Relion® 615 series

Voltage Protection and Control REU615 Product Guide

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Contents

1. Description

The voltage protection and control IED, REU615 is available in two standard configurations, denoted A and B. Configuration A is preadapted for voltage and frequency-based protection schemes in utility and industrial power systems and distribution systems including networks with distributed power generation. The B configuration is designed for automatic voltage regulation of power transformers equipped with an on-load tap-changer. Both configurations also feature additional CB control, measuring and supervising functions. REU615 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

REU615 is available in two standard configurations. The standard signal configuration can be altered by means of the graphical signal matrix or the optional 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 using 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.
Voltage and frequency based protection and measurement functions, synchrocheck and load shedding	A
Automatic voltage regulator	B

Table 2. Supported functions

Functionality	A	B
Protection[1)2)]		
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	-	●
Residual overvoltage protection, instance 1	●[3)]	-
Residual overvoltage protection, instance 2	●[3)]	-
Residual overvoltage protection, instance 3	●[3)]	-
Three-phase undervoltage protection, instance 1	●	●
Three-phase undervoltage protection, instance 2	●	●
Three-phase undervoltage protection, instance 3	●	●
Three-phase overvoltage protection, instance 1	●	●
Three-phase overvoltage protection, instance 2	●	●
Three-phase overvoltage protection, instance 3	●	●
Positive-sequence undervoltage protection, instance 1	●	-
Positive-sequence undervoltage protection, instance 2	●	-
Negative-sequence overvoltage protection, instance 1	●	-
Negative-sequence overvoltage protection, instance 2	●	-
Frequency protection, instance 1	●	-
Frequency protection, instance 2	●	-
Frequency protection, instance 3	●	-
Frequency protection, instance 4	●	-
Frequency protection, instance 5	●	-
Frequency protection, instance 6	●	-
Three-phase thermal overload protection for power transformers, two time constants	-	●
Master trip, instance 1	●	●
Master trip, instance 2	●	●
Arc protection, instance 1	o[4)]	-
Arc protection, instance 2	o[4)]	-

Table 2. Supported functions, continued

Functionality	A	B
Arc protection, instance 3	o[4)]	-
Multi-purpose protection, instance 1[5)]	-	o
Multi-purpose protection, instance 2[5)]	-	o
Multi-purpose protection, instance 3[5)]	-	o
Load shedding and restoration, instance 1	●	-
Load shedding and restoration, instance 2	●	-
Load shedding and restoration, instance 3	●	-
Load shedding and restoration, instance 4	●	-
Load shedding and restoration, instance 5	●	-
Control		
Circuit-breaker control	●	●
Disconnector position indication, instance 1	●	●
Disconnector position indication, instance 2	●	●
Disconnector position indication, instance 3	●	●
Earthing switch indication	●	●
Tap changer position indication	-	●
Tap changer control with voltage regulator	-	●
Synchronism and energizing check	●	-
Condition Monitoring		
Trip circuit supervision, instance 1	●	●
Trip circuit supervision, instance 2	●	●
Current circuit supervision	-	●
Fuse failure supervision	-	●
Measurement		
Disturbance recorder	●	●
Three-phase current measurement, instance 1	-	●
Sequence current measurement	-	●
Three-phase voltage measurement	●	●
Residual voltage measurement	●	-
Sequence voltage measurement	●	●

Table 2. Supported functions, continued

Functionality	A	B
Three-phase power and energy measurement, including power factor	-	●
RTD/mA measurement	-	o
Frequency measurement	●	-

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

1) Note that all directional protection functions can also be used in non-directional mode.
2) 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.
3) Uo selectable by parameter, Uo measured as default.
4) Light only.
5) Multi-purpose protection is used for, for example, RTD/mA based protection.

3. Protection functions

Standard configuration A

Standard configuration A is intended for busbar voltage supervision, load shedding (disconnection) and restoration (reconnection) applications. It is also used for overfrequency and underfrequency protection of power generators and for other AC equipment, e.g. capacitor banks, requiring three-phase overvoltage protection, three-phase undervoltage protection, residual overvoltage protection, positive phase sequence undervoltage protection, negative phase sequence overvoltage protection and frequency supervision.

The integrated load shedding and restoration functionality offers five instances for disconnection and reconnection of less-important loads in network overload situations. The five instances enable the connected feeders to be more thoroughly prioritized and grouped thus facilitating the securing of critical applications.

If the restoration process is coordinated by an automation system or process control system, the IED's load shedding and restoration function can send a signal to the system when the prerequisites for network restoration are fulfilled.

Enhanced with optional hardware and software, standard configuration A also features three light detection channels for arc fault detection in the metering cubicle or busbar compartment of metal-enclosed switchgear. The arc-fault detection sensor interface is available on the optional communication module.

When an arc arises the detection signal is sent to the protection IED(s) of the incoming feeder(s) as a binary signal using either hardwired signalling or horizontal GOOSE messaging. By simultaneous utilization of the overcurrent condition of the incoming feeder protection IED and the received arc detection signal, the circuit breakers of the incoming feeders can selectively be tripped thus isolating the fault.

