



Relion® 615 series

Transformer Protection and Control RET615 Product Guide

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Transformer Protection and Control	1MRS756891 F
RET615	
Product version: 4.0	Issued: 2011-05-09
	Revision: F

1. Description

RET615 is a dedicated transformer protection and control IED (intelligent electronic device) for power transformers, unit and step-up transformers including power generator-transformer blocks in utility and industry power distribution systems.

RET615 is a member of ABB's Relion® product family and part of its 615 protection and control product series. The 615 series IEDs are characterized by their compactness and withdrawable-unit design.

Re-engineered from the ground up, the 615 series has been designed to unleash the full potential of the IEC 61850 standard for communication and interoperability between substation automation devices. Once the standard configuration IED has been given the application-specific settings, it can directly be put into service.

The 615 series IEDs support a range of communication protocols including IEC 61850 with GOOSE messaging, IEC 60870-5-103, Modbus® and DNP3.

2. Standard configurations

RET615 is available in eight alternative standard configurations. The standard signal configuration can be altered by means of the graphical signal matrix or the graphical application functionality of the Protection and Control IED Manager PCM600. Further, the application configuration functionality of PCM600 supports the creation of multi-layer logic functions utilizing various logical elements including timers and flip-flops. By combining protection functions with logic function blocks the IED configuration can be adapted to user specific application requirements.

Table 1. Standard configurations

Description	Std. conf.
Three-phase transformer differential protection for two-winding transformers, numerical restricted earth-fault protection for the high-voltage (HV) side, optional RTD/mA inputs	A
Three-phase transformer differential protection for two-winding transformers, numerical restricted earth-fault protection for the low-voltage (LV) side, optional RTD/mA inputs	B
Three-phase transformer differential protection for two-winding transformers, high-impedance based restricted earth-fault protection for the high-voltage (HV) side, optional RTD/mA inputs	C
Three-phase transformer differential protection for two-winding transformers, high-impedance based restricted earth-fault protection for the low-voltage (LV) side, optional RTD/mA inputs	D
Three-phase transformer differential protection for two-winding transformers, numerical restricted earth-fault protection for the high-voltage (HV) side, phase-voltage based protection and measurement functions	E
Three-phase transformer differential protection for two-winding transformers, numerical restricted earth-fault protection for the low-voltage (LV) side, phase-voltage based protection and measurement functions	F
Three-phase transformer differential protection for two-winding transformers, high-impedance based restricted earth-fault protection for the high-voltage (HV) side, phase-voltage based protection and measurement functions	G
Three-phase transformer differential protection for two-winding transformers, high-impedance based restricted earth-fault protection for the low-voltage (LV) side, phase-voltage based protection and measurement functions	H

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Table 2. Supported functions

Functionality	A	B	C	D	E	F	G	H
Protection¹⁾								
Stabilized and instantaneous differential protection for two-winding transformers	•	•	•	•	•	•	•	•
Multi-purpose protection, instance 1 ²⁾	o ³⁾	o ³⁾	o ³⁾	o ³⁾	-	-	-	-
Multi-purpose protection, instance 2 ²⁾	o ³⁾	o ³⁾	o ³⁾	o ³⁾	-	-	-	-
Multi-purpose protection, instance 3 ²⁾	o ³⁾	o ³⁾	o ³⁾	o ³⁾	-	-	-	-
Multi-purpose protection, instance 4 ²⁾	o ³⁾	o ³⁾	o ³⁾	o ³⁾	-	-	-	-
Multi-purpose protection, instance 5 ²⁾	o ³⁾	o ³⁾	o ³⁾	o ³⁾	-	-	-	-
Multi-purpose protection, instance 6 ²⁾	o ³⁾	o ³⁾	o ³⁾	o ³⁾	-	-	-	-
Master trip, instance 1	•	•	•	•	•	•	•	•
Master trip, instance 2	•	•	•	•	•	•	•	•
HV-side protection								
Numerical stabilized low impedance restricted earth-fault protection	•	-	-	-	•	-	-	-
High impedance based restricted earth-fault protection	-	-	•	-	-	-	•	-
Three-phase non-directional overcurrent protection, low stage, instance 1	•	•	•	•	•	•	•	•
Three-phase non-directional overcurrent protection, high stage, instance 1	•	•	•	•	•	•	•	•
Three-phase non-directional overcurrent protection, instantaneous stage, instance 1	•	•	•	•	•	•	•	•
Non-directional earth-fault protection, low stage, instance 1	• ⁴⁾	-	• ⁵⁾	-	• ⁴⁾	-	• ⁵⁾	-
Non-directional earth-fault protection, high stage, instance 1	• ⁴⁾	-	• ⁵⁾	-	• ⁴⁾	-	• ⁵⁾	-
Negative-sequence overcurrent protection, instance 1	•	•	•	•	•	•	•	•
Residual overvoltage protection, instance 1	-	-	-	-	• ⁶⁾	• ⁶⁾	• ⁶⁾	• ⁶⁾
Residual overvoltage protection, instance 2	-	-	-	-	• ⁶⁾	• ⁶⁾	• ⁶⁾	• ⁶⁾
Three-phase undervoltage protection, instance 1	-	-	-	-	•	•	•	•
Three-phase undervoltage protection, instance 2	-	-	-	-	•	•	•	•
Three-phase overvoltage protection, instance 1	-	-	-	-	•	•	•	•
Three-phase overvoltage protection, instance 2	-	-	-	-	•	•	•	•
Three-phase thermal overload protection for power transformers, two time constants	•	•	•	•	•	•	•	•

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Table 2. Supported functions, continued

Functionality	A	B	C	D	E	F	G	H
Circuit breaker failure protection ⁵⁾	●	●	●	●	●	●	●	●
LV-side protection								
Numerical stabilized low impedance restricted earth-fault protection	-	● ⁷⁾	-	-	-	● ⁷⁾	-	-
High impedance based restricted earth-fault protection	-	-	-	● ⁸⁾	-	-	-	● ⁸⁾
Three-phase non-directional overcurrent protection, low stage, instance 2	●	●	●	●	●	●	●	●
Three-phase non-directional overcurrent protection, high stage, instance 2	●	●	●	●	●	●	●	●
Three-phase non-directional overcurrent protection, instantaneous stage, instance 2	●	●	●	●	●	●	●	●
Non-directional earth-fault protection, low stage, instance 2	-	● ⁹⁾	-	● ¹⁰⁾	-	● ⁹⁾	-	● ¹⁰⁾
Non-directional earth-fault protection, high stage, instance 2	-	● ⁹⁾	-	● ¹⁰⁾	-	● ⁹⁾	-	● ¹⁰⁾
Negative-sequence overcurrent protection, instance 2	●	●	●	●	●	●	●	●
Arc protection, instance 1 ¹¹⁾	○	○	○	○	○	○	○	○
Arc protection, instance 2 ¹¹⁾	○	○	○	○	○	○	○	○
Arc protection, instance 3 ¹¹⁾	○	○	○	○	○	○	○	○
Control								
Disconnecter control, instance 1	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾
Disconnecter control, instance 2	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾
Earthing switch control	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾
Disconnecter position indication, instance 1	●	●	●	●	●	●	●	●
Disconnecter position indication, instance 2	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾
Disconnecter position indication, instance 3	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾
Earthing switch indication, instance 1	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾
Earthing switch indication, instance 2	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾	● ³⁾
Tap changer position indication	●	●	●	●	●	●	●	●
Circuit-breaker control (HV-side)	●	●	●	●	●	●	●	●
Condition monitoring								
Circuit-breaker condition monitoring	●	●	●	●	●	●	●	●
Trip circuit supervision, instance 1	●	●	●	●	●	●	●	●
Trip circuit supervision, instance 2	●	●	●	●	●	●	●	●
Fuse failure supervision	-	-	-	-	●	●	●	●

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Table 2. Supported functions, continued

Functionality	A	B	C	D	E	F	G	H
Runtime counter for machines and devices	•	•	•	•	•	•	•	•
Measurement								
Disturbance recorder	•	•	•	•	•	•	•	•
RTD/mA measurement	o	o	o	o	-	-	-	-
HV-side measurement								
Three-phase current measurement, instance 1	•	•	•	•	•	•	•	•
Sequence current measurement	•	•	•	•	•	•	•	•
Residual current measurement, instance 1	•	-	•	-	•	-	•	-
Three-phase voltage measurement	-	-	-	-	•	•	•	•
Residual voltage measurement	-	-	-	-	•	•	•	•
Sequence voltage measurement	-	-	-	-	•	•	•	•
Three-phase power and energy measurement, including power factor	-	-	-	-	•	•	•	•
LV-side measurement								
Three-phase current measurement, instance 2	•	•	•	•	•	•	•	•
Residual current measurement, instance 2	-	•	-	•	-	•	-	•

• = included, o = optional at the time of order

- 1) The instances of a protection function represent the number of identical function blocks available in a standard configuration. By setting the application specific parameters of an instance, a protection function stage can be established.
- 2) Multi-purpose protection is used for, for example, RTD/mA based protection
- 3) Available in IED and SMT but not connected to anything in logic.
- 4) Io selectable by parameter, Io measured as default
- 5) Io calculated is always used
- 6) Uo selectable by a parameter, Uo measured as default
- 7) IoB measured and 3IB are always used
- 8) IoB measured is always used
- 9) IoB selectable by parameter, IoB measured as default
- 10) IoB calculated is always used
- 11) IoB calculated and 3IB are always used

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3. Protections functions

The IED features, three-phase, multi-slope stabilized (biased) stage transformer differential protection and an instantaneous stage to provide fast and selective protection for phase-to-phase short-circuit, winding interturn fault and bushing flash-over protection. Besides second harmonic restraint an advanced waveform-based blocking algorithm ensures stability at transformer energization and a fifth harmonic restraint function ensures good protection stability at moderate overexcitation of power transformers. Sensitive restricted earth-fault protection (REF) completes the overall differential protection providing detection of even single phase-to-earth faults close to the neutral earthing point of the transformer. Either the conventional high-impedance scheme or a numerical low-impedance scheme can be selected for protection of the transformer windings. When low-impedance REF protection is used neither stabilizing resistors nor varistors are needed and as a further benefit the transforming ratio of the neutral earthing CTs can differ from those of the phase current transformers. Due to its unit protection character and absolute selectivity REF does not need to be time-graded with other protection schemes, and therefore high-speed fault clearance can be achieved.

The IED also incorporates a thermal overload protection function, which supervises the thermal stress of the transformer windings to prevent premature aging of the insulation of the windings. Multiple stages of short-circuit, phase-overcurrent, negative-phase-sequence and earth-fault back-up protection are separately available for both sides of the power transformer. Earth-fault protection based on the measured or calculated residual voltage is also available. Depending on the chosen standard configuration the IED also features three-phase overvoltage protection, three-phase undervoltage protection and residual overvoltage protection. Further, the IED also offers circuit-breaker failure protection.

Enhanced with optional hardware and software, the IED also features three light detection channels for arc fault protection of the circuit breaker, busbar and cable compartment of metal-enclosed indoor switchgear.

The arc-fault protection sensor interface is available on the optional communication module. Fast tripping increases staff safety and security and limits material damage in an arc fault situation.

