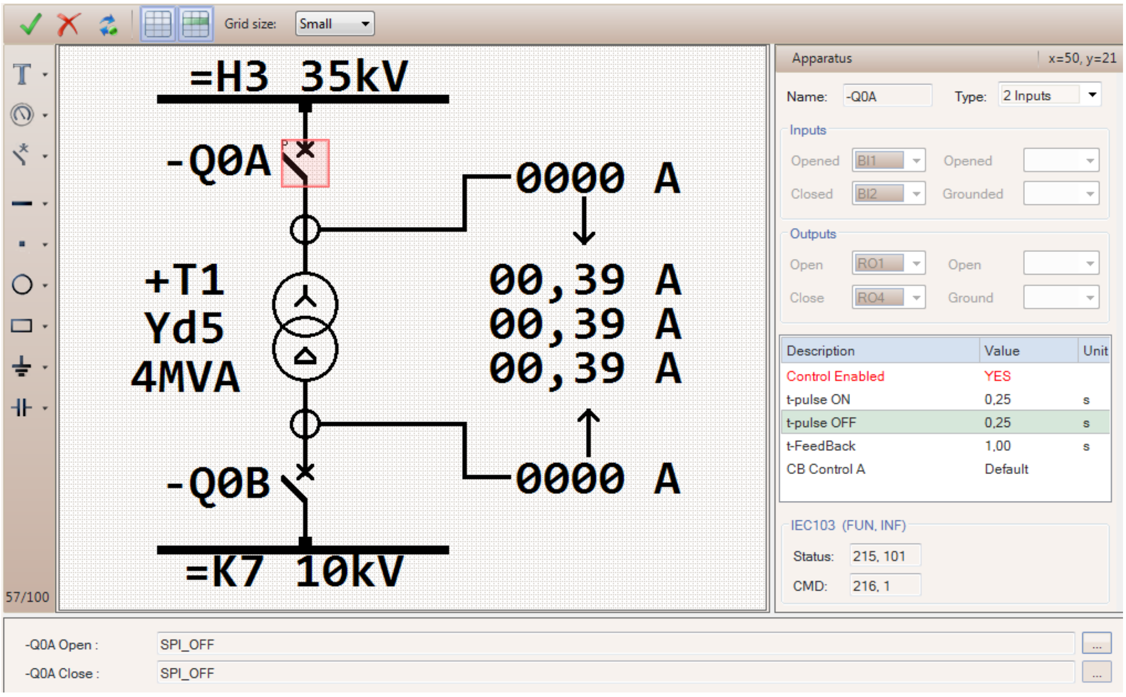
HMI interface gives the user a visual overview of the state of the plant, quick and easy access to the parameters and control of devices in the field. The main display includes the following:

- Single line diagram with the current state of the field apparatus showing all devices in the field
- Measured electrical values

HMI interface is completely configurable by the user. Since the switching devices change state during operation, there are four tags for each apparatus used to indicate the possible states: closed, open, intermediate, undefined. With the single line diagram display fields are associated with certain measurement depending on the type of scheme.

- **Examples of schemes**





TECHNICAL DATA

MEASUREMENT INPUTS

Current inputs

- Number of inputs	8
- Rated current	1 A, 5A
- 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

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

Analog inputs**

- Additional card D-type O/I units	8 RTD inputs 2 analog inputs
Measurement area of RTD input	-45 – 250 °C
Measurement accuracy of RTD input	1°C
Measurement area of analog input	0-20 mA
Measurement accuracy of analog input	0,5%

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

*** on demand*

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

Measurement accuracy

Currents	In range of 10-200% In 0,5% In or 1% current value
Temperature	1°C
Analog inputs	0,5%

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 of 1MHz, IEC 60255-22-1, class III	2.5kV peak value1MHz 400 waves at sec, for 2s
- Electrostatic discharge, IEC 60255-22-2 IEC 61000-4-2 + A1 + A2	±6kV by contact, ±8kV through air ±4kV by contact, ±8kV through air
- Resistance to electromagnetic field radiation IEC 60255-22-3 IEC 61000-4-3 + A1 + A2	10V/m, 27-500MHz, 80-1000MHz 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	1.2/50µs, DC clamps: ±1kV dif, ±2kV comm.
IEC 61000-4-5	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

Secondary equipment

RFD

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	8-35Hz 1g x axis, 0.5g y axis, class 1 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

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Protection functions

Stabilized three phase differential transformer protection (ANSI No. 87T)