The arc detection/protection schemes of the IEDs increase personnel safety and limit material damage within the switchgear in an arc fault situation.

Standard configuration B

Standard configuration B is intended for automatic voltage regulation of power transformers equipped with an on-load tap-changer. It also features three-stage three-phase non-directional overcurrent protection, three-phase undervoltage and overvoltage protection. The IED also incorporates a thermal overload protection function, which supervises the thermal stress of the transformer windings to prevent premature aging of the winding's insulation.

The use of the multi-purpose protection function requires that the optional RTD/mA input module has been chosen when ordering. The multi-purpose protection function enables protection based on analog values from the IEDs RTD/mA input module, or from other IEDs using analog horizontal GOOSE messaging. The protection function includes three instances, and the used analog values may, for example, consist of temperature, current, voltage or pressure values. By using the analog values, the set limit values and the timers of the protection function can be set to operate when the input values are below or exceeds the set values.

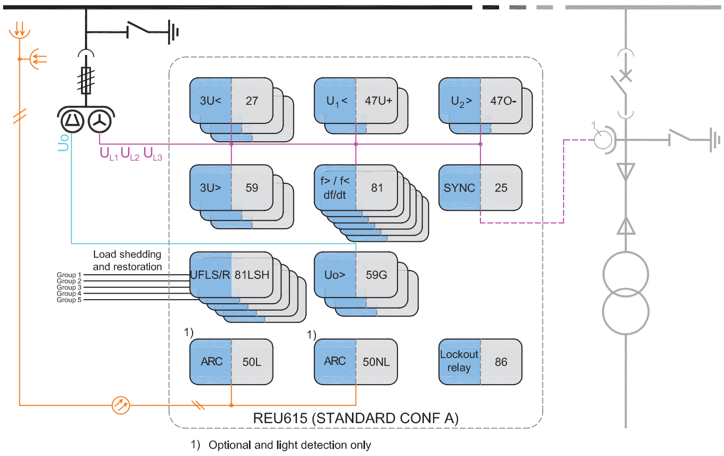

Figure 1. Protection function overview of standard configuration A

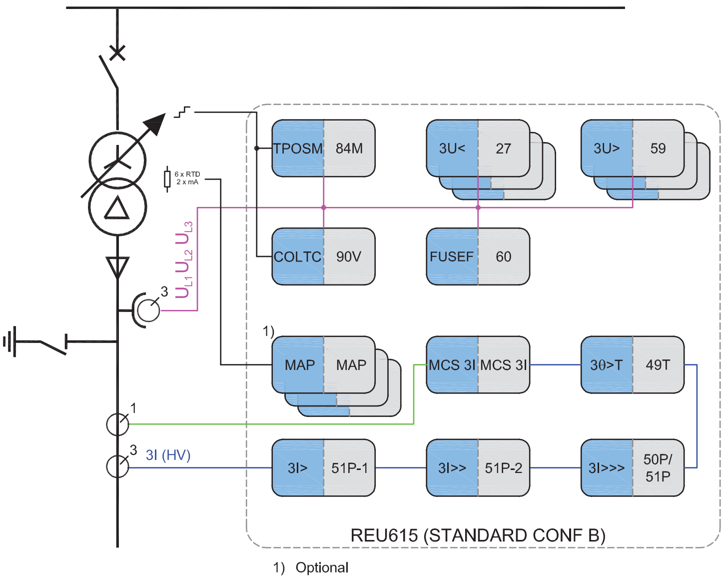

Figure 2. Protection function overview of standard configuration B

4. Application

Standard configuration A

The A configuration of REU615 is intended to be used in medium voltage switchgear, supplied with a dedicated voltage measurement cubicle. The A configuration of REU615 provides busbar overvoltage and undervoltage supervision, network residual overvoltage supervision and frequency supervision. REU615 offers the functionality needed to provide load shedding or generation rejection to enhance network stability. In generator and motor applications REU615 provides supplementary protection by detecting any deviation from the permitted frequency and voltage values. An integrated synchro-check function ensures a synchronized connection of the equipment into the network. In distribution networks containing distributed power generation REU615 can be used for loss-of-mains (LOM) protection for single power generating units.

Standard configuration B

The B configuration of REU615 including voltage regulation is intended for automatic and manual voltage regulation of power transformers equipped with motor driven on-load tap-changers. In small substations with a single power transformer, REU615 can be used for load-side voltage regulation. For substations with two or more power transformers operating in parallel three alternative voltage regulation principles are available, i.e. the master/follower principle, the negative reactance principle (NRP) and the minimizing circulating current (MCC) principle.