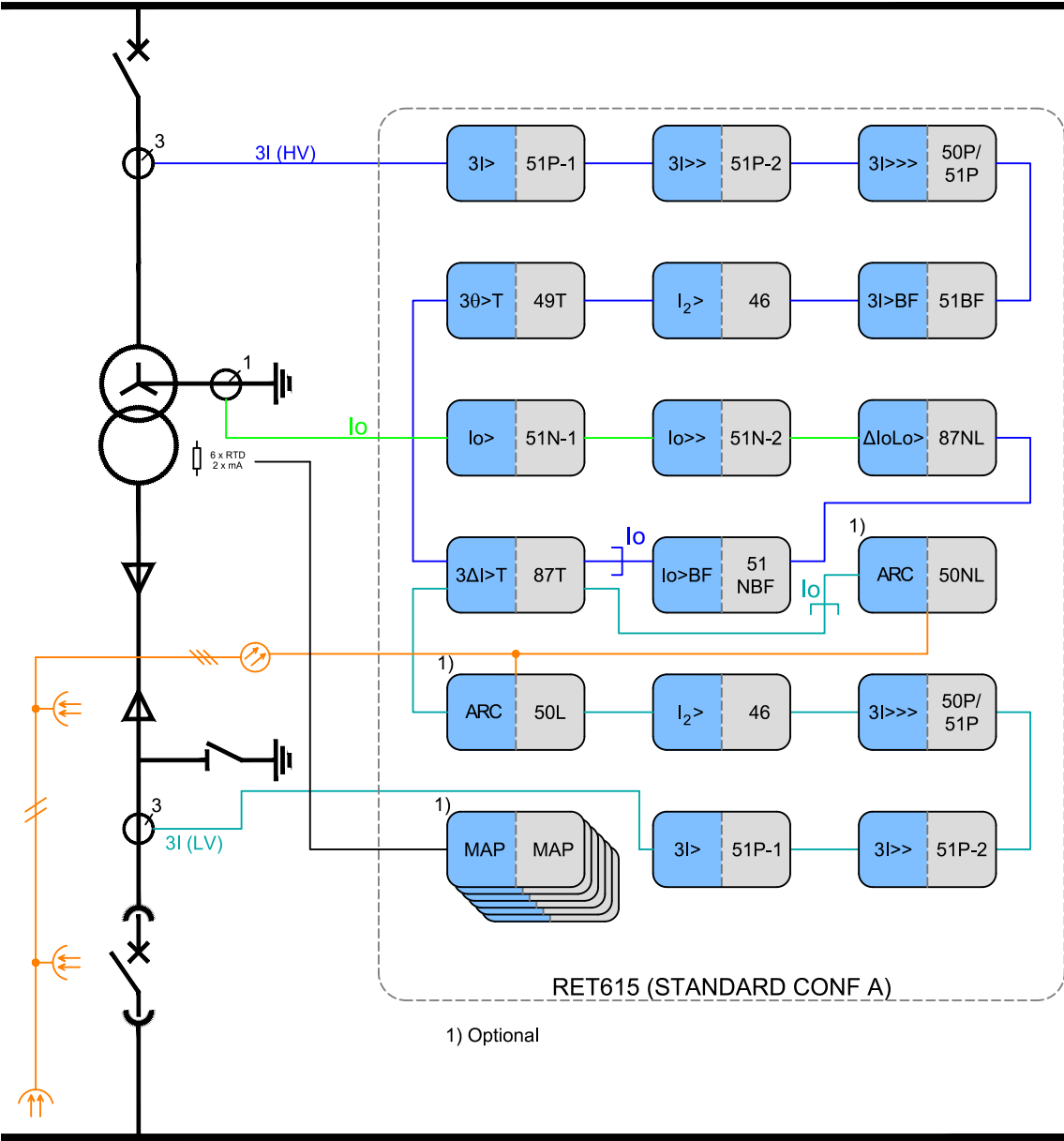


Figure 1. Protection function overview of standard configuration A

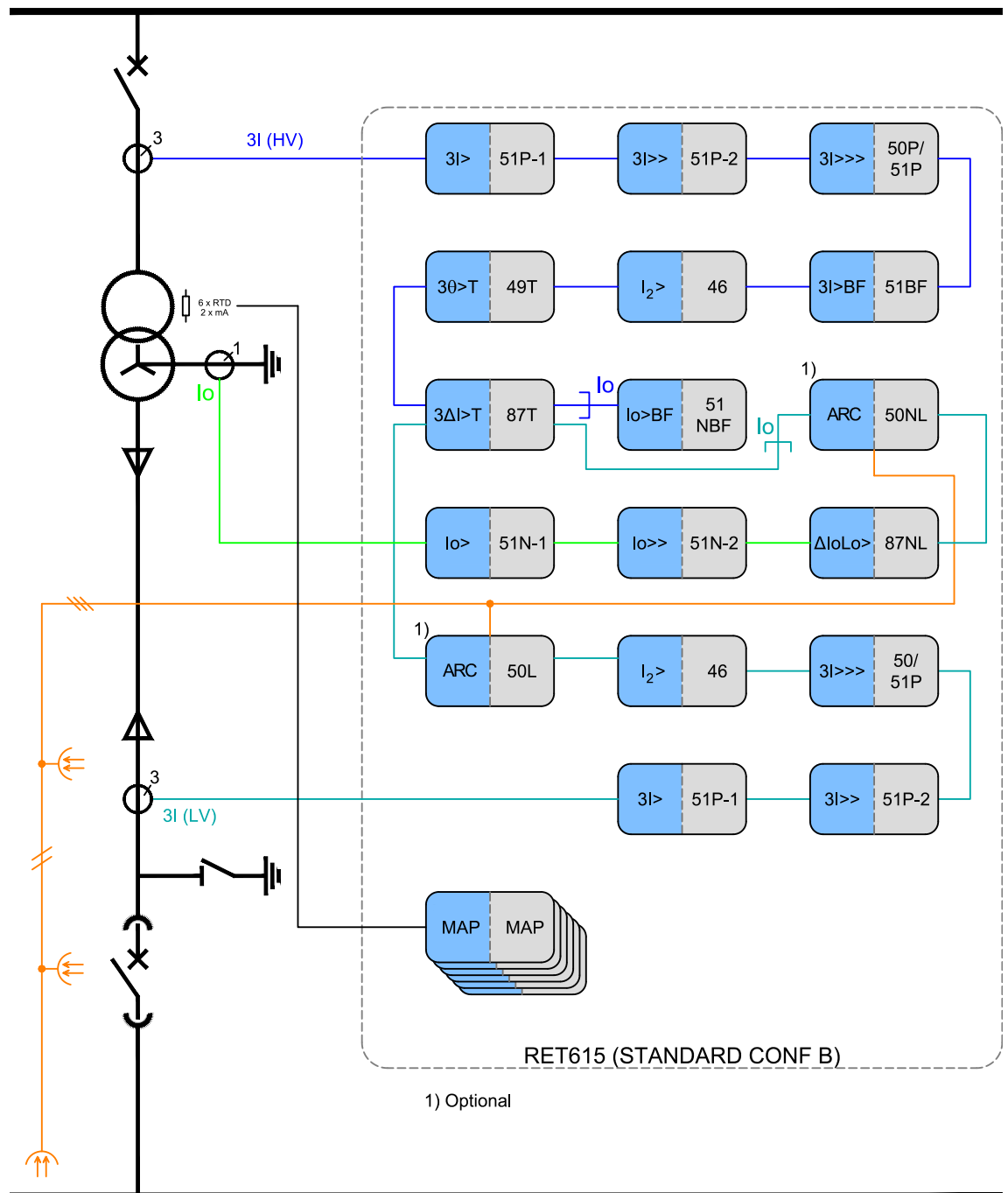


Figure 2. Protection function overview of standard configuration B

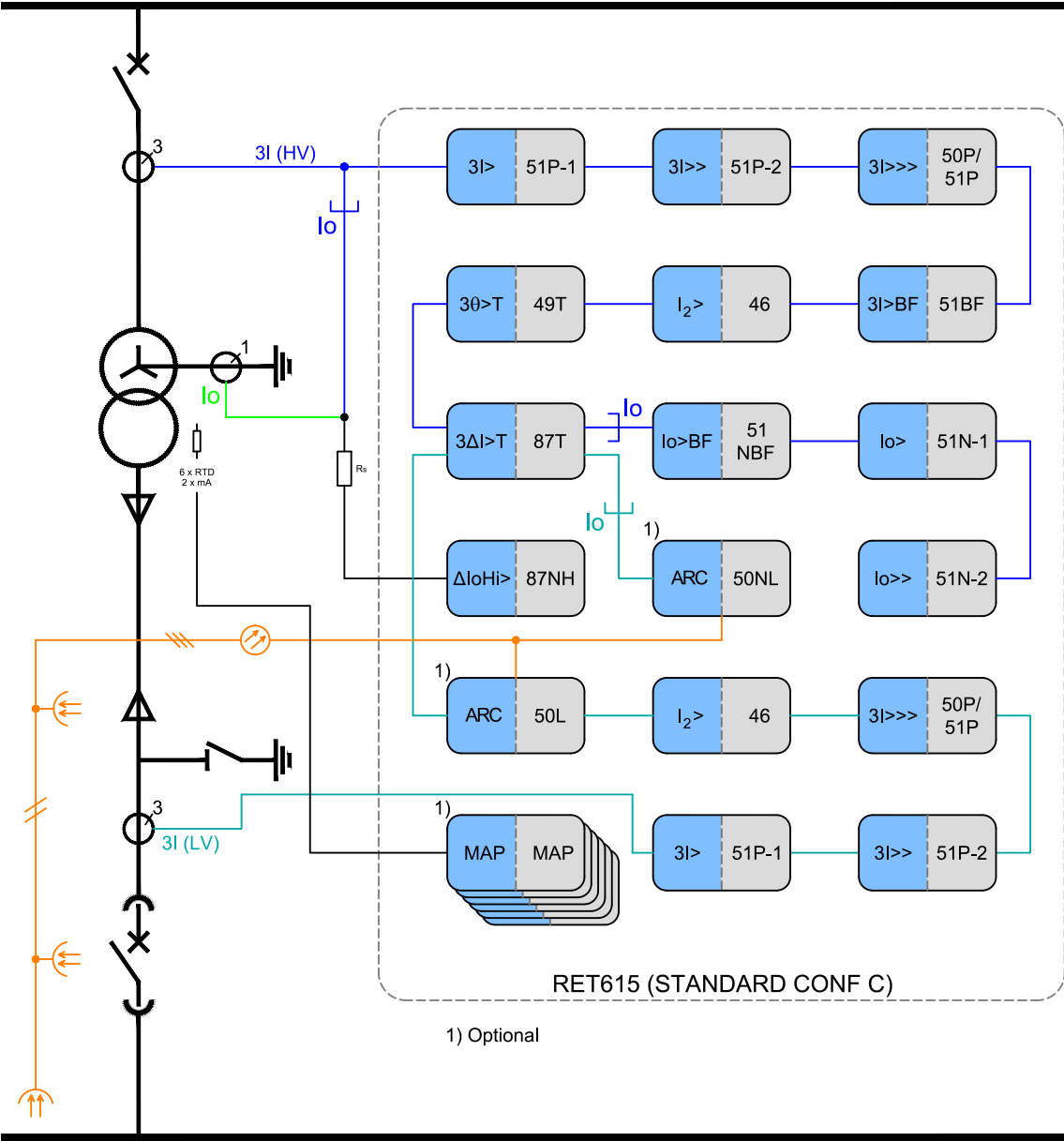


Figure 3. Protection function overview of standard configuration C

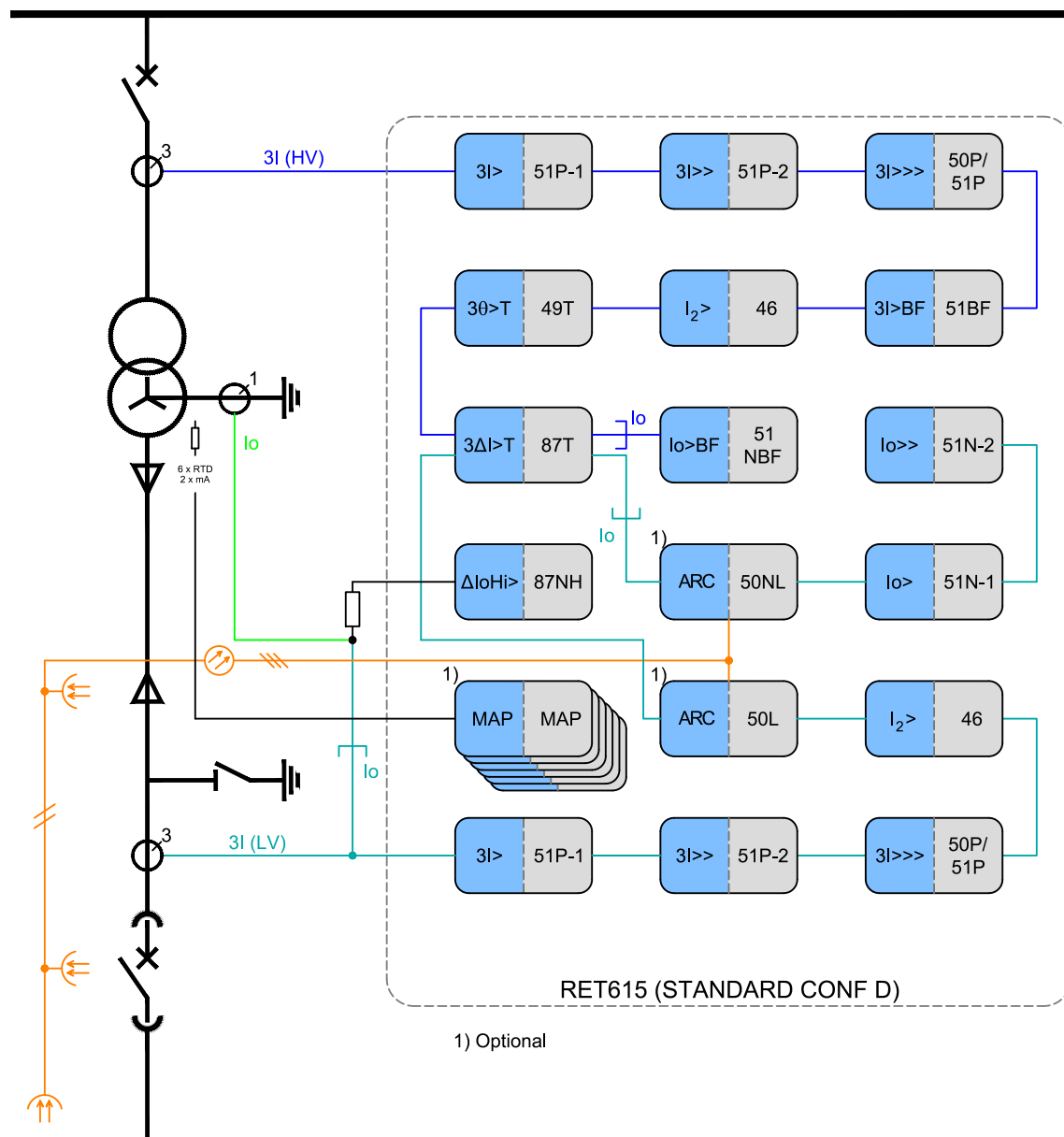


Figure 4. Protection function overview of standard configuration D

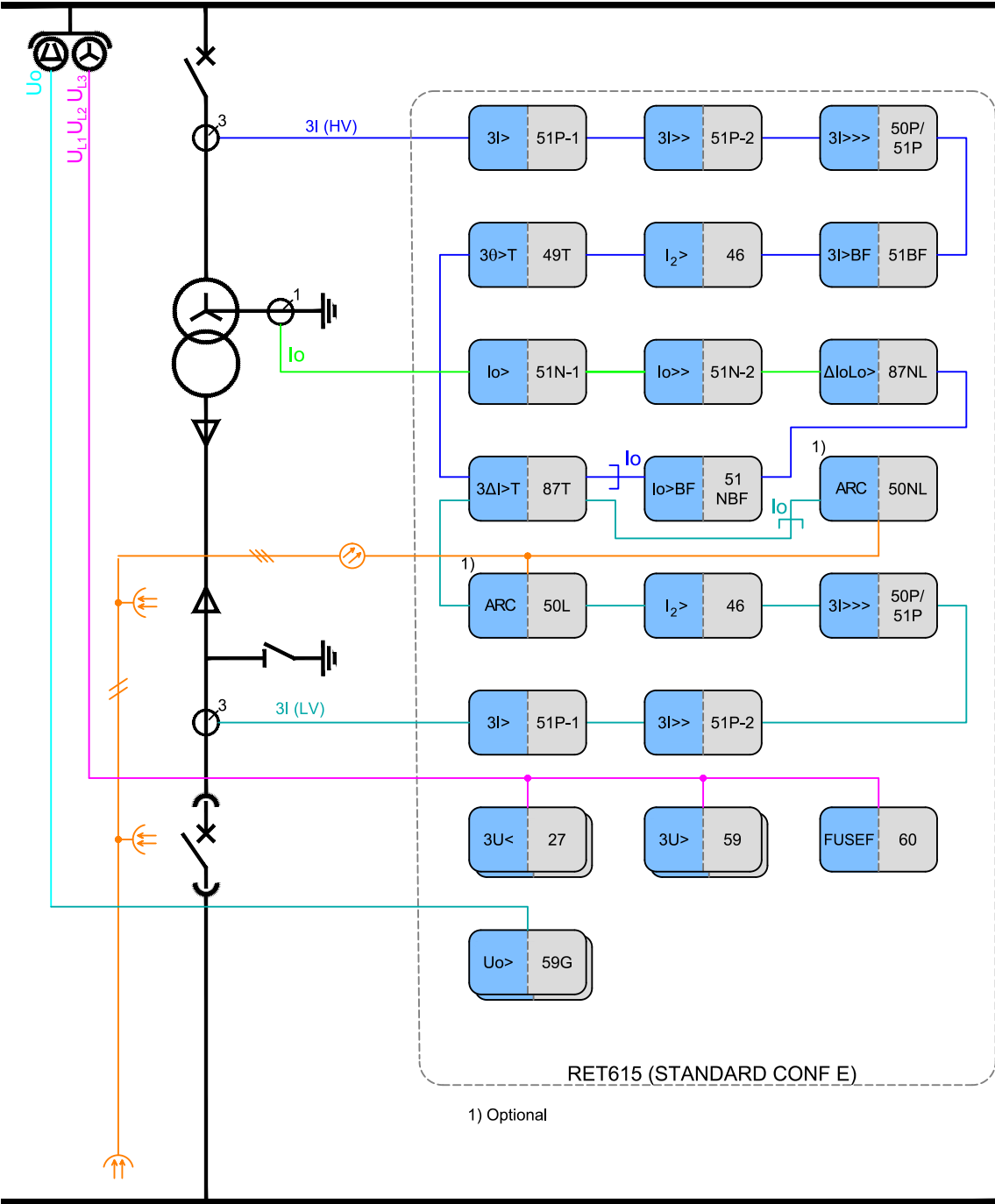


Figure 5. Protection function overview of standard configuration E

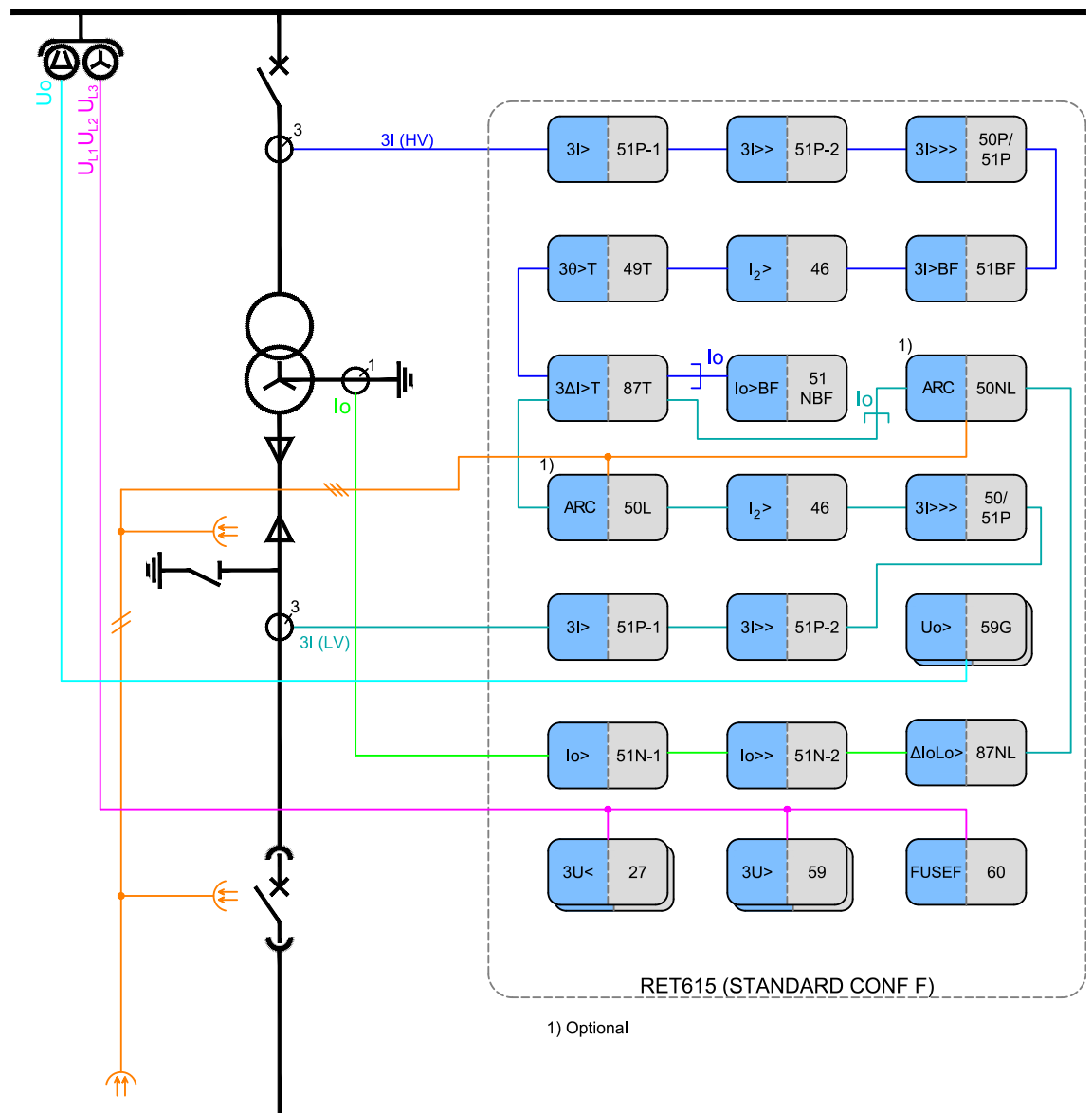


Figure 6. Protection function overview of standard configuration F

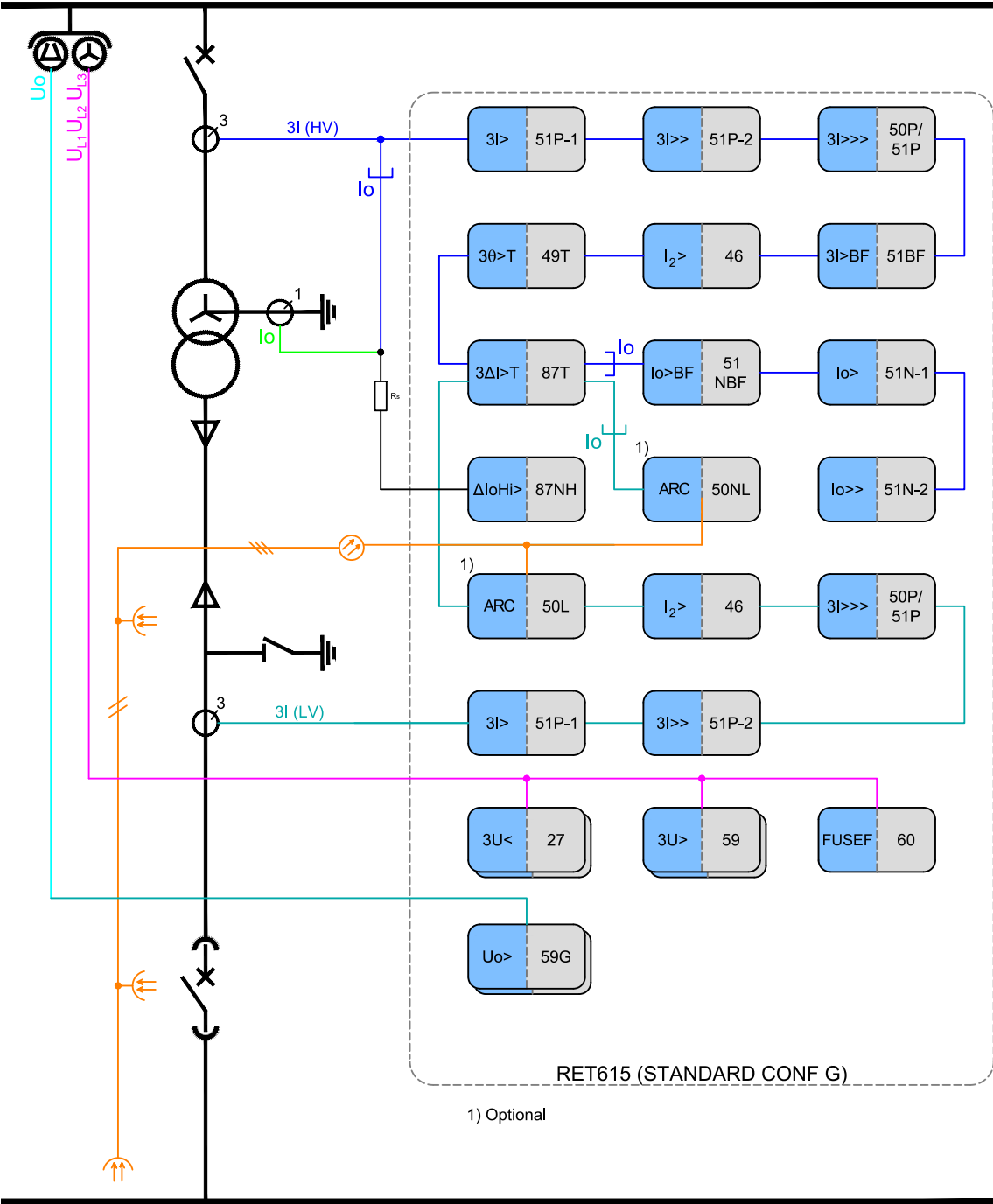


Figure 7. Protection function overview of standard configuration G

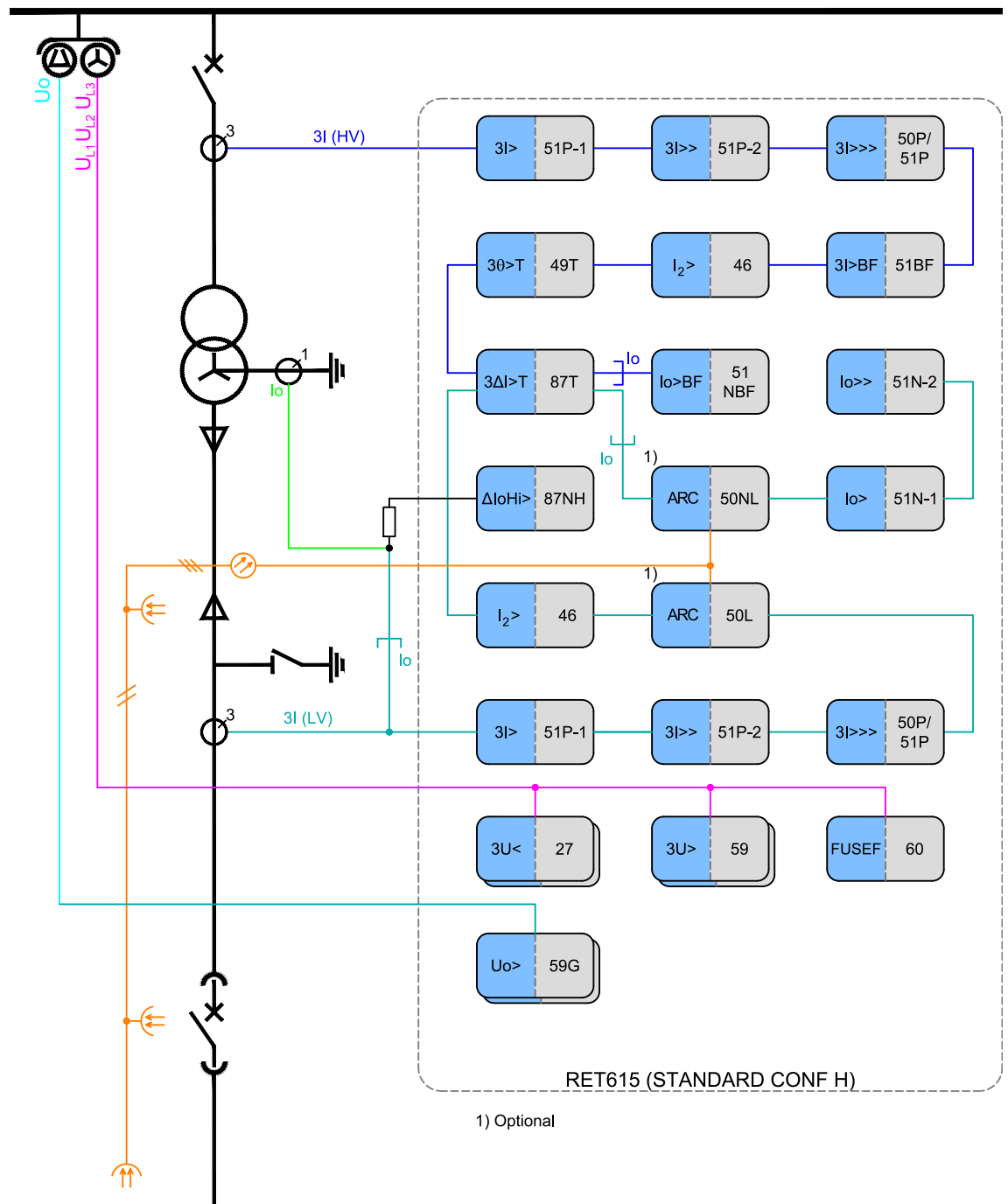


Figure 8. Protection function overview of standard configuration H

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4. Application

RET615 provides main protection for two-winding power transformers and power generator-transformer blocks. As of now, there are eight standard configurations offering comprehensive protection functions for detection and elimination of operational disturbance conditions and power transformer faults.

The standard configurations A, C, E and G are intended for power transformers with earthed HV-side neutrals. The A and E configuration features low impedance REF protection while the C and G configuration offers high impedance REF protection. The B, D, F and H configurations fit transformers with solidly-earthed LV-side neutral or the LV side with a neutral earthing resistor. The B, D, F and H configurations also fit applications including a separate earthing transformer located within the area of protection. The A, B, E, and F configurations also suit applications, where the turns ratio of the CT of the neutral earthing circuit differs from the turns ratio of the line CTs. The C, D, G and H configurations require that the turns ratios of the CTs are equal.

Standard configurations E, F, G and H include phase-voltage protection and measurement

functions which provide two-stage power transformer overvoltage and undervoltage protection and/or supervision.

The optional RTD/mA module offered for the standard configurations A-D allow up to eight analog signals to be measured via the six RTD inputs and the two mA inputs using transducers. The RTD and mA inputs can be used for measuring the oil temperature at the bottom and top of the transformer. Furthermore, the RTD/mA inputs can be used for measuring the ambient air temperature. The RTD inputs also offer thermal protection of dry-type power transformers fitted with Pt-100 temperature sensors. Temperature measurement over the RTD/mA inputs extends the function of the three-phase thermal overload protection of the IED. Further, one of the RTD inputs can also be used as a direct resistance measuring input for position information of the on-load tap changer. Alternatively, the tap changer position indication can be obtained via a mA-transducer. The analog temperature or tap changer position values can, if required, be sent using analog horizontal GOOSE messaging to other IEDs. Analog values can also, vice versa, be received from other IEDs over the station bus, thus improving the extent of relevant information.

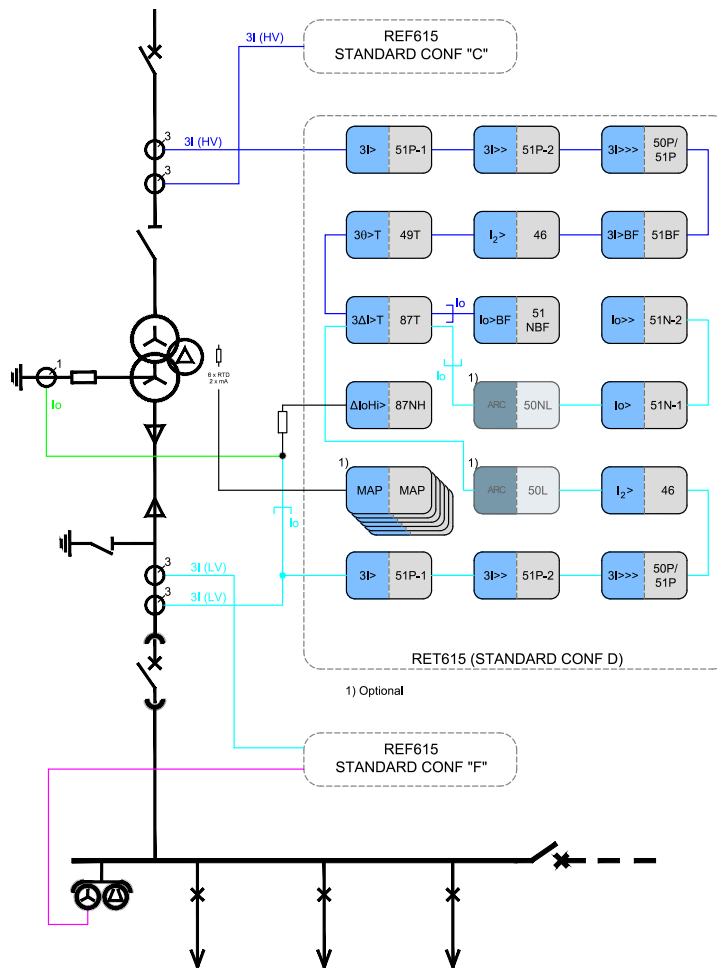