- Measurement inputs		IAA, IBA, ICA IAB, IBB, ICB	
- Function activation	Func.	OFF ON	
- *task* interval		5 ms	
- Pickup value	dI-basic	5 – 50 %	default: 20 %
- Pickup value	dI-start	10 – 50 %	default: 30 %
- Pickup value	TP2	100 – 300 %	default: 150 %
- 2. stage pickup value	dI>>	0.50 – 30.00 In	default: 1.00 In
- harmonic block function activation	HarmBLK	OFF 2nd 5th 2nd, 5th	
- 2. harmonic pickup value	2nd BLK	7 – 20 %	default: 15 %
- 5. harmonic pickup value	5th BLK	10 – 50 %	default: 35 %
- maximum inrush current	Imax	1.00 – 20.00 In	default: 7.00 In

Stabilized low impedance restricted earth-fault protection of transformer primary (ANSI No. 87TN-A)

- Measurement inputs		IAA, IBA, ICA, IEA	
- Function activation	Func.	OFF ON	
- *task* interval		5 ms	
- Pickup value	$dI_{0A}>$	5 – 50 %	default: 20 %
- time delay	t>	0,00 – 300,00 s	default: 0,05 s
- blocking by inrush function activation	InRushBLK	OFF ON	default: OFF

Stabilized low impedance restricted earth-fault protection of transformer secondary (ANSI No. 87TN-B)

- Measurement inputs		IAB, IBB, ICB, IEB	
- Function activation	Func.	OFF ON	
- *task* interval		5 ms	
- Pickup value	$dI_{0A}>$	5 – 50 %	default: 20 %
- time delay	t>	0,00 – 300,00 s	default: 0,05 s
- blocking by inrush function activation	InRushBLK	OFF ON	default: OFF

High impedance restricted earth-fault protection of transformers *(ANSI 87N, IEC ΔI₀>, REF)*

- Measurement inputs		IEA, IEB	
- Function activation	Func.	OFF ON	
- *task* interval		5 ms	
- Source current input	Source	IEA IEB	default: IEA
- Pickup value	dI_0>	5 – 50 %	default: 20 %

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

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

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

- Measurement inputs		IAA, IBA, ICA	
- Function activation	Func.	OFF ON	
- Pickup value	I>	0.10 – 5.00 In	step: 0.01 In
- Pickup time characteristic			
IEC-Normal inverse	k	0.05 – 1.00	step: 0.01
IEC-Very inverse			
IEC-Extremely inverse			
IEC-Long inverse			
ANSI-Inverse	TD	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*			
- Drop-out characteristic	Drop-out	Instant.	
- Working area - Release value		1.10 Ip 1.05 Ip (Ip/In ≥ 0,5)	
- Pickup current accuracy		5% pickup value. ± 2% current tolerance, 30 ms	
- Time accuracy		2% pickup value or 0.01 In	

Primary earthfault protection with definite time characteristic (ANSI No. 50N-A)

- Measurement input		IEA	
- Function activation	Func.	OFF IE> IE>, IE>> IE>, IE>>, IE>>>	
- First/second/third stage - Pickup value - Pickup time characteristic *Definite time*	 IE>, IE>>, IE>>> tE>, tE>>, tE>>>	 0.01 – 10.00 In 0.00 – 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
- 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	

Primary earthfault protection with inverse time characteristic (ANSI No. 51N-A)

- Measurement input		IEA	
- Function activation	Func.	OFF ON	
- Pickup value	IE>	0.01 – 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*	 kE TDE	 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/In ≥ 0,5)	

- Pickup current accuracy		5% pickup value. ± 2% current tolerance, 30 ms	
- Time accuracy		2% pickup value or 0.01 In	

Secondary earthfault protection with definite time characteristic (ANSI No. 50N-B)

- Measurement input		IEB	
- 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
- 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	

Secondary earthfault protection with inverse time characteristic (ANSI No. 51N-B)

- Measurement input		IEB	
- 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			
- 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	

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

- Measurement inputs		IAA, IBA, ICA	
- Function activation	Func.	OFF I2> I2>, I2>>	
- First/second stage			
- Pickup value	I2>, I2>>	0.10 – 3.00 In	step: 0.01 In
- Pickup time characteristic			
Definite time	t2>, t2>>	0.05 – 300.00 s	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		IAA, IBA, ICA	
- 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		IAA, IBA, ICA	
- 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	

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- Release time		< 50 ms	
- Pickup/release ratio		0.95	
- Time accuracy		2% pickup value or 10 ms	