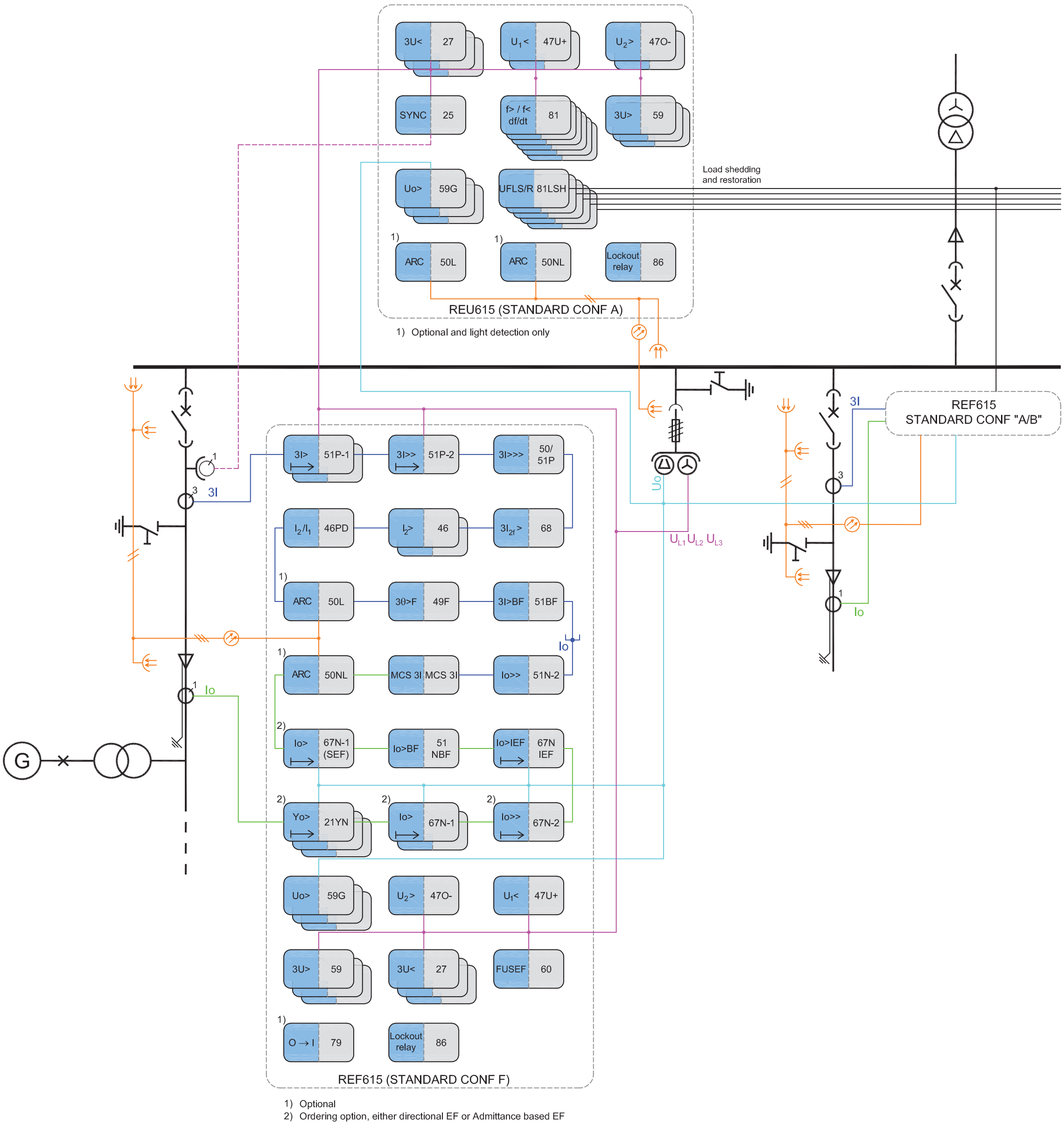

Figure 3. Busbar protection and supervision using REU615 with the standard configuration A. The arc protection schemes of REU615 and REF615 are employed for busbar protection for the voltage measurement bay and related parts of the busbar. Apart from the busbar protection and supervision the REU615 IED is utilized for centralized load shedding (disconnection) and restoration (reconnection) of one of the outgoing feeders. The synchro-check and energizing check functions incorporated in REU615 are employed for ensuring a safe connection of the outgoing feeder, including distributed generation, to the network.