Figure 9. Main protection of a Yyn(d) connected power transformer and control of the HV-side circuit breaker using a RET615 with the standard configuration D. Restricted E/F protection with a high impedance scheme is applied on the transformer LV-side. A REF615 with the standard configuration C is used as redundant back-up protection on the HV-side. In addition, a REF615 with the standard configuration F is used on the LV-side to provide, besides O/C and E/F back-up protection, busbar overvoltage and undervoltage protection. Further, the REF615 with the standard configuration F enables local/remote control of the circuit breaker on the LV-side. The RTD inputs of the RET615 are utilized for monitoring the oil temperature of the transformer. In addition, the mA inputs are utilized for measuring the tap-changer position values.

5. Supported ABB solutions

ABB’s 615 series protection and control IEDs together with the Grid Automation controller COM600 constitute a genuine IEC 61850 solution for reliable power distribution in utility and industrial power systems. To facilitate and streamline the system engineering ABB’s IEDs are supplied with Connectivity Packages containing a compilation of software and IED-specific information including single-line diagram templates, a full IED data model including event and parameter lists. By utilizing the Connectivity Packages the IEDs can be readily configured via the PCM600 Protection and Control IED Manager and integrated with the Grid Automation controller COM600 or the MicroSCADA Pro network control and management system.

The 615 series IEDs offer native support for the IEC 61850 standard also including binary and analog horizontal GOOSE messaging. Compared with traditional hard-wired inter-device signaling, peer-to-peer communication over a switched Ethernet LAN offers an advanced and versatile platform for power system protection. Fast software-based communication, continuous supervision of the integrity of the protection and communication system, and inherent flexibility for reconfiguration and upgrades are among the distinctive features of the protection system approach enabled by the full implementation of the IEC 61850 substation automation standard.

At the substation level COM600 uses the data content of the bay level IEDs to offer enhanced

substation level functionality. COM600 features a web-browser based HMI providing a customizable graphical display for visualizing single line mimic diagrams for switchgear bay solutions. The SLD feature is especially useful when 615 series IEDs without the optional single line diagram feature are used. Further, the web HMI of COM600 offers an overview of the whole substation, including IED-specific single line diagrams, thus enabling convenient information accessibility. To enhance personnel safety, the web HMI also enables remote access to substation devices and processes. Furthermore, COM600 can be used as a local data warehouse for technical documentation of the substation and for network data collected by the IEDs. The collected network data facilitates extensive reporting and analyzing of network fault situations using the data historian and event handling features of COM600. The data historian can be used for accurate process performance monitoring by following process and equipment performance calculations with real-time and history values. Better understanding of the process behaviour by joining time-based process measurements with production and maintenance events helps the user in understanding the process dynamics.