Inrush detection (eng. Inrush detection)

- Function activation for: 50, 51, 50N-A, 51N-A, 50N-B, 51N-B, 87TN-A, 87TN-B	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

Transformer thermal overload protection (ANSI No. 49T)

- Measurement inputs		IAA, IBA, ICA	
- Function activation	Func.	OFF ON Alarm only	
- *Task* interval		100 ms	
- Time constant 1	Time const. 1	1 – 999 min	step: 1min
- Time constant 2	Time const. 2	1 – 999 min	step: 1min
- weight factor of time constant 1	p	0,00 – 1,00	step: 0,01
- Ambient temperature	TempAMB	- 40 – 100 ºC	step: 1 ºC
- Referred temperature	TempREF	- 40 – 100 ºC	step: 1 ºC
- Maximal cable temperature	TempMAX	40 – 150 ºC	step: 1 ºC
- Alarm temperature	49F ALARM	50 – 120 % TempMAX	step: 1 %
- trip temperature	49F TRIP	50 – 120 % TempMAX	step: 1 %
- Allowed reclosing temperature	TempRECL	40 – 100 % TempMAX	step: 1 %

Circuit breaker failure protection (ANSI No. 50BF)

- Measurement inputs		IAA, IBA, ICA	
- Function activation	Func.	OFF ON	
- Minimal current for CB being considered closed	Current tresh.	0.01 – 1.00 A	
- Function start		- internal trip signal - local or remote trip	
- Time delay	t-BF	0.05 – 60.00 s	step: 0.01 s

- Time accuracy		2% of set value or 10 ms	
- Start criteria	CB contact	ON, OFF	

Trip circuit supervision (ANSI No. 74TCS)

- Function activation	Func.	OFF A B A&B	
- Control current of trip circuit		5 mA	
- Time delay	t>	0.10 – 3.00 s	step: 0.01 s
- Time accuracy		2% of set value or 10 ms	
- Block manual close	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

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	

CB Wear Monitoring

- Measurement inputs		IA, IB, IC	
- Function activation	Func.	OFF ON	
- Square current limit	SumI^2	0-1000000000 kA	step: 1
- Breaker opening time	T-opening	0,001-0,5 s	step: 0,001s
- Breaker breaking time	T-breaking	0,001-0,6 s	step: 0,001s
- Current threshold	Curr.thresh.	0,04-1,00 In	step: 0,01In
- Measurement values			
Accumulated current value in phase A	Σ IA	0-2000000000 kA	step: 1
Accumulated current value in phase B	Σ IB	0-2000000000 kA	step: 1
Accumulated current value in phase C	Σ IC	0-2000000000 kA	step: 1
Accumulated square current value in phase A	Σ IA^2	0-2000000000	step: 1
Accumulated square current value in phase B	Σ IB^2	0-2000000000	step: 1
Accumulated square current value in phase C	Σ IC^2	0-2000000000	step: 1
Breaker trip counter	Num of TRIPs	0-2000000000	step: 1
Manipulation counter 1A	Oper.Count. 1A	0-2000000000	step: 1
Manipulation counter 1B	Oper.Count. 1B	0-2000000000	step: 1
Manipulation counter 2A	Oper.Count. 2A	0-2000000000	step: 1
Manipulation counter 2B	Oper.Count.	0-2000000000	step: 1

	2B		
Manipulation counter 3A	Oper.Count. 3A	0-2000000000	step: 1
Manipulation counter 3B	Oper.Count. 3B	0-2000000000	step: 1
Manipulation counter 4A	Oper.Count. 4A	0-2000000000	step: 1
Manipulation counter 4B	Oper.Count. 4B	0-2000000000	step: 1
Manipulation counter 5A	Oper.Count. 5A	0-2000000000	step: 1
Manipulation counter 5B	Oper.Count. 5B	0-2000000000	step: 1
Manipulation counter 6A	Oper.Count. 6A	0-2000000000	step: 1
Manipulation counter 6B	Oper.Count. 6B	0-2000000000	step: 1
Manipulation counter 7A	Oper.Count. 7A	0-2000000000	step: 1
Manipulation counter 7B	Oper.Count. 7B	0-2000000000	step: 1
Manipulation counter 8A	Oper.Count. 8A	0-2000000000	step: 1
Manipulation counter 8B	Oper.Count. 8B	0-2000000000	step: 1
Manipulation counter 9A	Oper.Count. 9A	0-2000000000	step: 1
Manipulation counter 9B	Oper.Count. 9B	0-2000000000	step: 1
Manipulation counter 10A	Oper.Count. 10A	0-2000000000	step: 1
Manipulation counter 10B	Oper.Count. 10B	0-2000000000	step: 1