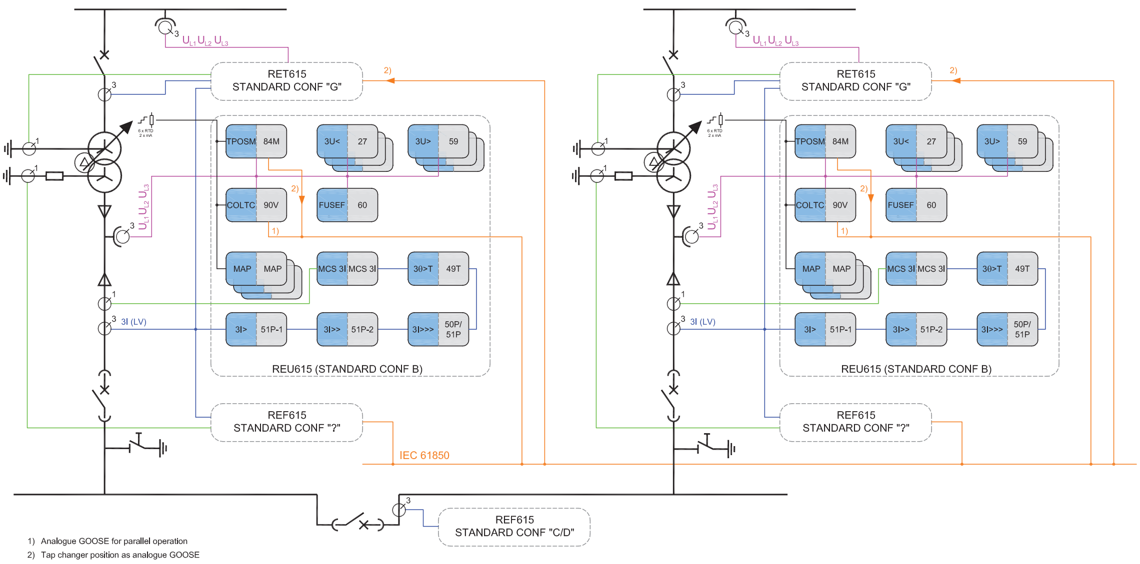

Figure 4. Tap changer control and power transformer thermal overload protection using REU615 with the standard configuration B. The tap changer position information is received as a mA-signal from the tap changer operation mechanism. The position value is sent to the transformer differential protection function of the RET615 IED using GOOSE messaging. Further, the analog GOOSE messaging enables the tap changer control of two parallel running power transformers. The RTD inputs complement the thermal overload protection by measuring the oil and ambient temperature of the power transformer.

5. Supported ABB solutions

ABB's 615 series protection and control IEDs together with the COM600 Station Automation device 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 COM600 Station Automation device 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
Station Automation COM600	3.4 or later
MicroSCADA Pro	9.2 SP2 or later
System 800xA	5.0 Service Pack 2

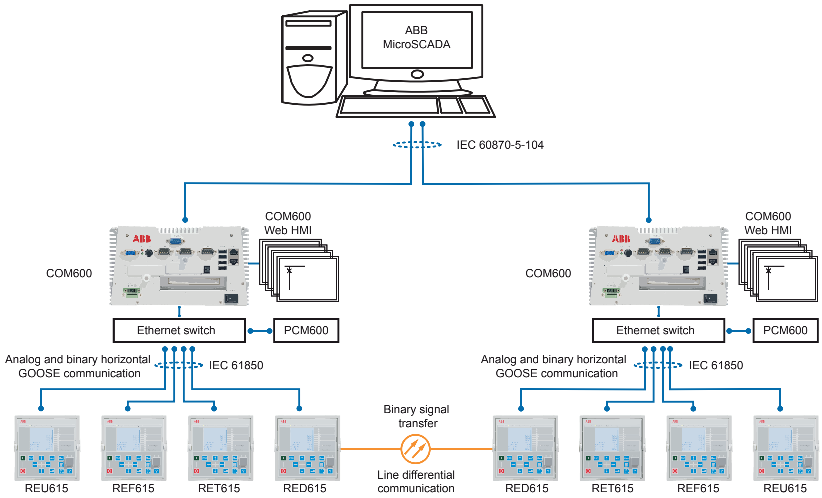

Figure 5. Utility power distribution network example using 615 series IEDs, Station Automation COM600 and MicroSCADA Pro

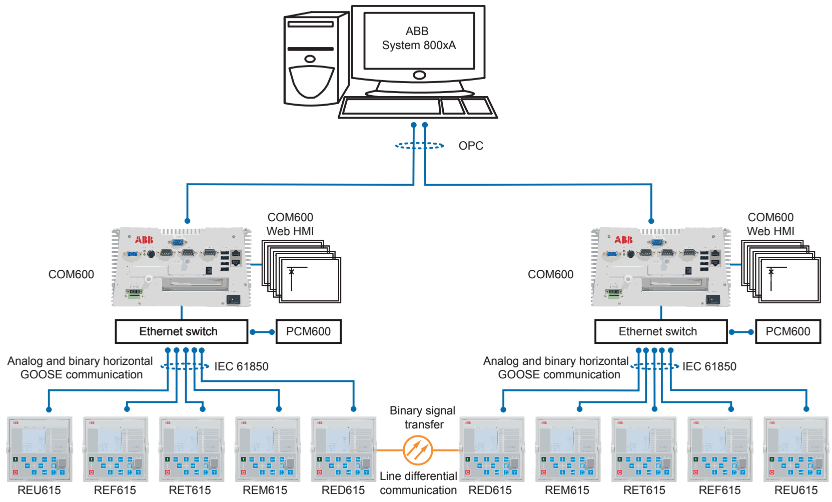

Figure 6. Industrial power system example using 615 series IEDs, Station Automation COM600 and System 800xA

6. Control

The IED offers control of one circuit breaker with dedicated push-buttons for circuit breaker opening and closing. Further, the optional large graphical LCD of the IED's HMI includes a single-line diagram (SLD) with position indication for the relevant circuit breaker. Interlocking schemes required by the application are configured using the signal matrix or the application configuration feature of PCM600.