COM600 also features gateway functionality providing seamless connectivity between the substation IEDs and network-level control and management systems such as MicroSCADA Pro and System 800xA

Table 3. Supported ABB solutions

Product	Version
Grid Automation controller COM600	3.5 or later
MicroSCADA Pro SYS 600	9.3 FP1 or later
System 800xA	5.0 Service Pack 2

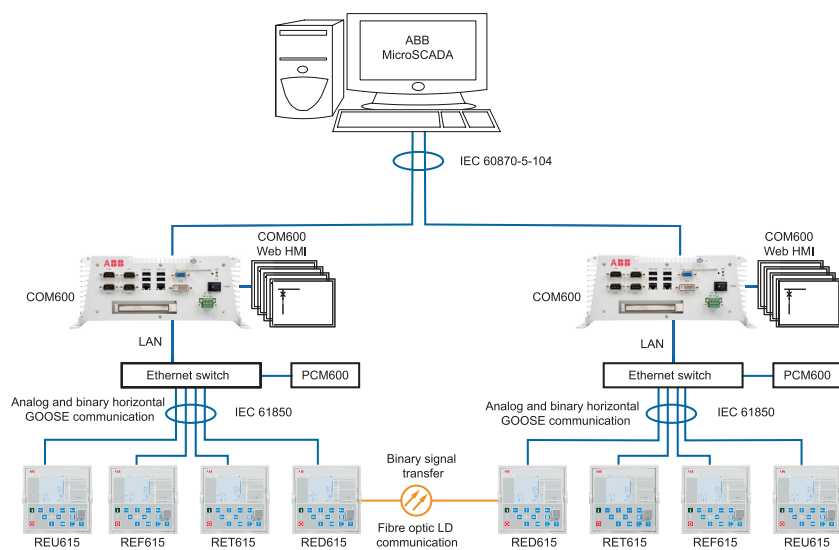


Figure 10. Utility power distribution network example using 615 series IEDs, Grid Automation controller COM600 and MicroSCADA Pro

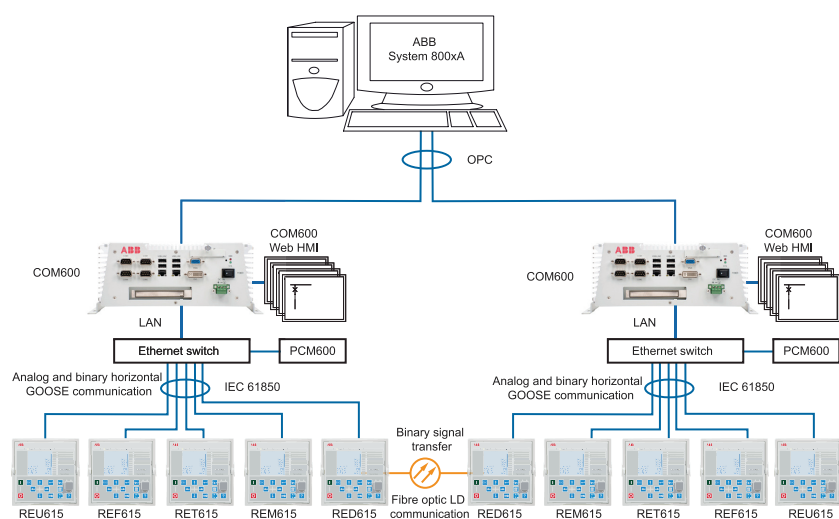


Figure 11. Industrial power system example using 615 series IEDs, Grid Automation controller COM600 and System 800xA

6. Control

RET615 integrates functionality for the control of a circuit breaker via the front panel HMI or by means of remote controls. In addition to the

circuit-breaker control the IED features two control blocks which are intended for motor-operated control of disconnectors or circuit breaker truck and for their position indications.

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Further, the IED offers one control block which is intended for motor-operated control of one earthing switch control and its position indication.

Two physical binary inputs and two physical binary outputs are needed in the IED for each controllable primary device taken into use. Depending on the chosen standard configuration of the IED the number of unused binary inputs and binary outputs varies. Further, some standard configurations also offer optional hardware modules that increase the number of available binary inputs and outputs.

In case the amount of available binary inputs and/or outputs of the chosen standard configuration is not sufficient, the following alternatives are recommended:

- To modify the chosen standard configuration of the IED in order to release some binary inputs or binary outputs which have originally been configured for other purposes, when applicable.
- To integrate an external input or output module for example, RIO600 to the IED. The binary inputs and outputs of the external I/O module can be used for the less time critical binary signals of the application. The integration enables releasing of some initially reserved binary inputs and outputs of the IED in the standard configuration.

The suitability of the binary outputs of the IED which have been selected for controlling of primary devices should be carefully verified, for example the make and carry as well as the breaking capacity. In case the requirements for the control-circuit of the primary device are not met, the use of external auxiliary relays should to be considered.

The optional large graphical LCD of the IED's HMI includes a single-line diagram (SLD) with position indication for the relevant primary devices. Interlocking schemes required by the application are configured using the signal matrix or the application configuration functionality of PCM600.

7. Measurement

The IED continuously measures the high voltage (HV) side and the low-voltage (LV) side phase currents and the neutral current of the protected transformer. In addition, the IED calculates the

symmetrical components of the currents and voltages, maximum current demand value over a user-selectable pre-set time frame, the active and reactive power, the power factor, and the active and reactive energy values. Calculated values are also obtained from the protection and condition monitoring functions of the IED. Depending on the standard configuration, the IED also measures the phase voltages, the residual voltage and the voltage sequence components.

For standard configuration A, B, C and D RTD/mA inputs are offered as an option. By means of the optional RTD/mA module the IED can measure up to eight analog signals such as temperature, pressure and tap changer position values via the six RTD inputs or the two mA inputs using transducers.

The values measured can be accessed locally via the user interface on the IED front panel or remotely via the communication interface of the IED. The values can also be accessed locally or remotely using the web-browser based user interface.

8. Disturbance recorder

The IED is provided with a disturbance recorder featuring up to 12 analog and 64 binary signal channels. The analog channels can be set to record either the waveform or the trend of the currents and voltage measured.

The analog channels can be set to trigger the recording function when the measured value falls below or exceeds the set values. The binary signal channels can be set to start a recording on the rising or the falling edge of the binary signal or both.

By default, the binary channels are set to record external or internal IED signals, for example the start or trip signals of the IED stages, or external blocking or control signals. Binary IED signals such as a protection start or trip signal, or an external IED control signal over a binary input can be set to trigger the recording. The recorded information is stored in a non-volatile memory and can be uploaded for subsequent fault analysis.

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9. Event log

To collect sequence-of-events (SoE) information, the IED incorporates a non-volatile memory with a capacity of storing 1024 events with associated time stamps. The non-volatile memory retains its data also in case the IED temporarily loses its auxiliary supply. The event log facilitates detailed pre- and post-fault analyses of feeder faults and disturbances. The increased capacity to process and store data and events in the IED offers prerequisites to support the growing information demand of future network configurations.

The SoE information can be accessed locally via the user interface on the IED front panel or remotely via the communication interface of the IED. The information can further be accessed, either locally or remotely, using the web-browser based user interface.

10. Recorded data

The IED has the capacity to store the records of 128 latest fault events. The records enable the user to analyze the power system events. Each record includes current, voltage and angle values, time stamp, etc. The fault recording can be triggered by the start signal or the trip signal of a protection block, or by both. The available measurement modes include DFT, RMS and peak-to-peak. In addition, the maximum demand current with time stamp is separately recorded. By default, the records are stored in a non-volatile memory.

11. Condition monitoring

The condition monitoring functions of the IED constantly monitors the performance and the condition of the circuit breaker. The monitoring comprises the spring charging time, SF6 gas pressure, the travel-time and the inactivity time of the circuit breaker.

The monitoring functions provide operational circuit breaker history data, which can be used for scheduling preventive circuit breaker maintenance.

12. Trip-circuit supervision

The trip-circuit supervision continuously monitors the availability and operability of the trip circuit. It provides open-circuit monitoring both when the circuit breaker is in its closed and in its open

position. It also detects loss of circuit-breaker control voltage.

13. Self-supervision

The IED's built-in self-supervision system continuously monitors the state of the IED hardware and the operation of the IED software. Any fault or malfunction detected is used for alerting the operator.

A permanent IED fault will block the protection functions to prevent incorrect operation.

14. Access control

To protect the IED from unauthorized access and to maintain information integrity, the IED is provided with a four-level, role-based authentication system with administrator-programmable individual passwords for the viewer, operator, engineer and administrator level. The access control applies to the front-panel user interface, the web-browser based user interface and the PCM600 tool.

15. Inputs and outputs

The IED is equipped with six phase-current inputs and one neutral-current input or six phase-current inputs, one neutral-current input, three phase-voltage inputs and one residual voltage input. The rated level of the current inputs is 1/5 A and selectable in the IED software. The three phase-voltage inputs and the residual-voltage input covers the rated voltages 60-210 V. Both phase-to-phase voltages and phase-to-earth voltages can be connected. In addition, the binary input thresholds 18...176 V DC are selected by adjusting the IED's parameter settings.

All binary inputs and outputs contacts are freely configurable with the signal matrix or application configuration functionality of PCM600.

As an option for standard configurations A, B, C and D, the IED offers six RTD inputs and two mA inputs. By means of the optional RTD/mA module the IED can measure up to eight analog signals such as temperature, pressure and tap changer position values via the six RTD inputs or the two mA inputs using transducers. The values can, apart from measuring and monitoring purposes,

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be used for tripping and alarm purposes using the offered optional multipurpose protection functions.

Please refer to the Input/output overview table and the terminal diagrams for more detailed information about the inputs and outputs.

Table 4. Input/output overview

Standard configuration	Analog inputs				Binary inputs/outputs	
	CT	VT	RTD inputs	mA inputs	BI	BO
A ¹⁾	7	-	6 ²⁾	2 ²⁾	8 (14) ³⁾	10 (13) ³⁾
B ¹⁾	7	-	6 ²⁾	2 ²⁾	8 (14) ³⁾	10 (13) ³⁾
C ¹⁾	7	-	6 ²⁾	2 ²⁾	8 (14) ³⁾	10 (13) ³⁾
D ¹⁾	7	-	6 ²⁾	2 ²⁾	8 (14) ³⁾	10 (13) ³⁾
E	7	5 ⁴⁾	-	-	12	10
F	7	5 ⁴⁾	-	-	12	10
G	7	5 ⁴⁾	-	-	12	10
H	7	5 ⁴⁾	-	-	12	10

1) The optional I/O module and the optional RTD/mA modules are mutually exclusive

2) With optional RTD/mA module

3) With optional binary I/O module

4) One of the five inputs is reserved for future applications

16. Station communication

The IED supports a range of communication protocols including IEC 61850, IEC 60870-5-103, Modbus® and DNP3. Operational information and controls are available through these protocols. However, some communication functionality, for example, horizontal communication between the IEDs, is only enabled by the IEC 61850 communication protocol.

The IEC 61850 communication implementation supports all monitoring and control functions. Additionally, parameter settings, disturbance recordings and fault records can be accessed using the IEC 61850 protocol. Disturbance recordings are available to any Ethernet-based application in the standard COMTRADE file format. The IED supports simultaneous event reporting to five different clients on the station bus.

The IED can send binary signals to other IEDs (so called horizontal communication) using the IEC 61850-8-1 GOOSE (Generic Object Oriented Substation Event) profile. Binary GOOSE messaging can, for example, be employed for

protection and interlocking-based protection schemes. The IED meets the GOOSE performance requirements for tripping applications in distribution substations, as defined by the IEC 61850 standard. Further, the IED supports the sending and receiving of analog values using GOOSE messaging. Analog GOOSE messaging enables fast transfer of analog measurement values over the station bus, thus facilitating for example sharing of RTD input values, such as surrounding temperature values, to other IED applications.

For a self-healing Ethernet solution the IED offers an optional fibre-optic communication module providing two optical and one galvanic Ethernet network interfaces. Alternatively, the IED features an optional galvanic communication module with two galvanic and one optical Ethernet network interfaces or three galvanic interfaces. The third Ethernet interface provides connectivity of any other Ethernet devices to an IEC 61850 station bus inside of a switchgear bay.

The self-healing Ethernet ring solution enables a cost efficient communication ring controlled by a

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managed switch with rapid spanning tree protocol (RSTP) support to be created. The managed switch controls the consistency of the loop, routes the data and corrects the data flow in case of a communication disturbance. The IEDs in the ring topology act as unmanaged switches forwarding unrelated data traffic. The Ethernet ring solution supports the connection of up to thirty 615 series IEDs. If more than 30 IEDs are to be connected, it is recommended that the network is split into several rings with no more than 30 IEDs per ring. The self-healing Ethernet ring solution avoids single point of failure concerns and improves the reliability of the communication. The solution can be applied for the Ethernet-based IEC 61850, Modbus and DNP3 protocols.

All communication connectors, except for the front port connector, are placed on integrated optional communication modules. The IED can be connected to Ethernet-based communication systems via the RJ-45 connector (100Base-TX) or the fibre-optic LC connector (100Base-FX). If connection to a serial bus is required, the 10-pin RS-485 screw-terminal or the fibre-optic ST connector can be used.

Modbus implementation supports RTU, ASCII and TCP modes. Besides standard Modbus functionality, the IED supports retrieval of time-stamped events, changing the active setting group and uploading of the latest fault records. If a Modbus TCP connection is used, five clients can be connected to the IED simultaneously. Further, Modbus serial and Modbus TCP can be used in parallel, and if required both IEC 61850 and Modbus protocols can be run simultaneously.

The IEC 60870-5-103 implementation supports two parallel serial bus connections to two different masters. Besides basic standard functionality, the IED supports changing of the active setting group and uploading of disturbance recordings in IEC 60870-5-103 format.

DNP3 supports both serial and TCP modes for connection to one master. Further, changing of the active setting group is supported.

When the IED uses the RS-485 bus for the serial communication, both two- and four wire connections are supported. Termination and pull-up/down resistors can be configured with jumpers on the communication card so external resistors are not needed.

The IED supports the following time synchronization methods with a time-stamping resolution of 1 ms:

Ethernet-based:

- SNTP (Simple Network Time Protocol)

With special time synchronization wiring:

- IRIG-B (Inter-Range Instrumentation Group - Time Code Format B)

In addition, the IED supports time synchronization via the following serial communication protocols:

- Modbus
- DNP3
- IEC 60870-5-103

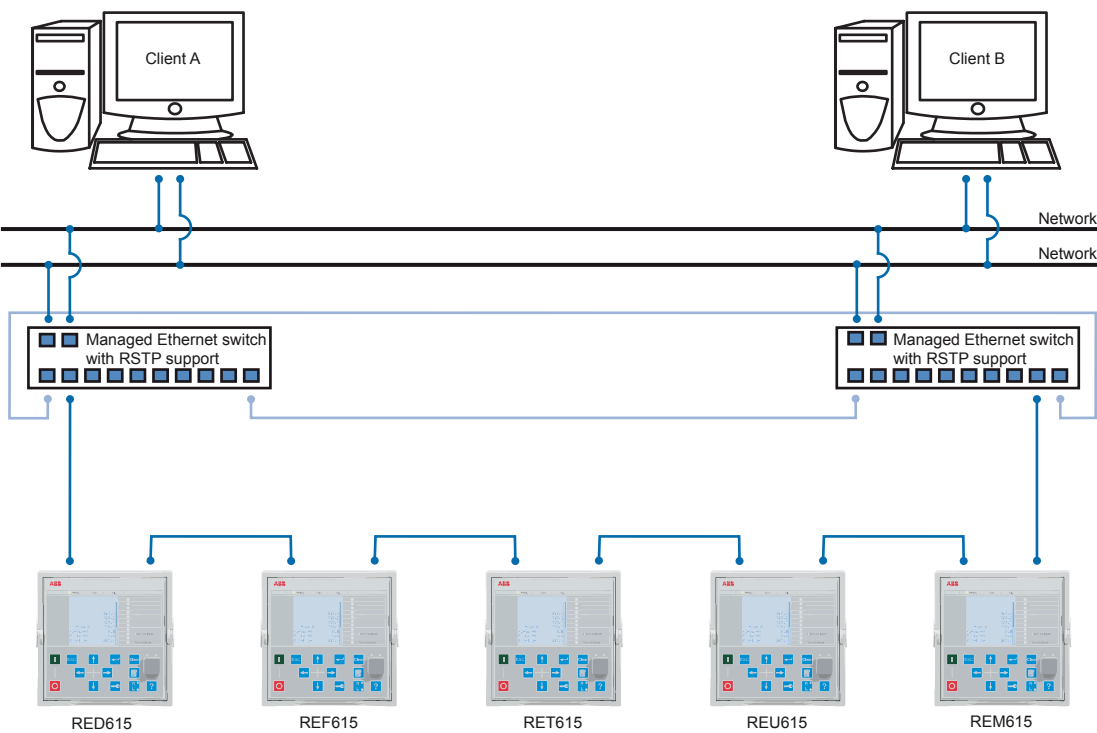


Figure 12. Self-healing Ethernet ring solution

Table 5. Supported station communication interfaces and protocols

Interfaces/Protocols	Ethernet		Serial	
	100BASE-TX RJ-45	100BASE-FX LC	RS-232/RS-485	Fibre-optic ST
IEC 61850	•	•	-	-
MODBUS RTU/ASCII	-	-	•	•
MODBUS TCP/IP	•	•	-	-
DNP3 (serial)	-	-	•	•
DNP3 TCP/IP	•	•	-	-
IEC 60870-5-103	-	-	•	•