Primary breaker operation time	Oper. time	0-10000000 hours	step 1h
Secondary breaker operation time	Oper. time	0-10000000 hours	step 1h

Change group

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

Circuit Breaker control

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

Transformer thermal supervision (ANSI 23) **

- Function activation	Func.	OFF ON	default: OFF
- location of RTD element no. 1	Location1	None/Other/Oil/Ambeint/ Winding/Bearing	default: None
- pickup value of 1. Stage of term. Input no. 1	RTD1 St.1	0 – 250°C	default: 100˘C
- pickup value of 2. Stage of term. Input no. 1	RTD1 St.2	0 – 250°C	default: 120˘C
- location of RTD element no. 2	Location2	None/Other/Oil/Ambeint/ Winding/Bearing	default: None
- pickup value of 1. Stage of term. Input no. 2	RTD2 St.1	0 – 250°C	default: 100˘C

- pickup value of 2. Stage of term. Input no. 2	RTD2 St.2	0 – 250°C	default: 120˘C
- location of RTD element no. 3	Location3	None/Other/Oil/Ambeint/ Winding/Bearing	default: None
- pickup value of 1. Stage of term. Input no. 3	RTD3 St.1	0 – 250°C	default: 100˘C
- pickup value of 2. Stage of term. Input no. 3	RTD3 St.2	0 – 250°C	default: 120˘C
- location of RTD element no. 4	Location4	None/Other/Oil/Ambeint/ Winding/Bearing	default: None
- pickup value of 1. Stage of term. Input no. 4	RTD4 St.1	0 – 250°C	default: 100˘C
- pickup value of 2. Stage of term. Input no. 4	RTD4 St.2	0 – 250°C	default: 120˘C
- location of RTD element no. 5	Location5	None/Other/Oil/Ambeint/ Winding/Bearing	default: None
- pickup value of 1. Stage of term. Input no. 5	RTD5 St.1	0 – 250°C	default: 100˘C
- pickup value of 2. Stage of term. Input no. 5	RTD5 St.2	0 – 250°C	default: 120˘C
- location of RTD element no. 6	Location6	None/Other/Oil/Ambeint/ Winding/Bearing	default: None
- pickup value of 1. Stage of term. Input no. 6	RTD6 St.1	0 – 250°C	default: 100˘C
- pickup value of 2. Stage of term. Input no. 6	RTD6 St.2	0 – 250°C	default: 120˘C
- location of RTD element no. 7	Location6	None/Other/Oil/Ambeint/ Winding/Bearing	default: None
- pickup value of 1. Stage of term. Input no. 7	RTD6 St.1	0 – 250°C	default: 100˘C
- pickup value of 2. Stage of term. Input no. 7	RTD6 St.2	0 – 250°C	default: 120˘C

- RTD sensor measuring range		-45 – 250 °C
- RTD sensor measuring accuracy		1 °C

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	12s / 8
		1kHz	24s / 8
Reset Event log	Delete event log	password	
Reset Trip log	Delete trip log	password	
Reset Disturbance log	Delete disturbance log	password	

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Measurement transformers ratios			
- rated primary current on side A	CTA prim	1 – 2000 A	default: 100 A
- rated secondary current on side A	CTA sec	1 A 5 A	default: 1 A
- rated primary current on side B	CTB prim	1 – 2000 A	default: 100 A
- rated secondary current on side B	CTB sec	1 A 5 A	default: 1 A
- rated primary current Io on side A	CToA prim	1 – 2000 A	default: 100 A
- rated secondary current Io on side A	CToA sec	1 A 5 A	default: 1 A
- rated primary current Io on side B	CToB prim	1 – 2000 A	default: 100 A
- rated secondary current Io on side B	CToB sec	1 A 5 A	default: 1 A
- measurement transformer grounding on side A	CTA Starpoint	Transformer Busbar	default: Transformer
- measurement transformer grounding on side B	CTB Starpoint	Transformer Busbar	default: Transformer
- ground current measurement transformer grounding on side A	CToA Starpoint	Transformer Ground	default: Transformer
- ground current measurement transformer grounding on side B	CToB Starpoint	Transformer Ground	default: Transformer