Standard configuration A incorporates a synchro-check function to ensure that the voltage, phase angle and frequency on either side of an open circuit breaker satisfy the conditions for safe interconnection of two networks. Standard configuration B includes functionality for controlling the voltage on the load side of the power transformer. Based on the measured values the IED sends control commands to the tap changer thus enabling automatic voltage regulation.

7. Measurement

The offered measurement functions depend on the chosen standard configuration. Standard configuration A offers phase voltage, residual voltage and voltage phase sequence component measurement. In addition, the standard configuration includes frequency measurement.

IEDs with standard configuration B measure the three phase-currents and the symmetrical components of the currents, the phase voltages, the symmetrical components of the voltage and the phase unbalance value based on the ratio between the negative phase-sequence and positive phase-sequence current. Furher, the IED offers three-phase power and energy measurement including power factor. In addition, the IED calculates the demand value of current over a userselectable pre-set time frame and the thermal overload of the protected object.

For standard configuration B, 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.

9. Event log

To collect sequence-of-events (SoE) information, the IED incorporates a non-volatile memory with a capacity of storing 512 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 32 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 CB history data, which can be used for scheduling preventive CB 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 will be used for alerting the operator.

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

14. Fuse failure supervision

The fuse failure supervision detects failures between the voltage measurement circuit and the IED. The failures are detected by the negative-sequence based algorithm or by the delta voltage and delta current algorithm. Upon the detection of a failure the fuse failure supervision function activates an alarm and blocks voltage-dependent protection functions from unintended operation.

15. Current circuit supervision

Current circuit supervision is used for detecting faults in the current transformer secondary circuits. On detecting of a fault the current circuit supervision function activates an alarm LED and blocks certain protection functions to avoid unintended operation. The current circuit supervision function calculates the sum of the phase currents from the protection cores and compares the sum with the measured single reference current from a core balance current transformer or from separate cores in the phase current transformers.

16. 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.

17. Inputs and outputs

Depending on the standard configuration selected, the IED is equipped with three phase-voltage inputs and one residual current input or three phase current inputs, one residual-current input and three phase voltage inputs.

The residual current input and the phase-current inputs are rated 1/5 A. 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.

The phase-current input 1 A or 5 A, the residual-current input 1 A or 5 A, and the rated voltage of the residual voltage input are selected in the IED software. 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 B 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, 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	-	5	-	–	12	10
B1)	4	3	62)	22)	8 (14)3)	10 (13)3)

1) The optional I/O module and the optional RTD/mA modules are mutually exclusive
2) Optional
3) With optional binary I/O module ( )

18. 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. In REU615 analog GOOSE messaging is employed in control schemes of parallel running transformers where measured values are exchanged between the IEDs.

The IED offers an optional second Ethernet bus for station bus communication redundancy. The IED communication module options include both galvanic and fibre-optic Ethernet combinations. The communication module including one fibre-optic LC port and two galvanic RJ-45 ports is used when the loop between the IEDs is built using CAT5 STP cables. The LC port can in this case be used for connecting the IED to communication ports outside the switchgear. The communication module including three RJ-45 ports is used when the whole substation bus is based on CAT5 STP cabling.

The redundant Ethernet solution enables a cost efficient communication loop controlled by a 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 redundant network solution avoids single point of failure concerns and improves the reliability of the communication. The redundancy 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