• = Supported

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17. Technical data

Table 6. Dimensions

Description	Value	
Width	frame	177 mm
	case	164 mm
Height	frame	177 mm (4U)
	case	160 mm
Depth		201 mm (153 + 48 mm)
Weight	complete IED	4.1 kg
	plug-in unit only	2.1 kg

Table 7. Power supply

Description	Type 1	Type 2
U _{aux} nominal	100, 110, 120, 220, 240 V AC, 50 and 60 Hz	24, 30, 48, 60 V DC
	48, 60, 110, 125, 220, 250 V DC	
Maximum interruption time in the auxiliary DC voltage without resetting the IED	50 ms at U _n rated	
U _{aux} variation	38...110% of U _n (38...264 V AC)	50...120% of U _n (12...72 V DC)
	80...120% of U _n (38.4...300 V DC)	
Start-up threshold		19.2 V DC (24 V DC * 80%)
Burden of auxiliary voltage supply under quiescent (P _q)/operating condition	DC < 12.0 W (nominal)/< 18.0 W (max) AC < 16.0 W (nominal)/< 21.0 W (max)	DC < 12.0 W (nominal)/< 18.0 W (max)
Ripple in the DC auxiliary voltage	Max 15% of the DC value (at frequency of 100 Hz)	
Fuse type	T4A/250 V	

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Table 8. Energizing inputs

Description		Value
Rated frequency		50/60 Hz ± 5 Hz
Current inputs	Rated current, I_n	1/5 A ¹⁾
	Thermal withstand capability:	
	• Continuously	20 A
	• For 1 s	500 A
	Dynamic current withstand:	
	• Half-wave value	1250 A
Input impedance		<20 mΩ
Voltage inputs	Rated voltage	60...210 V AC
	Voltage withstand:	
	• Continuous	240 V AC
	• For 10 s	360 V AC
Burden at rated voltage		<0.05 VA

1) Residual current and/or phase current

Table 9. Binary inputs

Description	Value
Operating range	±20% of the rated voltage
Rated voltage	24...250 V DC
Current drain	1.6...1.9 mA
Power consumption	31.0...570.0 mW
Threshold voltage	18...176 V DC
Reaction time	3 ms

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Table 10. RTD/mA measurement (XRGGIO130)

Description		Value	
RTD inputs	Supported RTD sensors	100 Ω platinum 250 Ω platinum 100 Ω nickel 120 Ω nickel 250 Ω nickel 10 Ω copper	TCR 0.00385 (DIN 43760) TCR 0.00385 TCR 0.00618 (DIN 43760) TCR 0.00618 TCR 0.00618 TCR 0.00427
	Supported resistance range	0...2 k Ω	
	Maximum lead resistance (three-wire measurement)	25 Ω per lead	
	Isolation	2 kV (inputs to protective earth)	
	Response time	<4 s	
	RTD/resistance sensing current	Maximum 0.33 mA rms	
	Operation accuracy	Resistance	Temperature
		$\pm 2.0\%$ or $\pm 1\ \Omega$	$\pm 1^\circ\text{C}$ 10 Ω copper: $\pm 2^\circ\text{C}$
mA inputs	Supported current range	0...20 mA	
	Current input impedance	44 $\Omega \pm 0.1\%$	
	Operation accuracy	$\pm 0.5\%$ or $\pm 0.01\ \text{mA}$	

Table 11. Signal output X100: SO1

Description	Value
Rated voltage	250 V AC/DC
Continuous contact carry	5 A
Make and carry for 3.0 s	15 A
Make and carry for 0.5 s	30 A
Breaking capacity when the control-circuit time constant L/R < 40 ms	1 A/0.25 A/0.15 A
Minimum contact load	100 mA at 24 V AC/DC

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Table 12. Signal outputs and IRF output

Description	Value
Rated voltage	250 V AC/DC
Continuous contact carry	5 A
Make and carry for 3.0 s	10 A
Make and carry 0.5 s	15 A
Breaking capacity when the control-circuit time constant L/ R<40 ms, at 48/110/220 V DC	1 A/0.25 A/0.15 A
Minimum contact load	10 mA at 5 V AC/DC

Table 13. Double-pole power output relays with TCS function

Description	Value
Rated voltage	250 V AC/DC
Continuous contact carry	8 A
Make and carry for 3.0 s	15 A
Make and carry for 0.5 s	30 A
Breaking capacity when the control-circuit time constant L/ R<40 ms, at 48/110/220 V DC (two contacts connected in series)	5 A/3 A/1 A
Minimum contact load	100 mA at 24 V AC/DC
Trip-circuit supervision (TCS):	
• Control voltage range	20...250 V AC/DC
• Current drain through the supervision circuit	~1.5 mA
• Minimum voltage over the TCS contact	20 V AC/DC (15...20 V)

Table 14. Single-pole power output relays

Description	Value
Rated voltage	250 V AC/DC
Continuous contact carry	8A
Make and carry for 3.0 s	15 A
Make and carry for 0.5 s	30 A
Breaking capacity when the control-circuit time constant L/ R<40 ms, at 48/110/220 V DC	5 A/3 A/1 A
Minimum contact load	100 mA at 24 V AC/DC

Table 15. Front port Ethernet interfaces

Ethernet interface	Protocol	Cable	Data transfer rate
Front	TCP/IP protocol	Standard Ethernet CAT 5 cable with RJ-45 connector	10 Mbits/s

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Table 16. Station communication link, fibre-optic

Connector	Fibre type ¹⁾	Wave length	Max. distance	Permitted path attenuation ²⁾
LC	MM 62.5/125 or 50/125 µm glass fibre core	1300 nm	2 km	<8 dB
ST	MM 62.5/125 or 50/125 µm glass fibre core	820-900 nm	1 km	<11 dB

1) (MM) multi-mode fibre, (SM) single-mode fibre

2) Maximum allowed attenuation caused by connectors and cable together

Table 17. IRIG-B

Description	Value
IRIG time code format	B004, B005 ¹⁾
Isolation	500V 1 min.
Modulation	Unmodulated
Logic level	TTL Level
Current consumption	2...4 mA
Power consumption	10...20 mW

1) According to 200-04 IRIG -standard

Table 18. Lens sensor and optical fibre for arc protection

Description	Value
Fibre-optic cable including lens	1.5 m, 3.0 m or 5.0 m
Normal service temperature range of the lens	-40...+100°C
Maximum service temperature range of the lens, max 1 h	+140°C
Minimum permissible bending radius of the connection fibre	100 mm

Table 19. Degree of protection of flush-mounted IED

Description	Value
Front side	IP 54
Rear side, connection terminals	IP 20

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Table 20. Environmental conditions

Description	Value
Operating temperature range	-25...+55°C (continuous)
Short-time service temperature range	-40...+85°C (<16h) ¹⁾²⁾
Relative humidity	<93%, non-condensing
Atmospheric pressure	86...106 kPa
Altitude	Up to 2000 m
Transport and storage temperature range	-40...+85°C

1) Degradation in MTBF and HMI performance outside the temperature range of -25...+55 °C

2) For IEDs with an LC communication interface the maximum operating temperature is +70 °C

Table 21. Environmental tests

Description	Type test value	Reference
Dry heat test	96 h at +55°C 16 h at +85°C¹⁾	IEC 60068-2-2
Dry cold test	96 h at -25°C 16 h at -40°C	IEC 60068-2-1
Damp heat test	6 cycles (12 h + 12 h) at +25°C...+55°C, humidity >93%	IEC 60068-2-30
Change of temperature test	5 cycles (3 h + 3 h) at -25°C...+55°C	IEC60068-2-14
Storage test	96 h at -40°C 96 h at +85°C	IEC 60068-2-1 IEC 60068-2-2

1) For IEDs with an LC communication interface the maximum operating temperature is +70°C

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Table 22. Electromagnetic compatibility tests

Description	Type test value	Reference
1 MHz/100 kHz burst disturbance test:		IEC 61000-4-18 IEC 60255-22-1, class III IEEE C37.90.1-2002
• Common mode	2.5 kV	
• Differential mode	2.5 kV	
3 MHz, 10 MHz and 30 MHz burst disturbance test:		IEC 61000-4-18 IEC 60255-22-1, class III
• Common mode	2.5 kV	
Electrostatic discharge test:		IEC 61000-4-2 IEC 60255-22-2 IEEE C37.90.3-2001
• Contact discharge	8 kV	
• Air discharge	15 kV	
Radio frequency interference test:	10 V (rms) f=150 kHz...80 MHz 10 V/m (rms) f=80...2700 MHz 10 V/m f=900 MHz 20 V/m (rms) f=80...1000 MHz	IEC 61000-4-6 IEC 60255-22-6, class III IEC 61000-4-3 IEC 60255-22-3, class III ENV 50204 IEC 60255-22-3, class III IEEE C37.90.2-2004
Fast transient disturbance test:		IEC 61000-4-4 IEC 60255-22-4 IEEE C37.90.1-2002
• All ports	4 kV	
Surge immunity test:		IEC 61000-4-5 IEC 60255-22-5
• Communication	1 kV, line-to-earth	
• Other ports	4 kV, line-to-earth 2 kV, line-to-line	
Power frequency (50 Hz) magnetic field immunity test:		IEC 61000-4-8
• Continuous	300 A/m	
• 1...3 s	1000 A/m	
Pulse magnetic field immunity test:	1000 A/m 6.4/16 µs	IEC 61000-4-9
Damped oscillatory magnetic field immunity test:		IEC 61000-4-10
• 2 s	100 A/m	
• 1 MHz	400 transients/s	

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Table 22. Electromagnetic compatibility tests, continued

Description	Type test value	Reference
Voltage dips and short interruptions:	30%/10 ms 60%/100 ms 60%/1000 ms >95%/5000 ms	IEC 61000-4-11
Power frequency immunity test: • Common mode • Differential mode	Binary inputs only 300 V rms 150 V rms	IEC 61000-4-16 IEC 60255-22-7, class A
Conducted common mode disturbances:	15 Hz...150 kHz Test level 3 (10/1/10 V rms)	IEC 61000-4-16
Emission tests: • Conducted 0.15-0.50 MHz 0.5-30 MHz • Radiated 30-230 MHz 230-1000 MHz	 < 79 dB(μV) quasi peak < 66 dB(μV) average < 73 dB(μV) quasi peak < 60 dB(μV) average < 40 dB(μV/m) quasi peak, measured at 10 m distance < 47 dB(μV/m) quasi peak, measured at 10 m distance	EN 55011, class A IEC 60255-25

Table 23. Insulation tests

Description	Type test value	Reference
Dielectric tests	2 kV, 50 Hz, 1 min 500 V, 50 Hz, 1 min, communication	IEC 60255-5 and IEC 60255-27
Impulse voltage test	5 kV, 1.2/50 μs, 0.5 J 1 kV, 1.2/50 μs, 0.5 J, communication	IEC 60255-5 and IEC 60255-27
Insulation resistance measurements	>100 MΩ, 500 V DC	IEC 60255-5 and IEC 60255-27
Protective bonding resistance	<0.1 Ω, 4 A, 60 s	IEC 60255-27

Table 24. Mechanical tests

Description	Reference	Requirement
Vibration tests (sinusoidal)	IEC 60068-2-6 (test Fc) IEC 60255-21-1	Class 2
Shock and bump test	IEC 60068-2-27 (test Ea shock) IEC 60068-2-29 (test Eb bump) IEC 60255-21-2	Class 2
Seismic test	IEC 60255-21-3	Class 2

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Table 25. Product safety

Description	Reference
LV directive	2006/95/EC
Standard	EN 60255-27 (2005) EN 60255-1 (2009)

Table 26. EMC compliance

Description	Reference
EMC directive	2004/108/EC
Standard	EN 50263 (2000) EN 60255-26 (2007)

Table 27. RoHS compliance

Description
Complies with RoHS directive 2002/95/EC

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Protection functions

Table 28. Three-phase non-directional overcurrent protection (PHxPTOC)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the current measured: f_n ± 2 Hz		
	PHLPTOC	$\pm 1.5\%$ of the set value or $\pm 0.002 \times I_n$		
	PHHPTOC and PHIPTOC	$\pm 1.5\%$ of set value or $\pm 0.002 \times I_n$ (at currents in the range of $0.1 \dots 10 \times I_n$) $\pm 5.0\%$ of the set value (at currents in the range of $10 \dots 40 \times I_n$)		
Start time ¹⁾²⁾		Minimum	Typical	Maximum
	PHIPTOC: $I_{Fault} = 2 \times \text{set Start value}$	16 ms	19 ms	23 ms
	$I_{Fault} = 10 \times \text{set Start value}$	11 ms	12 ms	14 ms
	PHHPTOC and PHLPTOC: $I_{Fault} = 2 \times \text{set Start value}$	22 ms	24 ms	25 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Retardation time		< 30 ms		
Operate time accuracy in definite time mode		$\pm 1.0\%$ of the set value or ± 20 ms		
Operate time accuracy in inverse time mode		$\pm 5.0\%$ of the theoretical value or ± 20 ms ³⁾		
Suppression of harmonics		RMS: No suppression DFT: -50 dB at $f = n \times f_n$, where $n = 2, 3, 4, 5, \dots$ Peak-to-Peak: No suppression P-to-P+backup: No suppression		

1) Set *Operate delay time* = 0,02 s, *Operate curve type* = IEC definite time, *Measurement mode* = default (depends on stage), current before fault = $0.0 \times I_n$, $f_n = 50$ Hz, fault current in one phase with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements

2) Includes the delay of the signal output contact

3) Includes the delay of the heavy-duty output contact

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Table 29. Three-phase non-directional overcurrent protection (PHxPTOC) main settings

Parameter	Function	Value (Range)	Step
Start Value	PHLPTOC	$0.05 \dots 5.00 \times I_n$	0.01
	PHHPTOC	$0.10 \dots 40.00 \times I_n$	0.01
	PHIPTOC	$1.00 \dots 40.00 \times I_n$	0.01
Time multiplier	PHLPTOC	0.05...15.00	0.01
	PHHPTOC	0.05...15.00	0.01
Operate delay time	PHLPTOC	40...200000 ms	10
	PHHPTOC	40...200000 ms	10
	PHIPTOC	20...200000 ms	10
Operating curve type ¹⁾	PHLPTOC	Definite or inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
	PHHPTOC	Definite or inverse time Curve type: 1, 3, 5, 9, 10, 12, 15, 17	
	PHIPTOC	Definite time	

1) For further reference please refer to the Operating characteristics table

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Table 30. Non-directional earth-fault protection (EFxPTOC)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the current measured: f_n ± 2 Hz		
	EFLPTOC	$\pm 1.5\%$ of the set value or $\pm 0.002 \times I_n$		
	EFHPTOC and EFIPTOC	$\pm 1.5\%$ of set value or $\pm 0.002 \times I_n$ (at currents in the range of $0.1 \dots 10 \times I_n$) $\pm 5.0\%$ of the set value (at currents in the range of $10 \dots 40 \times I_n$)		
Start time ¹⁾²⁾		Minimum	Typical	Maximum
	EFIPTOC:			
	$I_{Fault} = 2 \times \text{set } Start \text{ value}$	16 ms	19 ms	23 ms
	$I_{Fault} = 10 \times \text{set } Start \text{ value}$	11 ms	12 ms	14 ms
	EFHPTOC and EFLPTOC:			
	$I_{Fault} = 2 \times \text{set } Start \text{ value}$	22 ms	24 ms	25 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Retardation time		< 30 ms		
Operate time accuracy in definite time mode		$\pm 1.0\%$ of the set value or ± 20 ms		
Operate time accuracy in inverse time mode		$\pm 5.0\%$ of the theoretical value or ± 20 ms ³⁾		
Suppression of harmonics		RMS: No suppression DFT: -50 dB at $f = n \times f_n$, where $n = 2, 3, 4, 5, \dots$ Peak-to-Peak: No suppression		

1) *Measurement mode* = default (depends on stage), current before fault = $0.0 \times I_n$, $f_n = 50$ Hz, earth-fault current with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements

2) Includes the delay of the signal output contact

3) Maximum *Start value* = $2.5 \times I_n$, *Start value* multiples in range of 1.5 to 20

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Table 31. Non-directional earth-fault protection (EFxPTOC) main settings

Parameter	Function	Value (Range)	Step
Start value	EFLPTOC	$0.010...5.000 \times I_n$	0.005
	EFHPTOC	$0.10...40.00 \times I_n$	0.01
	EFIPTOC	$1.00...40.00 \times I_n$	0.01
Time multiplier	EFLPTOC	0.05...15.00	0.01
	EFHPTOC	0.05...15.00	0.01
Operate delay time	EFLPTOC	40...200000 ms	10
	EFHPTOC	40...200000 ms	10
	EFIPTOC	20...200000 ms	10
Operating curve type ¹⁾	EFLPTOC	Definite or inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
	EFHPTOC	Definite or inverse time Curve type: 1, 3, 5, 9, 10, 12, 15, 17	
	EFIPTOC	Definite time	