Basic data of energy transformer

- transformer rated power	Pn	1 – 2000 MVA	default: 8 MVA
- transformer rated frequency	fn	50 Hz 60 Hz	default: 50 Hz
- transformer primary rated voltage	U1n	0,01 – 99,99 kV	default: 35,00 kV
- transformer secondary rated voltage	U2n	0,01 – 99,99 kV	default: 10,00 kV
- tap changer correction coefficient of primary side	Tap1	0,50 – 2,00	default: 1,00
- tap changer correction coefficient of secondary side	Tap2	0,50 – 2,00	default: 1,00
- Connection group HV	HV	Y YN D Z ZN	default: Y
- Connection group LV	LV	y yn d z zn	default: y
- Connection group clock number	Clock	0 – 11	default: 0
- Io elimination	Io elim	OFF HV LV HV, LV	default: OFF
- phase sequence	PaseSeq	0,240,120 0,120,240	Default: 0,240,120

Circuit breaker

Minimal current to consider CB closed	Curr. tresh	0,04 – 1,00 A	step: 0,01 A

DISPLAY OF MEASUREMENTS ON FRONT PANEL SCREEN

DIFFERENTIAL VALUES

dIA	Primary value of differential current in phase A (A)
dIB	Primary value of differential current in phase B (A)
dIC	Primary value of differential current in phase C (A)
dIEA	Primary value of differential current IEA (A)
dIEB	Primary value of differential current IEB (A)
dIA	Nominal value of differential current in phase A (In)
dIB	Nominal value of differential current in phase B (In)
dIC	Nominal value of differential current in phase C (In)
dIEA	Nominal value of differential current IEA (In)
dIEB	Nominal value of differential current IEB (In)

PRIMARY VALUES

AA:	Primary value of current IAA (A)
BA:	Primary value of current IBA (A)
CA:	Primary value of current ICA (A)
EA:	Primary value of current IEA (A)
AB:	Primary value of current IAB (A)
BB:	Primary value of current IBB (A)
CB:	Primary value of current ICB (A)
EB:	Primary value of current IEB (A)

SECONDARY VALUES

AA:	Secondary value of current IAA (A)
BA:	Secondary value of current IBA (A)
CA:	Secondary value of current ICA (A)
EA:	Secondary value of current IEA (A)
AB:	Secondary value of current IAB (A)
BB:	Secondary value of current IBB (A)
CB:	Secondary value of current ICB (A)
EB:	Secondary value of current IEB (A)

NOMINAL VALUES

AA:	Nominal value of current IAA (In)
BA:	Nominal value of current IBA (In)
CA:	Nominal value of current ICA (In)
EA:	Nominal value of current IEA (In)
AB:	Nominal value of current IAB (In)
BB:	Nominal value of current IBB (In)
CB:	Nominal value of current ICB (In)
EB:	Nominal value of current IEB (In)
I2A x In:	Nominal value of inverse component of primary current
I1A x In:	Nominal value of direct component of primary current
I2B x In:	Nominal value of inverse component of secondary current
I1B x In:	Nominal value of direct component of secondary current

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:

RFD 6 3 2 - 0 0 A 1 E - 2 0

Function

Series

Variant
3 – Large 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)
D – analog unit D-type (7RTD+2AI)

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)
D – analog unit D-type (7RTD+2AI)