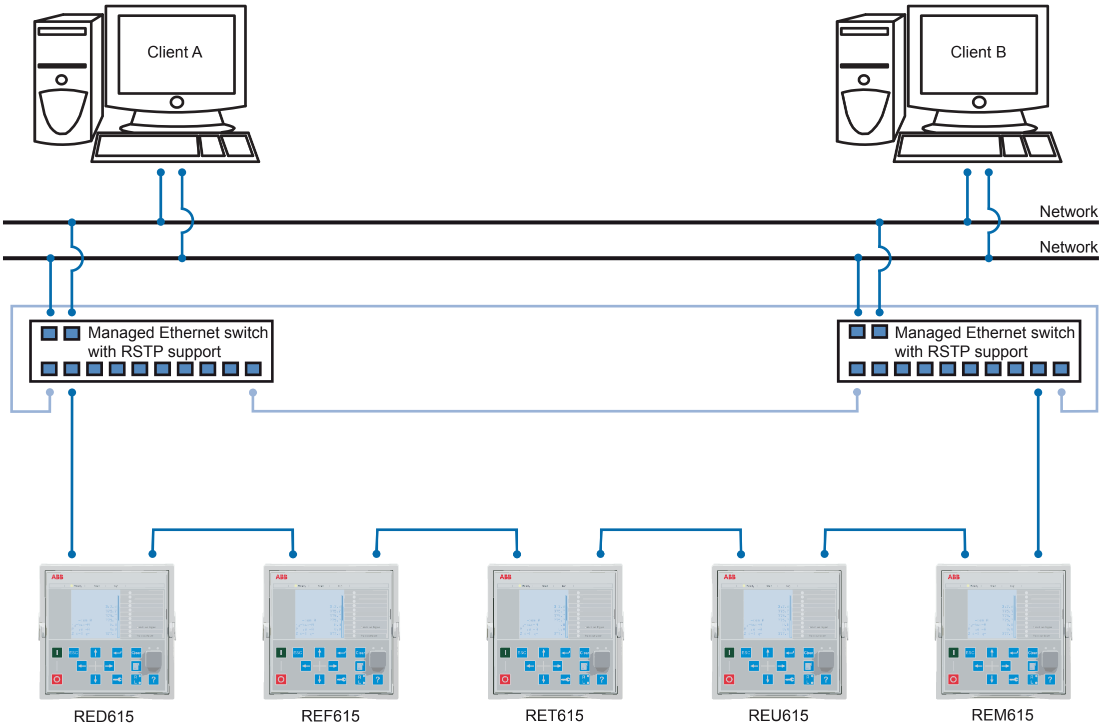

Figure 7. Redundant Ethernet solution

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

19. 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	
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)/< 21.0W (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)	
Maximum interruption time in the auxiliary DC voltage without resetting the IED	30 ms at $V_n$rated	
Fuse type	T4A/250 V	

Table 8. 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

Table 9. 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 kΩ	
	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
		± 2.0% or ±1 Ω	±1°C 10 Ω copper: ±2°C
mA inputs	Supported current range	0…20 mA	
	Current input impedance	44 Ω ± 0.1%	
	Operation accuracy	Resistance	
		±0.5% or ±0.01 mA	

Table 10. 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	100 mA at 24 V AC/DC

Table 11. 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 12. Single-pole power output relays

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, at 48/110/220 V DC	1 A/0.25 A/0.15 A
Minimum contact load	100 mA at 24 V AC/DC

Table 13. 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

Table 14. Station communication link, fibre-optic

Connector	Fibre type[1)]	Wave length	Max. distance	Permitted path attenuation[2)]
LC	MM 62.5/125 μm glass fibre core	1300 nm	2 km	<8 dB
LC	SM 9/125 μm	1300 nm	2-20 km	<8 dB
ST	MM 62.5/125 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 15. 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 16. 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 17. Degree of protection of flush-mounted IED

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

Table 18. Environmental conditions

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

Table 19. Environmental tests

Description	Type test value	Reference
Dry heat test (humidity <50%)	• 96 h at +55ºC • 16 h at +85ºC[1)]	IEC 60068-2-2
Dry cold test	• 96 h at -25ºC • 16 h at -40ºC	IEC 60068-2-1
Damp heat test, cyclic	• 6 cycles (12 h + 12 h) at +25°C…+55°C, humidity >93%	IEC 60068-2-30
Storage test	• 96 h at -40ºC • 96 h at +85ºC	IEC 60068-2-48

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

Table 20. Electromagnetic compatibility tests

Description	Type test value	Reference
1 MHz/100 kHz burst disturbance test: • Common mode • Differential mode	 2.5 kV 2.5 kV	IEC 61000-4-18 IEC 60255-22-1, class III IEEE C37.90.1-2002
Electrostatic discharge test: • Contact discharge • Air discharge	 8 kV 15 kV	IEC 61000-4-2 IEC 60255-22-2 IEEE C37.90.3-2001
Radio frequency interference tests:	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 60255-22-6, class III IEC 61000-4-6 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 tests: • All ports	 4kV	IEC 61000-4-4 IEC 60255-22-4 IEEE C37.90.1-2002
Surge immunity test: • Communication • Other ports	 1 kV, line-to-earth 4 kV, line-to-earth 2 kV, line-to-line	IEC 61000-4-5 IEC 60255-22-5
Power frequency (50 Hz) magnetic field: • Continuous • 1-3 s	 300 A/m 1000 A/m	IEC 61000-4-8

Table 20. 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
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 21. Insulation tests

Description	Type test value	Reference
Dielectric tests • Test voltage	2 kV, 50 Hz, 1 min 500 V, 50 Hz, 1 min, communication	IEC 60255-5 and IEC 60255-27
Impulse voltage test • Test voltage	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 • Isolation resistance	>100 MΩ, 500 V DC	IEC 60255-5 and IEC 60255-27
Protective bonding resistance • Resistance	<0.1 Ω, 4 A, 60 s	IEC 60255-27

Table 22. 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

Table 23. Product safety

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

Table 24. EMC compliance

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

Table 25. RoHS compliance

Description
Complies with RoHS directive 2002/95/EC

Protection functions

Table 26. Three-phase non-directional overcurrent protection (PHxPTOC)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the current measured: f_n ±2 Hz		
	PHLPTOC	±1.5% of the set value or ±0.002 x I_n		
	PHHPTOC and PHIPTOC	±1.5% of set value or ±0.002 x I_n (at currents in the range of 0.1…10 x I_n) ±5.0% of the set value (at currents in the range of 10…40 x I_n)		
Start time 1)2)		Minimum	Typical	Maximum
	PHIPTOC: I_{Fault} = 2 x set *Start value* I_{Fault} = 10 x set *Start value*	16 ms 11 ms	19 ms 12 ms	23 ms 14 ms
	PHHPTOC and PHLPTOC: I_{Fault} = 2 x 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		±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		RMS: No suppression DFT: -50 dB at f = n x f_n, where n = 2, 3, 4, 5, … 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 x In, fn = 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