1) For further reference please refer to the Operating characteristics table

Table 32. Residual overvoltage protection (ROVPTOV)

Characteristic	Value			
Operation accuracy	Depending on the frequency of the voltage measured: f_n ± 2 Hz			
	$\pm 1.5\%$ of the set value or $\pm 0.002 \times U_n$			
Start time ¹⁾²⁾	$U_{\text{Fault}} = 1.1 \times \text{set Start value}$	Minimum	Typical	Maximum
		55 ms	56 ms	58 ms
Reset time	< 40 ms			
Reset ratio	Typical 0.96			
Retardation time	< 35 ms			
Operate time accuracy in definite time mode	$\pm 1.0\%$ of the set value or ± 20 ms			
Suppression of harmonics	DFT: -50 dB at $f = n \times f_n$, where $n = 2, 3, 4, 5, \dots$			

1) Residual voltage before fault = $0.0 \times U_n$, $f_n = 50$ Hz, residual voltage with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements

2) Includes the delay of the signal output contact

Table 33. Residual overvoltage protection (ROVPTOV) main settings

Parameter	Function	Value (Range)	Step
Start value	ROVPTOV	$0.010...1.000 \times U_n$	0.001
Operate delay time	ROVPTOV	40...300000 ms	1

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Table 34. Negative phase-sequence overcurrent protection (NSPTOC)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the current measured: f_n ± 2 Hz $\pm 1.5\%$ of the set value or $\pm 0.002 \times I_n$		
Start time ¹⁾²⁾		Minimum	Typical	Maximum
	$I_{Fault} = 2 \times \text{set } Start \text{ value}$	22 ms	24 ms	25 ms
	$I_{Fault} = 10 \times \text{set } Start \text{ value}$	14 ms	16 ms	17 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Retardation time		< 35 ms		
Operate time accuracy in definite time mode		$\pm 1.0\%$ of the set value or ± 20 ms		
Operate time accuracy in inverse time mode		$\pm 5.0\%$ of the theoretical value or ± 20 ms ³⁾		
Suppression of harmonics		DFT: -50 dB at $f = n \times f_n$, where $n = 2, 3, 4, 5, \dots$		

1) Negative sequence current before fault = 0.0, $f_n = 50$ Hz, results based on statistical distribution of 1000 measurements

2) Includes the delay of the signal output contact

3) Maximum *Start value* = $2.5 \times I_n$, *Start value* multiples in range of 1.5 to 20

Table 35. Negative phase-sequence overcurrent protection (NSPTOC) main settings

Parameter	Function	Value (Range)	Step
Start value	NSPTOC	$0.01 \dots 5.00 \times I_n$	0.01
Time multiplier	NSPTOC	0.05... 15.00	0.01
Operate delay time	NSPTOC	40...200000 ms	10
Operating curve type ¹⁾	NSPTOC	Definite or inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	

1) For further reference please refer to the Operating characteristics table

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Table 36. Three-phase overvoltage protection (PHPTOV)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the voltage measured: f_n ± 2 Hz $\pm 1.5\%$ of the set value or $\pm 0.002 \times U_n$		
Start time ¹⁾²⁾		Minimum	Typical	Maximum
	$U_{\text{Fault}} = 1.1 \times \text{set Start value}$	22 ms	24 ms	26 ms
Reset time		< 40 ms		
Reset ratio		Depends of the set <i>Relative hysteresis</i>		
Retardation time		< 35 ms		
Operate time accuracy in definite time mode		$\pm 1.0\%$ of the set value or ± 20 ms		
Operate time accuracy in inverse time mode		$\pm 5.0\%$ of the theoretical value or ± 20 ms ³⁾		
Suppression of harmonics		DFT: -50 dB at $f = n \times f_n$, where $n = 2, 3, 4, 5, \dots$		

- 1) *Start value* = $1.0 \times U_n$, Voltage before fault = $0.9 \times U_n$, $f_n = 50$ Hz, overvoltage in one phase-to-phase with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Maximum *Start value* = $1.20 \times U_n$, *Start value* multiples in range of 1.10 to 2.00

Table 37. Three-phase overvoltage protection (PHPTOV) main settings

Parameter	Function	Value (Range)	Step
Start value	PHPTOV	$0.05 \dots 1.60 \times U_n$	0.01
Time multiplier	PHPTOV	$0.05 \dots 15.00$	0.01
Operate delay time	PHPTOV	$40 \dots 300000$ ms	10
Operating curve type ¹⁾	PHPTOV	Definite or inverse time Curve type: 5, 15, 17, 18, 19, 20	

- 1) For further reference please refer to the Operating characteristics table

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Table 38. Three phase undervoltage protection (PHPTUV)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the voltage measured: fn ±2 Hz		
		±1.5% of the set value or ±0.002 x Un		
Start time ¹⁾²⁾	U _{Fault} = 0.9 x set <i>Start value</i>	Minimum	Typical	Maximum
		62 ms	64 ms	66 ms
Reset time		< 40 ms		
Reset ratio		Depends on the set <i>Relative hysteresis</i>		
Retardation time		< 35 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms ³⁾		
Suppression of harmonics		DFT: -50 dB at f = n x fn, where n = 2, 3, 4, 5,...		

1) *Start value* = $1.0 \times U_n$, Voltage before fault = $1.1 \times U_n$, $f_n = 50$ Hz, undervoltage in one phase-to-phase with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements

2) Includes the delay of the signal output contact

3) Minimum *Start value* = 0.50, *Start value* multiples in range of 0.90 to 0.20

Table 39. Three-phase undervoltage protection (PHPTUV) main settings

Parameter	Function	Value (Range)	Step
Start value	PHPTUV	$0.05 \dots 1.20 \times U_n$	0.01
Time multiplier	PHPTUV	0.05...15.00	0.01
Operate delay time	PHPTUV	60...300000 ms	10
Operating curve type ¹⁾	PHPTUV	Definite or inverse time Curve type: 5, 15, 21, 22, 23	

1) For further reference please refer to the Operating characteristics table

Table 40. Thermal overload protection, two time constants (T2PTTR)

Characteristic	Value
Operation accuracy	Depending on the frequency of the current measured: f_n ± 2 Hz
	Current measurement: $\pm 1.5\%$ of the set value or $\pm 0.002 \times I_n$ (at currents in the range of $0.01 \dots 4.00 \times I_n$)
Operate time accuracy ¹⁾	$\pm 2.0\%$ of the theoretical value or ± 0.50 s

1) Overload current > $1.2 \times$ Operate level temperature

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Table 41. Thermal overload for protection, two time constants (T2PTTR) main settings

Parameter	Function	Value (Range)	Step
Temperature rise	T2PTTR	0.0...200.0°C	0.1
Max temperature	T2PTTR	0.0...200.0°C	0.1
Operate temperature	T2PTTR	80.0...120.0 %	0.1
Weighting factor p	T2PTTR	0.00...1.00	0.01
Short time constant	T2PTTR	6...60000 s	1
Current reference	T2PTTR	0.05...4.00 x I _n	0.01
Operation	T2PTTR	Off On	-

Table 42. Transformer differential protection of two-winding transformers (TR2PTDF)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the current measured: f _n ±2 Hz		
		±3.0% of the set value or ±0.002 x I _n		
Operate time ¹⁾²⁾		Minimum	Typical	Maximum
	Low stage	34 ms	40 ms	44 ms
	High stage	21 ms	22 ms	24 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Suppression of harmonics		DFT: -50 dB at f = n x f _n , where n = 2, 3, 4, 5, ...		

1) Current before fault = 0.0, f_n = 50 Hz, results based on statistical distribution of 1000 measurements

2) Includes the delay of the output contact. When differential current = 2 x set operate value and f_n = 50 Hz.

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Table 43. Stabilized differential protection for two-winding transformers (TR2PTDF) main settings

Parameter	Function	Value (Range)	Step
Restraint mode	TR2PTDF	2.h & 5.h & wav Waveform 2.h & waveform 5.h & waveform	-
High operate value	TR2PTDF	500...3000 %	10
Low operate value	TR2PTDF	5...50 %	1
Slope section 2	TR2PTDF	10...50 %	1
End section 2	TR2PTDF	100...500 %	1
Start value 2.H	TR2PTDF	7...20 %	1
Start value 5.H	TR2PTDF	10...50 %	1
Operation	TR2PTDF	Off On	-
Winding 1 type	TR2PTDF	Y YN D Z ZN	-
Winding 2 type	TR2PTDF	Y YN D Z ZN	-
Zro A elimination	TR2PTDF	Not eliminated Winding 1 Winding 2 Winding 1 and 2	-

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Table 44. Numerical stabilized low impedance restricted earth-fault protection (LREFPNDF)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the current measured: f_n ± 2 Hz $\pm 2.5\%$ of the set value or $\pm 0.002 \times I_n$		
Start time ¹⁾²⁾	$I_{Fault} = 2.0 \times \text{set } Operate \text{ value}$	Minimum	Typical	Maximum
		38 ms	40 ms	43 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Retardation time		< 35 ms		
Operate time accuracy in definite time mode		$\pm 1.0\%$ of the set value or ± 20 ms		
Suppression of harmonics		DFT: -50 dB at $f = n \times f_n$, where $n = 2, 3, 4, 5, \dots$		

1) Current before fault = 0.0, $f_n = 50$ Hz, results based on statistical distribution of 1000 measurements

2) Includes the delay of the signal output contact

Table 45. Stabilized restricted earth-fault protection (LREFPNDF) main settings

Parameter	Function	Value (Range)	Step
Operate value	LREFPNDF	5...50 %	1
Restraint mode	LREFPNDF	None 2nd harmonic	-
Start value 2.H	LREFPNDF	10...50 %	1
Minimum operate time	LREFPNDF	40...300000 ms	1
Operation	LREFPNDF	Off On	-

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Table 46. High-impedance based restricted earth-fault protection (HREFPDIF)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the current measured: f_n ± 2 Hz		
		$\pm 1.5\%$ of the set value or $\pm 0.002 \times I_n$		
Start time ¹⁾²⁾		Minimum	Typical	Maximum
	$I_{Fault} = 2.0 \times \text{set } Operate \text{ value}$	16 ms 11 ms	21 ms 13 ms	23 ms 14 ms
	$I_{Fault} = 10.0 \times \text{set } Operate \text{ value}$			
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Retardation time		< 35 ms		
Operate time accuracy in definite time mode		$\pm 1.0\%$ of the set value or ± 20 ms		

1) Current before fault = 0.0, $f_n = 50$ Hz, results based on statistical distribution of 1000 measurements

2) Includes the delay of the signal output contact

Table 47. High-impedance based restricted earth-fault protection (HREFPDIF) main settings

Parameter	Function	Value (Range)	Step
Operate value	HREFPDIF	1.0...50.0 %	0.1
Minimum operate time	HREFPDIF	40...300000 ms	1
Operation	HREFPDIF	Off On	-

Table 48. Circuit breaker failure protection (CCBRBRF)

Characteristic	Value
Operation accuracy	Depending on the frequency of the current measured: f_n ± 2 Hz
	$\pm 1.5\%$ of the set value or $\pm 0.002 \times I_n$
Operate time accuracy	$\pm 1.0\%$ of the set value or ± 20 ms

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Table 49. Circuit breaker failure protection (CCBRBRF) main settings

Parameter	Function	Value (Range)	Step
Current value (Operating phase current)	CCBRBRF	0.05...1.00 x I _n	0.05
Current value Res (Operating residual current)	CCBRBRF	0.05...1.00 x I _n	0.05
CB failure mode (Operating mode of function)	CCBRBRF	1=Current 2=Breaker status 3=Both	-
CB fail trip mode	CCBRBRF	1=Off 2=Without check 3=Current check	-
Retrip time	CCBRBRF	0...60000 ms	10
CB failure delay	CCBRBRF	0...60000 ms	10
CB fault delay	CCBRBRF	0...60000 ms	10

Table 50. Arc protection (ARCSARC)

Characteristic	Value			
Operation accuracy	±3% of the set value or ±0.01 x I _n			
Operate time		Minimum	Typical	Maximum
	Operation mode = "Light +current" ¹⁾²⁾	9 ms	12 ms	15 ms
	Operation mode = "Light only" ²⁾	9 ms	10 ms	12 ms
Reset time	< 40 ms			
Reset ratio	Typical 0.96			

- 1) Phase start value = 1.0 x I_n, current before fault = 2.0 x set Phase start value, f_n = 50 Hz, fault with nominal frequency, results based on statistical distribution of 200 measurements
- 2) Includes the delay of the heavy-duty output contact

Table 51. Arc protection (ARCSARC) main settings

Parameter	Function	Value (Range)	Step
Phase start value (Operating phase current)	ARCSARC	0.50...40.00 x I _n	0.01
Ground start value (Operating residual current)	ARCSARC	0.05...8.00 x I _n	0.01
Operation mode	ARCSARC	1=Light+current 2=Light only 3=BI controlled	

Table 52. Multipurpose protection (MAPGAPC)

Characteristic	Value
Operation accuracy	±1.0% of the set value or ±20 ms

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Table 53. Multipurpose analog protection (MAPGAPC) main settings

Parameter	Function	Value (Range)	Step
Start value	MAPGAPC	-10000.0...10000.0	0.1
Operate delay time	MAPGAPC	0...200000 ms	100
Operation mode	MAPGAPC	Over Under	-

Table 54. Operation characteristics

Parameter	Values (Range)
Operating curve type	1=ANSI Ext. inv. 2=ANSI Very. inv. 3=ANSI Norm. inv. 4=ANSI Mod inv. 5=ANSI Def. Time 6=L.T.E. inv. 7=L.T.V. inv. 8=L.T. inv. 9=IEC Norm. inv. 10=IEC Very inv. 11=IEC inv. 12=IEC Ext. inv. 13=IEC S.T. inv. 14=IEC L.T. inv 15=IEC Def. Time 17=Programmable 18=RI type 19=RD type
Operating curve type (voltage protection)	5=ANSI Def. Time 15=IEC Def. Time 17=Inv. Curve A 18=Inv. Curve B 19=Inv. Curve C 20=Programmable 21=Inv. Curve A 22=Inv. Curve B 23=Programmable

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Measurement functions

Table 55. Three-phase current measurement (CMMXU)

Characteristic	Value
Operation accuracy	Depending on the frequency of the current measured: f_n ± 2 Hz $\pm 0.5\%$ or $\pm 0.002 \times I_n$ (at currents in the range of $0.01 \dots 4.00 \times I_n$)
Suppression of harmonics	DFT: -50 dB at $f = n \times f_n$, where $n = 2, 3, 4, 5, \dots$ RMS: No suppression

Table 56. Three-phase voltage measurement (VMMXU)

Characteristic	Value
Operation accuracy	Depending on the frequency of the voltage measured: f_n ± 2 Hz At voltages in range $0.01 \dots 1.15 \times U_n$ $\pm 0.5\%$ or $\pm 0.002 \times U_n$
Suppression of harmonics	DFT: -50 dB at $f = n \times f_n$, where $n = 2, 3, 4, 5, \dots$ RMS: No suppression

Table 57. Voltage sequence components (VSMSQI)

Characteristic	Value
Operation accuracy	Depending on the frequency of the voltage measured: f_n ± 2 Hz At voltages in range $0.01 \dots 1.15 \times U_n$ $\pm 1.0\%$ or $\pm 0.002 \times U_n$
Suppression of harmonics	DFT: -50 dB at $f = n \times f_n$, where $n = 2, 3, 4, 5, \dots$

Table 58. Residual current measurement (RESCMMXU)

Characteristic	Value
Operation accuracy	Depending on the frequency of the current measured: f/f_n $= \pm 2$ Hz $\pm 0.5\%$ or $\pm 0.002 \times I_n$ at currents in the range of $0.01 \dots 4.00 \times I_n$
Suppression of harmonics	DFT: -50 dB at $f = n \times f_n$, where $n = 2, 3, 4, 5, \dots$ RMS: No suppression

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Table 59. Residual voltage measurement (RESVMMXU)

Characteristic	Value
Operation accuracy	Depending on the frequency of the current measured: f/f_n = ± 2 Hz
	$\pm 0.5\%$ or $\pm 0.002 \times U_n$
Suppression of harmonics	DFT: -50 dB at $f = n \times f_n$, where $n = 2, 3, 4, 5, \dots$ RMS: No suppression

Table 60. Three-phase power and energy (PEMMXU)

Characteristic	Value
Operation accuracy	At all three currents in range $0.10 \dots 1.20 \times I_n$ At all three voltages in range $0.50 \dots 1.15 \times U_n$ At the frequency $f_n \pm 1$ Hz Active power and energy in range $ PF > 0.71$ Reactive power and energy in range $ PF < 0.71$
	$\pm 1.5\%$ for power (S, P and Q) ± 0.015 for power factor $\pm 1.5\%$ for energy
Suppression of harmonics	DFT: -50 dB at $f = n \times f_n$, where $n = 2, 3, 4, 5, \dots$

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Table 61. RTD/mA measurement (XRGGIO130)

Description		Value	
RTD inputs	Supported RTD sensors	100 Ω platinum	TCR 0.00385 (DIN 43760)
		250 Ω platinum	TCR 0.00385
		100 Ω nickel	TCR 0.00618 (DIN 43760)
		120 Ω nickel	TCR 0.00618
		250 Ω nickel	TCR 0.00618
		10 Ω copper	TCR 0.00427
	Supported resistance range	0...2 k Ω	
	Maximum lead resistance (three-wire measurement)	25 Ω per lead	
	Isolation	2 kV (inputs to protective earth)	
	Response time	<4 s	
	RTD/resistance sensing current	Maximum 0.33 mA rms	
	Operation accuracy	Resistance	Temperature
		$\pm 2.0\%$ or $\pm 1 \Omega$	$\pm 1^\circ\text{C}$
			10 Ω copper: $\pm 2^\circ\text{C}$
	Operation accuracy		
mA inputs	Supported current range	0...20 mA	
	Current input impedance	44 $\Omega \pm 0.1\%$	
	Operation accuracy	$\pm 0.5\%$ or $\pm 0.01 \text{ mA}$	

18. Local HMI

The IED is available with two optional displays, a large one and a small one. The large display is suited for IED installations where the front panel user interface is frequently used and a single line diagram is required. The small display is suited for remotely controlled substations where the IED is only occasionally accessed locally via the front panel user interface.