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

Transformer thermal supervision
1 - NO
2 – YES

Nominal frequency
E - 50Hz
F - 60Hz

SW package
1..9

Rear optic port
0 – plastic
1 – glass and plastic
2 – glass

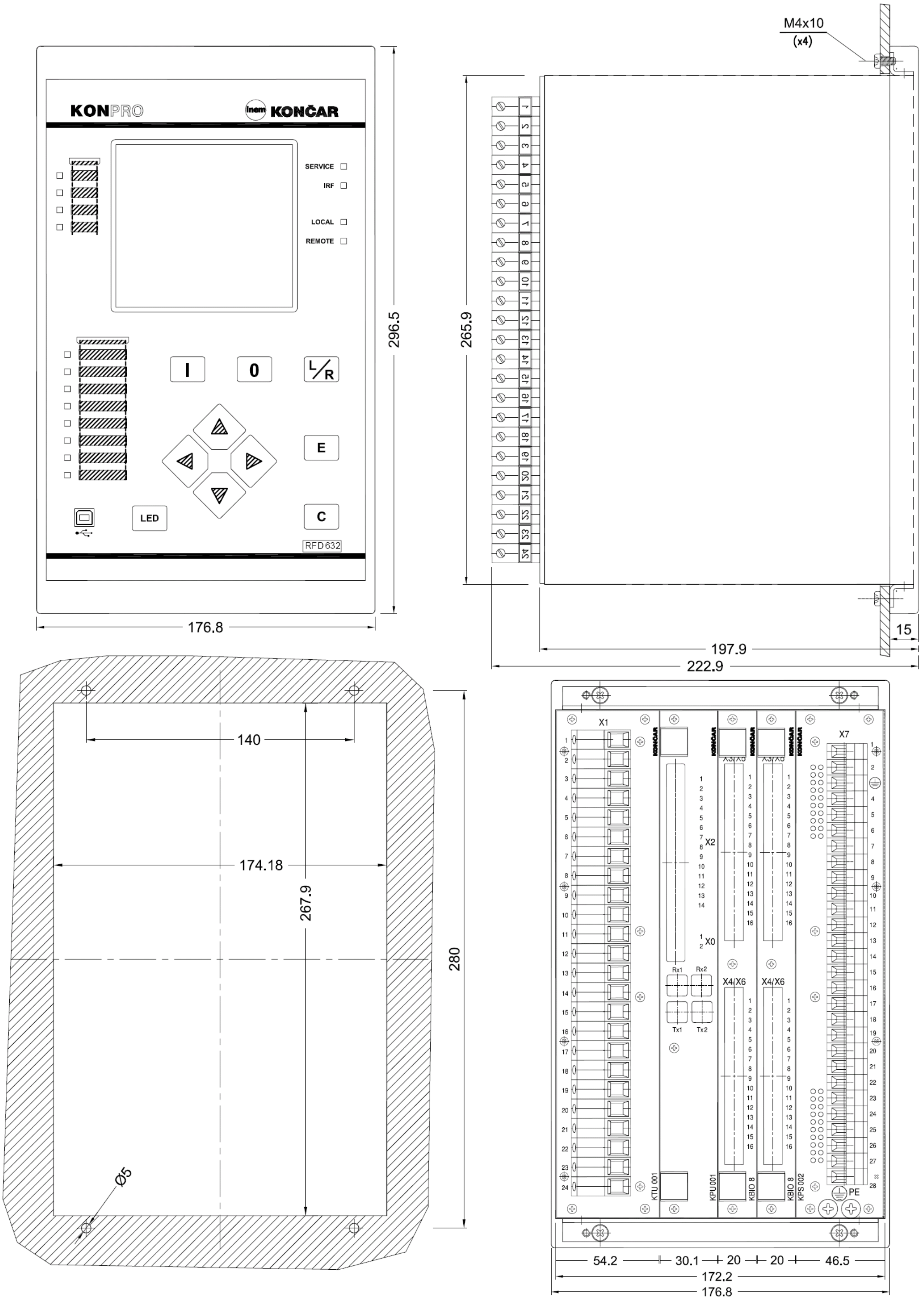
LIST OF STANDARD FUNCTIONS FOR INDIVIDUAL RELAY TYPE

RFD SW package 2

IEC	ANSI	FUNCTION DESCRIPTION/RELAY TYPE	RFD 632	RFD 633
		Protection functions - current		
dI>, >>	**87T**	Stabilized three-phase transformer differential protection	•	•
dIE>	**87TN-A**	Stabilized low impedance earth-fault protection of primary	•	•
dIE>	**87TN-B**	Stabilized low impedance earth-fault protection of secondary	•	•
dI_{REF}>	**87N**	High impedance restricted earth-fault protection of transformers	•	•
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	•	•
I_{ub}>	**46DP**	Current unbalance protection	•	•
$3I_{th}$>	**49T**	Transformer thermal overload protection	•	•
	INR	Inrush Restraint	•	•
		Supervisory functions		
	50BF	Breaker failure protection	•	•
	74TC	Trip circuit supervision (CB_A, CB_B)	•	•
	23	Transformer thermal supervision **		
		Time synchronization	•	•
		Event logger(event recorder + trip logger)	•	•
		Disturbance recorder	•	•
		Management level (local/remote)	•	•
		Circuit breaker wear monitor	•	•
		Measurement		
		6xI, 2xIE, 2xI1, 2xI2, 3xdI, 2xdIE, 7xRTD, 2xAI	•	•
		Control		
		Breaker control	•	•
		Apparatus control according to the selected scheme	•	•

*** on demand*

MEASURMENT SCHEMATIC AND RELAY DIMENSIONS



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