Table 27. Three-phase non-directional overcurrent protection (PHxPTOC) main settings

Parameter	Function	Value (Range)	Step
Start Value	PHLPTOC	0.05...5.00 x I_n	0.01
	PHHPTOC	0.10...40.00 x I_n	0.01
	PHIPTOC	1.00...40.00 x I_n	0.01
Time multiplier	PHLPTOC	0.05...15.00	0.05
	PHHPTOC	0.05...15.00	0.05
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

Table 28. Three-phase overvoltage protection (PHPTOV)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the voltage measured: f_n ±2 Hz		
		±1.5% of the set value or ±0.002 x U_n		
Start time[1)2)]		Minimum	Typical	Maximum
	U_{Fault} = 1.1 x set *Start value*	22 ms	24 ms	26 ms
Reset time		< 40 ms		
Reset ratio		Depends of the set *Relative hysteresis*		
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 f_n, where n = 2, 3, 4, 5, …		

1) *Start value* = 1.0 x U_n, Voltage before fault = 0.9 x 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 x U_n, *Start value* multiples in range of 1.10 to 2.00

Table 29. Three-phase overvoltage protection (PHPTOV) main settings

Parameter	Function	Value (Range)	Step
Start value	PHPTOV	0.05...1.60 x U_n	0.01
Time multiplier	PHPTOV	0.05...15.00	0.05
Operate delay time	PHPTOV	40...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

Table 30. 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 U_n		
Start time[1)2)]		Minimum	Typical	Maximum
	U_{Fault} = 0.9 x set *Start value*	62 ms	64 ms	66 ms
Reset time		< 40 ms		
Reset ratio		Depends on the set *Relative hysteresis*		
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 f_n, where n = 2, 3, 4, 5, …		

1) *Start value* = 1.0 x U_n, Voltage before fault = 1.1 x 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 31. Three-phase undervoltage protection (PHPTUV) main settings

Parameter	Function	Value (Range)	Step
Start value	PHPTUV	0.05...1.20 x U_n	0.01
Time multiplier	PHPTUV	0.05...15.00	0.05
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 32. Positive sequence undervoltage protection (PSPTUV)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the voltage measured: f_n ±2 Hz		
		±1.5% of the set value or ±0.002 x U_n		
Start time[1)2)]		Minimum	Typical	Maximum
	U_{Fault} = 0.99 x set *Start value* U_{Fault} = 0.9 x set *Start value*	51 ms 43 ms	53 ms 45 ms	54 ms 46 ms
Reset time		< 40 ms		
Reset ratio		Depends of the set *Relative hysteresis*		
Retardation time		< 35 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Suppression of harmonics		DFT: -50 dB at f = n x f_n, where n = 2, 3, 4, 5, …		

1) *Start value* = 1.0 x U_n, Positive sequence voltage before fault = 1.1 x U_n, f_n = 50 Hz, positive sequence undervoltage 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. Positive sequence undervoltage protection (PSPTUV) main settings

Parameter	Function	Value (Range)	Step
Start value	PSPTUV	0.010...1.200 x U_n	0.001
Operate delay time	PSPTUV	40...120000 ms	10
Voltage block value	PSPTUV	0.01...1.0 x U_n	0.01

Table 34. Negative sequence overvoltage protection (NSPTOV)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the voltage measured: f_n ±2 Hz		
		±1.5% of the set value or ±0.002 × U_n		
Start time1)2)		Minimum	Typical	Maximum
	U_{Fault} = 1.1 × set *Start value* U_{Fault} = 2.0 × set *Start value*	33 ms 24 ms	35 ms 26 ms	37 ms 28 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Retardation time		< 35 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Suppression of harmonics		DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5, …		

1) Negative-sequence voltage before fault = 0.0 × U_n, f_n = 50 Hz, negative-sequence overvoltage 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 35. Negative sequence overvoltage protection (NSPTOV) main settings

Parameter	Function	Value (Range)	Step
Start value	NSPTOV	0.010...1.000 x U_n	0.001
Operate delay time	NSPTOV	40...120000 ms	1

Table 36. Frequency protection (FRPFRQ)

Characteristic		Value
Operation accuracy	f>/f<	±10 mHz
	df/dt	±100 mHz/s (in range |df/dt| < 5 Hz/s) ± 2.0% of the set value (in range 5 Hz/s < |df/dt| < 15 Hz/s)
Start time	f>/f<	< 80 ms
	df/dt	< 120 ms
Reset time		< 150 ms
Operate time accuracy		±1.0% of the set value or ±30 ms