Both LCD displays offer front-panel user interface functionality with menu navigation and menu views. However, the large display offers increased front-panel usability with less menu scrolling and improved information overview. In addition, the large display includes a user-configurable single line diagram (SLD) with position indication for the associated primary equipment. Depending on the chosen standard configuration, the IED displays the related measuring values, apart from the

default single line diagram. The SLD view can also be accessed using the web-browser based user interface. The default SLD can be modified according to user requirements by using the graphical display editor in PCM600.

The local HMI includes a push button (L/R) for local/remote operation of the IED. When the IED is in the local mode, the IED can be operated only by using the local front panel user interface. When the IED is in the remote mode, the IED can execute commands sent from a remote location. The IED supports the remote selection of local/remote mode via a binary input. This feature facilitates, for example, the use of an external switch at the substation to ensure that all IEDs are in the local mode during maintenance work and that the circuit breakers cannot be operated remotely from the network control centre.

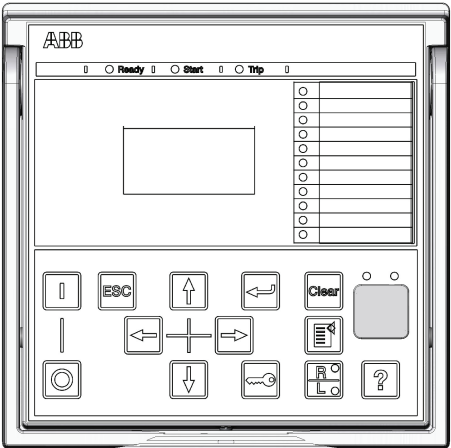


Figure 13. Small display

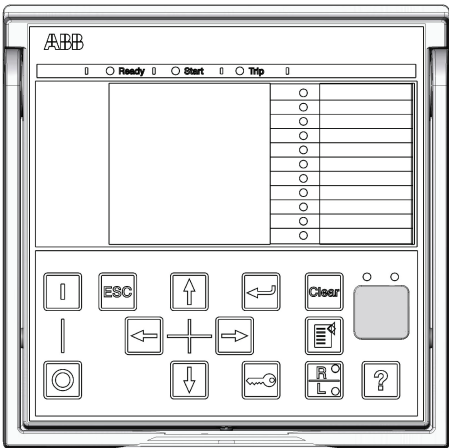


Figure 14. Large display

Table 62. Small display

Character size ¹⁾	Rows in the view	Characters per row
Small, mono-spaced (6x12 pixels)	5	20
Large, variable width (13x14 pixels)	4	8 or more

1) Depending on the selected language

Table 63. Large display

Character size ¹⁾	Rows in the view	Characters per row
Small, mono-spaced (6x12 pixels)	10	20
Large, variable width (13x14 pixels)	8	8 or more

1) Depending on the selected language

19. Mounting methods

By means of appropriate mounting accessories the standard IED case for the 615 series IED can be flush mounted, semi-flush mounted or wall mounted. The flush mounted and wall mounted IED cases can also be mounted in a tilted position (25°) using special accessories.

Further, the IEDs can be mounted in any standard 19" instrument cabinet by means of 19" mounting panels available with cut-outs for one or two IEDs. Alternatively, the IED can be mounted in 19" instrument cabinets by means of 4U Combiflex equipment frames.

For the routine testing purposes, the IED cases can be equipped with test switches, type RTXP 18, which can be mounted side by side with the IED cases.

Mounting methods:

- Flush mounting
- Semi-flush mounting
- Semi-flush mounting in a 25° tilt
- Rack mounting
- Wall mounting
- Mounting to a 19" equipment frame
- Mounting with a RTXP 18 test switch to a 19" rack

Panel cut-out for flush mounting:

- Height: 161.5±1 mm
- Width: 165.5±1 mm

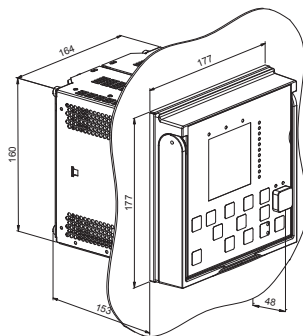


Figure 15. Flush mounting

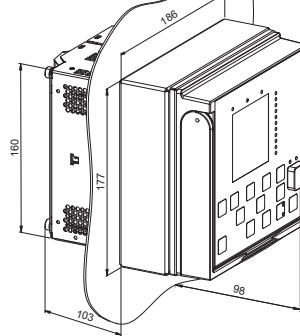


Figure 16. Semi-flush mounting

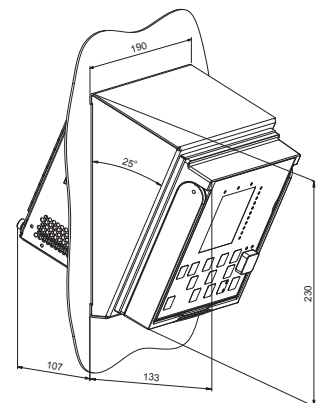


Figure 17. Semi-flush with a 25° tilt

20. IED case and IED plug-in unit

For safety reasons, the IED cases for current measuring IEDs are provided with automatically operating contacts for short-circuiting the CT secondary circuits when a IED unit is withdrawn from its case. The IED case is further provided with a mechanical coding system preventing current measuring IED units from being inserted into a IED case for a voltage measuring IED unit and vice versa, i.e. the IED cases are assigned to a certain type of IED plug-in unit.

on the upper part of the plug-in-unit. An order number label is placed on the side of the plug-in unit as well as inside the case. The order number consists of a string of codes generated from the IED's hardware and software modules.

Use the ordering key information to generate the order number when ordering complete IEDs.

21. Selection and ordering data

The IED type and serial number label identifies the protection IED. The label is placed above the HMI

#	Description	
1	IED	
	615 series IED (including case)	H
	615 series IED (including case) with test switch, wired and in - stalled in a 19" equipment panel	K
	615 series IED (including case) with test switch, wired and in - stalled in a mounting bracket for CombiFlex rack mounting (RGHT 19" 4U variant C)	L
2	Standard	
	IEC	B
3	Main application	
	Transformer protection and control	T

H

B

T

ABGBABCC1BBN1XE

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The standard configuration determines the I/O hardware and available options.
The example below shows standard configuration "A" with chosen options.

HBT ABGBA BCC1BBN1XE

#	Description																																		
4-8	Standard configurations, analog and binary I/O options Standard configuration descriptions in short: A = Three-phase transformer differential protection for two-winding transform - ers, numerical restricted earth-fault protection for the high-voltage (HV) side, CB control and optional RTD/mA inputs B = Three-phase transformer differential protection for two-winding transform - ers, numerical restricted earth-fault protection for the low-voltage (LV) side, CB control, optional RTD/mA inputs C = Three-phase transformer differential protection for two-winding transform - ers, high-impedance based restricted earth-fault protection for the high-voltage (HV) side, optional RTD/mA inputs D = Three-phase transformer differential protection for two-winding transform - ers, high-impedance based restricted earth-fault protection for the low-voltage (LV) side, CB control and optional RTD/mA inputs E = Three-phase transformer differential protection for two-winding transform - ers, numerical restricted earth-fault protection for the high-voltage (HV) side, phase-voltage based protection and measurement functions F = Three-phase transformer differential protection for two-winding transform - ers, numerical restricted earth-fault protection for the low-voltage (LV) side, phase-voltage based protection and measurement functions and CB control G = Three-phase transformer differential protection for two-winding transform - ers, high-impedance based restricted earth-fault protection for the high-voltage (HV) side, phase-voltage based protection and measurement functions and CB control H = Three-phase transformer differential protection for two-winding transform - ers, high-impedance based restricted earth-fault protection for the low-voltage (LV) side, phase-voltage based protection and measurement functions and CB control <table> <tr> <th>Std. conf.</th><th>I/O options</th></tr> <tr> <td>A</td><td>7I (lo 1/5 A) + 8 BI + 10 BO ABABA</td></tr> <tr> <td>A</td><td>7I (lo 1/5 A) + 14 BI + 13 BO ABABB</td></tr> <tr> <td>A</td><td>7I (lo 1/5 A) + 6 RTD + 2 mA + 8 BI + 10 BO ABGBA</td></tr> <tr> <td>B</td><td>7I (lo 1/5 A) + 8 BI + 10 BO BBABA</td></tr> <tr> <td>B</td><td>7I (lo 1/5 A) + 14 BI + 13 BO BBABB</td></tr> <tr> <td>B</td><td>7I (lo 1/5 A) + 6 RTD + 2 mA + 8 BI + 10 BO BBGBA</td></tr> <tr> <td>C</td><td>7I (lo 1/5 A) + 8 BI + 10 BO CBABA</td></tr> <tr> <td>C</td><td>7I (lo 1/5 A) + 14 BI + 13 BO CBABB</td></tr> <tr> <td>C</td><td>7I (lo 1/5 A) + 6 RTD + 2 mA + 8 BI + 10 BO CBGBA</td></tr> <tr> <td>D</td><td>7I (lo 1/5 A) + 8 BI + 10 BO DBABA</td></tr> <tr> <td>D</td><td>7I (lo 1/5 A) + 14 BI + 13 BO DBABB</td></tr> <tr> <td>D</td><td>7I (lo 1/5 A) + 6 RTD + 2 mA + 8 BI + 10 BO DGBA</td></tr> <tr> <td>E</td><td>7I (lo 1/5 A) + 5U + 12 BI + 10 BO EBCAD</td></tr> <tr> <td>F</td><td>7I (lo 1/5 A) + 5U + 12 BI + 10 BO FBCAD</td></tr> <tr> <td>G</td><td>7I (lo 1/5 A) + 5U + 12 BI + 10 BO GBCAD</td></tr> <tr> <td>H</td><td>7I (lo 1/5 A) + 5U + 12 BI + 10 BO HBCAD</td></tr> </table>	Std. conf.	I/O options	A	7I (lo 1/5 A) + 8 BI + 10 BO ABABA	A	7I (lo 1/5 A) + 14 BI + 13 BO ABABB	A	7I (lo 1/5 A) + 6 RTD + 2 mA + 8 BI + 10 BO ABGBA	B	7I (lo 1/5 A) + 8 BI + 10 BO BBABA	B	7I (lo 1/5 A) + 14 BI + 13 BO BBABB	B	7I (lo 1/5 A) + 6 RTD + 2 mA + 8 BI + 10 BO BBGBA	C	7I (lo 1/5 A) + 8 BI + 10 BO CBABA	C	7I (lo 1/5 A) + 14 BI + 13 BO CBABB	C	7I (lo 1/5 A) + 6 RTD + 2 mA + 8 BI + 10 BO CBGBA	D	7I (lo 1/5 A) + 8 BI + 10 BO DBABA	D	7I (lo 1/5 A) + 14 BI + 13 BO DBABB	D	7I (lo 1/5 A) + 6 RTD + 2 mA + 8 BI + 10 BO DGBA	E	7I (lo 1/5 A) + 5U + 12 BI + 10 BO EBCAD	F	7I (lo 1/5 A) + 5U + 12 BI + 10 BO FBCAD	G	7I (lo 1/5 A) + 5U + 12 BI + 10 BO GBCAD	H	7I (lo 1/5 A) + 5U + 12 BI + 10 BO HBCAD
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H	7I (lo 1/5 A) + 5U + 12 BI + 10 BO HBCAD																																		

HBT ABGBA BC C1BBN1XE

#	Description	
9	Communication modules (Serial/Ethernet)	
10	Serial RS-485, incl. an input for IRIG-B + Ethernet 100Base-FX (1 x LC)	AA
	Serial RS-485, incl. an input for IRIG-B + Ethernet 100Base-TX (1 x RJ-45)	AB
	Serial RS-485, incl. an input for IRIG-B	AN
	Serial glass fibre (ST), incl. an RS-485 connector and an input for IRIG-B (cannot be combined with arc protection)	BN
	Serial glass fibre (ST) + Ethernet 100Base-TX (1 x RJ-45) + Serial RS-485 connector, RS-232/485 D-Sub 9 connector + input for IRIG-B (cannot be combined with arc protection)	BB
	Serial glass fibre (ST) + Ethernet 100Base-TX (3 x RJ-45)	BD
	Serial glass fibre (ST) + Ethernet 100Base-TX and -FX (2 x RJ-45 + 1 x LC)	BC
	Serial glass fibre (ST) + Ethernet 100Base-TX and -FX (1 x RJ-45 + 2 x LC)	BE
	Ethernet 100Base-FX (1 x LC)	NA
	Ethernet 100Base-TX (1 x RJ-45)	NB
Ethernet 100Base-TX (2 x RJ-45 + 1 x LC)	NC	
Ethernet 100Base-TX (3 x RJ-45)	ND	
Ethernet 100Base-TX and -FX (1 x RJ-45 + 2 x LC)	NE	
No communication module	NN	

If serial communication is chosen, please choose a serial communication module including Ethernet (for example "BC") if a service bus for PCM600 or the WebHMI is required.

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#	Description	
11	Communication protocols	
	IEC 61850 (for Ethernet communication modules and IEDs without a communication module)	A
	Modbus (for Ethernet/serial or Ethernet + serial communication modules)	B
	IEC 61850 + Modbus (for Ethernet or serial + Ethernet communication modules)	C
	IEC 60870-5-103 (for serial or Ethernet + serial communication modules)	D
	DNP3 (for Ethernet/serial or Ethernet + serial communication modules)	E

#	Description	
12	Language	
	English	1
	English and German	3
	English and Swedish	4
	English and Spanish	5
	English and Russian	6
	English and Polish	7
	English and Portuguese (Brazilian)	8
	English and Italian	A
	English and French	C
	English and Czech	E
13	Front panel	
	Small LCD	A
	Large LCD with single line diagram (SLD)	B
14	Option 1	
	Arc protection (requires a communication module, cannot be combined with communication modules BN or BB)	B
	None	N
15	Option 2	
	None	N
16	Power supply	
	48...250 V DC, 100...240 V AC	1
	24...60 V DC	2
17	Version	
18	Version 4.0	XE

Example code: **HBTABGBABCC1BBN1XE**

Your ordering code:

Digit (#)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Code																		

Figure 18. Ordering key for complete IEDs

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22. Accessories and ordering data

Table 64. Cables

Item	Order number
Cable for optical sensors for arc protection 1.5 m	1MRS120534-1.5
Cable for optical sensors for arc protection 3.0 m	1MRS120534-3.0
Cable for optical sensors for arc protection 5.0 m	1MRS120534-5.0

Table 65. Mounting accessories

Item	Order number
Semi-flush mounting kit	1MRS050696
Wall mounting kit	1MRS050697
Inclined semi-flush mounting kit	1MRS050831
19" rack mounting kit with cut-out for one IED	1MRS050694
19" rack mounting kit with cut-out for two IEDs	1MRS050695
Mounting bracket for one IED with test switch RTXP in 4U Combiflex (RHGT 19" variant C)	2RCA022642P0001
Mounting bracket for one IED in 4U Combiflex (RHGT 19" variant C)	2RCA022643P0001
19" rack mounting kit for one IED and one RTXP18 test switch (the test switch is not included in the delivery)	2RCA021952A0003
19" rack mounting kit for one IED and one RTXP24 test switch (the test switch is not included in the delivery)	2RCA022561A0003
Replacement kit for a Strömberg SP_J40 series relay (cut-out in the center of the installation plate)	2RCA027871A0001
Replacement kit for a Strömberg SP_J40 series relay (cut-out on the left or the right of the installation plate)	2RCA027874A0001
Replacement kit for two Strömberg SP_J3 series relays	2RCA027880A0001
19" rack replacement kit for Strömberg SP_J3/J6 series relays (one cut-out)	2RCA027894A0001
19" rack replacement kit for Strömberg SP_J3/J6 series relays (two cut-outs)	2RCA027897A0001
Replacement kit for a Strömberg SP_J6 series relay	2RCA027881A0001
Replacement kit for three BBC S_ series relays	2RCA027882A0001
Replacement kit for a SPA 300 series relay	2RCA027885A0001

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23. Tools

The IED is delivered as a pre-configured unit. The default parameter setting values can be changed from the front-panel user interface, the web-browser based user interface (WebHMI) or the PCM600 tool in combination with the IED-specific connectivity package.

The Protection and Control IED Manager PCM600 is available in two different variants, that is PCM600 Basic/Engineering and PCM600 Engineering Pro. Depending on the chosen variant, PCM600 offers extensive IED configuration functions such as IED signal configuration, application configuration, graphical display configuration including single line diagram configuration, and IEC 61850 communication configuration including horizontal GOOSE communication.

When the web-browser based user interface is used, the IED can be accessed either locally or

remotely using a web browser (IE 7.0 IE 8.0 or IE 9.0). For security reasons, the web-browser based user interface is disabled by default. The interface can be enabled with the PCM600 tool or from the front panel user interface. The functionality of the interface can be limited to read-only access by means of PCM600.

The IED connectivity package is a collection of software and specific IED information, which enable system products and tools to connect and interact with the IED. The connectivity packages reduce the risk of errors in system integration, minimizing device configuration and set-up times. Further, the Connectivity Packages for the 615 series IEDs include a flexible update tool for adding one additional local HMI language to the IED. The update tool is activated using PCM600 and enables multiple updates of the additional HMI language, thus offering flexible means for possible future language updates.

Table 66. Tools

Configuration and setting tools	Version
PCM600	2.4 SP1 or later
Web-browser based user interface	IE 7.0, IE 8.0 or IE 9.0
RET615 Connectivity Package	4.0 or later

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Table 67. Supported functions

Function	WebHMI	PCM600 Basic/ Engineering	PCM600 Engineering Pro
IED parameter setting	•	•	•
Saving of IED parameter settings in the IED	•	•	•
Signal monitoring	•	•	•
Disturbance recorder handling	•	•	•
Alarm LED viewing	•	•	•
Access control management	•	•	•
IED signal configuration (signal matrix)	-	•	•
Modbus® communication configuration (communication management)	-	•	•
DNP3 communication configuration (communication management)	-	•	•
IEC 60870-5-103 communication configuration (communication management)	-	•	•
Saving of IED parameter settings in the tool	-	•	•
Disturbance record analysis	-	•	•
XRIO parameter export/import	-	•	•
Graphical display configuration	-	•	•
Application configuration	-	•	•
IEC 61850 communication configuration, GOOSE (communication configuration)	-	-	•
Phasor diagram viewing	•	-	-
Event viewing	•	•	•
Saving of event data on the user's PC	•	-	-

• = Supported

24. Terminal diagrams

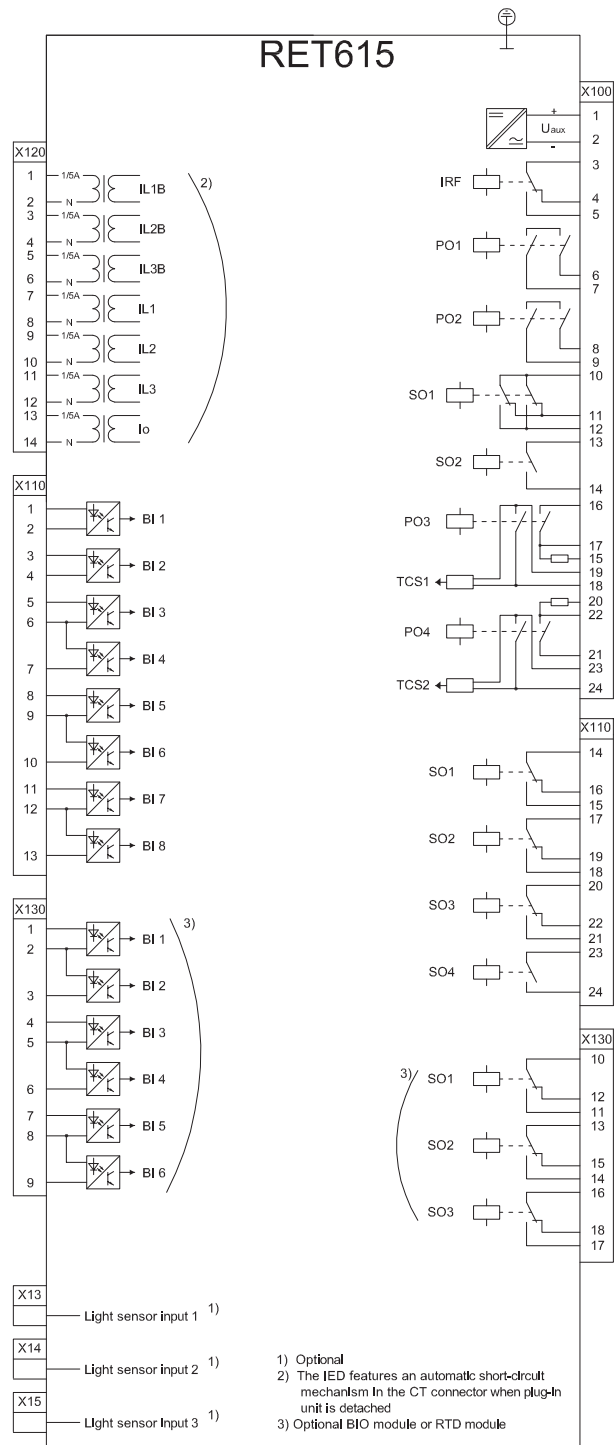


Figure 19. Terminal diagram of standard configurations A-D

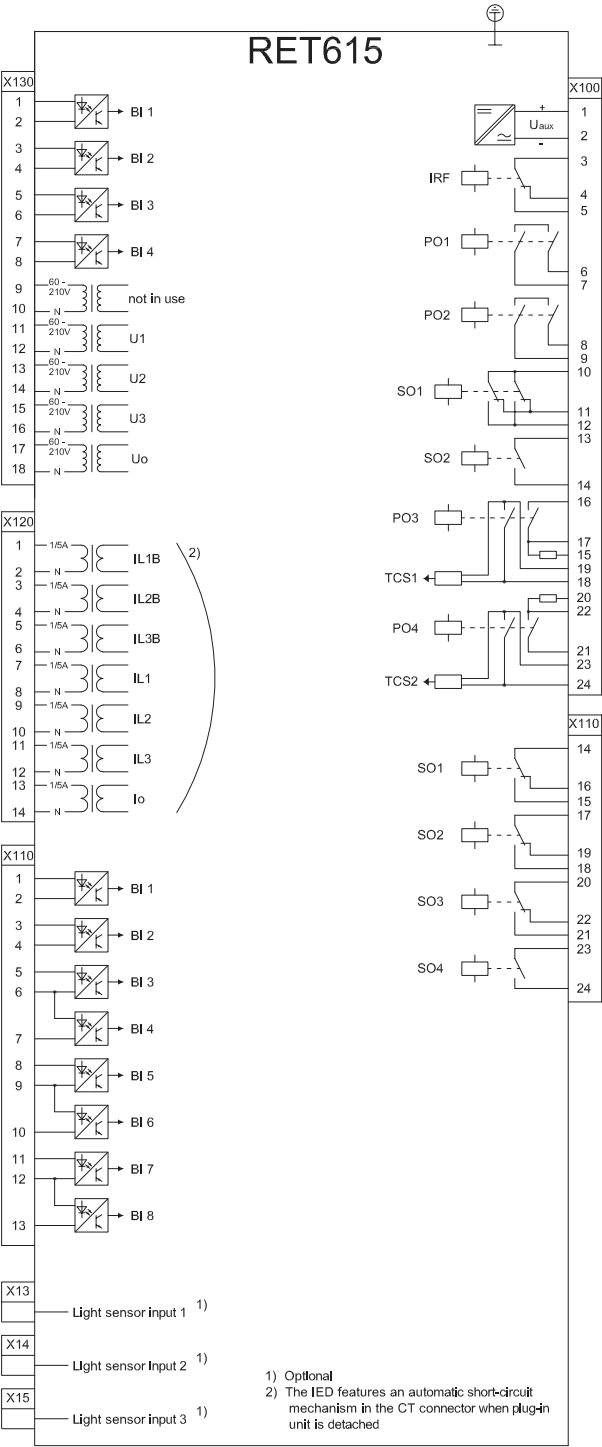


Figure 20. Terminal diagram of standard configurations E-H

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25. Certificates

KEMA has issued an IEC 61850 Certificate Level A1 for Relion® 615 series. Certificate number: 30920420-Consulting 09-1712.

Det Norske Veritas (DNV) has issued a Type Approval Certificate for RET615. Certificate number: E-11189.

The download area on the right hand side of the web page contains the latest product documentation, such as technical manual, installation manual, operation manual, etc.

The Features and Application tabs contain product related information in a compact format.

26. References

The www.abb.com/substationautomation portal offers you information about the distribution automation product and service range.

You will find the latest relevant information on the RET615 protection IED on the [product page](#).

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RET615

Overview Application Features Contacts

RET615 is a dedicated transformer protection and control IED for power transformers, unit and step-up transformers including power generator-transformer blocks in utility and industry power distribution systems. RET615 is a member of ABB's Relion® product family and part of its 615 product series. The 615 series IEDs are characterized by their compactness and withdrawable design. Re-engineered from the ground up, the 615 series has been designed to unleash the full potential of the IEC 61850 standard for communication and interoperability between substation automation devices.

RET615 is the ultimate protection and control IED for two-winding power transformers and power generator-transformer blocks. RET615 is available in four standard configurations to match the applied transformer neutral earthing principles with either high impedance or numerical low impedance restricted earth-fault protection schemes. CT ratio differences and phase shifts of all commonly employed power transformer vector groups are numerically compensated for. The standard RET615 configurations feature also local or remote control of the transformer HV side circuit breaker.

Related links
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Figure 21. Product page

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27. Functions, codes and symbols

Table 68. RET615 functions, codes and symbols

Function	IEC 61850	IEC 60617	IEC-ANSI
Protection			
Three-phase non-directional overcurrent protection, low stage	PHLPTOC1	3I> (1)	51P-1 (1)
	PHLPTOC2	3I> (2)	51P-1 (2)
Three-phase non-directional overcurrent protection, high stage	PHHPTOC1	3I>> (1)	51P-2 (1)
	PHHPTOC2	3I>> (2)	51P-2 (2)
Three-phase non-directional overcurrent protection, instantaneous stage	PHIPTOC1	3I>>> (1)	50P/51P (1)
	PHIPTOC2	3I>>> (2)	50P/51P (2)
Non-directional earth-fault protection, low stage	EFLPTOC1	Io> (1)	51N-1 (1)
	EFLPTOC2	Io> (2)	51N-1 (2)
Non-directional earth-fault protection, high stage	EFHPTOC1	Io>> (1)	51N-2 (1)
	EFHPTOC2	Io>> (2)	51N-2 (2)
Negative-sequence overcurrent protection	NSPTOC1	I2> (1)	46 (1)
	NSPTOC2	I2> (2)	46 (2)
Residual overvoltage protection	ROVPTOV1	Uo> (1)	59G (1)
	ROVPTOV2	Uo> (2)	59G (2)
Three-phase undervoltage protection	PHPTUV1	3U< (1)	27 (1)
	PHPTUV2	3U< (2)	27 (2)
Three-phase overvoltage protection	PHPTOV1	3U> (1)	59 (1)
	PHPTOV2	3U> (2)	59 (2)
Three-phase thermal overload protection for power transformers, two time constants	T2PTTR1	3Ith>T	49T
Stabilized and instantaneous differential protection for 2W transformers	TR2PTDF1	3dI>T	87T
Numerical stabilized low impedance restricted earth-fault protection	LREFPND1	dIoLo>	87NL
High impedance based restricted earth-fault protection	HREFPDIF1	dIoHi>	87NH
Circuit breaker failure protection	CCBRBRF1	3I>/Io>BF	51BF/51NBF
Master trip	TRPPTRC1	Master Trip (1)	94/86 (1)
	TRPPTRC2	Master Trip (2)	94/86 (2)
Arc protection	ARCSARC1	ARC (1)	50L/50NL (1)
	ARCSARC2	ARC (2)	50L/50NL (2)
	ARCSARC3	ARC (3)	50L/50NL (3)

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Table 68. RET615 functions, codes and symbols, continued

Function	IEC 61850	IEC 60617	IEC-ANSI
Multi-purpose protection	MAPGAPC1	MAP (1)	MAP (1)
	MAPGAPC2	MAP (2)	MAP (2)
	MAPGAPC3	MAP (3)	MAP (3)
	MAPGAPC4	MAP (4)	MAP (4)
	MAPGAPC5	MAP (5)	MAP (5)
	MAPGAPC6	MAP (6)	MAP (6)
Control			
Circuit-breaker control	CBXCBR1	I <-> O CB	I <-> O CB
Disconnecter control	DCXSWI1	I <-> O DCC (1)	I <-> O DCC (1)
	DCXSWI2	I <-> O DCC (2)	I <-> O DCC (2)
Earthing switch control	ESXSWI1	I <-> O ESC	I <-> O ESC
Disconnecter position indication	DCSXSWI1	I <-> O DC (1)	I <-> O DC (1)
	DCSXSWI2	I <-> O DC (2)	I <-> O DC (2)
	DCSXSWI3	I <-> O DC (3)	I <-> O DC (3)
Earthing switch indication	ESSXSWI1	I <-> O ES (1)	I <-> O ES (1)
	ESSXSWI2	I <-> O ES (2)	I <-> O ES (2)
Tap changer position indication	TPOSSLTC1	TPOSM	84M
Condition monitoring			
Circuit-breaker condition monitoring	SSCBR1	CBCM	CBCM
Trip circuit supervision	TCSSCBR1	TCS (1)	TCM (1)
	TCSSCBR2	TCS (2)	TCM (2)
Fuse failure supervision	SEQRUFUF1	FUSEF	60
Runtime counter for machines and devices	MDSOPT1	OPTS	OPTM
Measurement			
Disturbance recorder	RDRE1	-	-
Three-phase current measurement	CMMXU1	3I	3I
	CMMXU2	3I(B)	3I(B)
Sequence current measurement	CSMSQI1	I1, I2, I0	I1, I2, I0
Residual current measurement	RESCMMXU1	Io	In
	RESCMMXU2	Io(B)	In(B)
Three-phase voltage measurement	VMMXU1	3U	3U
Residual voltage measurement	RESVMMXU1	Uo	Vn

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Table 68. RET615 functions, codes and symbols, continued

Function	IEC 61850	IEC 60617	IEC-ANSI
Sequence voltage measurement	VSMSQI1	U1, U2, U0	U1, U2, U0
Three-phase power and energy measurement	PEMMXU1	P, E	P, E
RTD/mA measurement	XRGGIO130	X130 (RTD)	X130 (RTD)

28. Document revision history

Document revision/date	Product version	History
A/2009-07-03	2.0	First release
B/2009-10-01	2.0	Content updated
C/2010-06-11	3.0	Content updated to correspond to the product version
D/2010-06-29	3.0	Terminology updated
E/2010-09-07	3.0	Content updated
F/2012-05-11	4.0	Content updated to correspond to the product version

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