Table 37. Frequency protection (FRPFRQ) main settings

Parameter	Values (Range)	Unit	Step	Default	Description
Operation mode	1=Freq< 2=Freq> 3=df/dt 4=Freq< + df/dt 5=Freq> + df/dt 6=Freq< OR df/dt 7=Freq> OR df/dt			1=Freq<	Frequency protection operation mode selection
Start value Freq>	0.900...1.200	xFn	0.001	1.050	Frequency start value overfrequency
Start value Freq<	0.800...1.100	xFn	0.001	0.950	Frequency start value underfrequency
Start value df/dt	-0.200...0.200	xFn /s	0.005	0.010	Frequency start value rate of change
Operate Tm Freq	80...200000	ms	10	200	Operate delay time for frequency
Operate Tm df/dt	120...200000	ms	10	400	Operate delay time for frequency rate of change

Table 38. 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: ±1.5% of the set value or ±0.002 x I_n (at currents in the range of 0.01...4.00 x I_n)
Operate time accuracy[1)]	±2.0% of the theoretical value or ±0.50 s

1) Overload current > 1.2 x Operate level temperature

Table 39. 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 40. Residual overvoltage protection (ROVPTOV)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the voltage measured: f_n ±2 Hz		
		±1.5% of the set value or ±0.002 x U_n		
Start time[1)2)]		Minimum	Typical	Maximum
	U_{Fault} = 1.1 x set *Start value*	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		±1.0% of the set value or ±20 ms		
Suppression of harmonics		DFT: -50 dB at f = n x f_n, where n = 2, 3, 4, 5, …		

1) Residual voltage before fault = 0.0 x 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 41. Residual overvoltage protection (ROVPTOV) main settings

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

Table 42. 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 only"	9 ms	10 ms	12 ms
	Reset time		< 40 ms	
Reset ratio		Typical 0.96		

Table 43. 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	2=Light only 3=BI controlled	

Table 44. Multipurpose protection (MAPGAPC)

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

Table 45. 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 46. Load shedding (LSHDPFRQ)

Characteristic		Value
Operation accuracy	f<	±10 mHz
	df/dt	±100 mHz/s (in range |df/dt| < 5 Hz/s) ± 2.0% of the set value (in range 5 Hz/s < |df/dt| < 15 Hz/s)
Start time	f<	< 80 ms
	df/dt	< 120 ms
Reset time		< 150 ms
Operate time accuracy		±1.0% of the set value or ±30 ms

Table 47. Load shedding and restoration (LSHDPFRQ) main settings

Parameter	Function	Value (Range)	Step
Load shed mode	LSHDPFRQ	Freq< Freq< AND df/dt Freq< OR df/dt	-
Restore mode	LSHDPFRQ	Disabled Auto Manual	-
Start value Freq	LSHDPFRQ	0.800...1.200 x Fn	0.001
Start value df/dt	LSHDPFRQ	-0.200...-0.005 x Fn	0.005
Operate Tm Freq	LSHDPFRQ	80...200000 ms	10
Operate Tm df/dt	LSHDPFRQ	120...200000 ms	10
Restore start Val	LSHDPFRQ	0.800...1.200 x Fn	0.001
Restore delay time	LSHDPFRQ	80...200000 ms	10

Table 48. 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

Control functions

Table 49. Synchrocheck (SECRSYN)

Characteristic	Value
Operation accuracy	Depending on the frequency of the voltage measured: f_n ±1 Hz
	Voltage: ±3.0% of the set value or ±0.01 x U_n Frequency: ±10 mHz Phase angle: ±3°
Reset time	< 50 ms
Reset ratio	Typical 0.96
Operate time accuracy in definite time mode	±1.0% of the set value or ±20 ms

Table 50. Synchronism and energizing check (SECRSYN) main settings

Parameter	Values (Range)	Unit	Step	Default	Description
Live dead mode	-1=Off 1=Both Dead 2=Live L, Dead B 3=Dead L, Live B 4=Dead Bus, L Any 5=Dead L, Bus Any 6=One Live, Dead 7=Not Both Live			1=Both Dead	Energizing check mode
Difference voltage	0.01...0.50	xUn	0.01	0.05	Maximum voltage difference limit
Difference frequency	0.001...0.100	xFn	0.001	0.001	Maximum frequency difference limit
Difference angle	5...90	deg	1	5	Maximum angle difference limit
Synchrocheck mode	1=Off 2=Synchronous 3=Asynchronous			2=Synchronous	Synchrocheck operation mode
Control mode	1=Continuous 2=Command			1=Continuous	Selection of the synchrocheck command or continuous control mode
Dead line value	0.1...0.8	xUn	0.1	0.2	Voltage low-limit line for energizing check
Live line value	0.2...1.0	xUn	0.1	0.5	Voltage high-limit line for energizing check

Table 50. Synchronism and energizing check (SECRSYN) main settings, continued

Parameter	Values (Range)	Unit	Step	Default	Description
Close pulse	200...60000	ms	10	200	Breaker-closing pulse duration
Max energizing V	0.50...1.15	xUn	0.01	1.05	Maximum voltage for energizing
Phase shift	-180...180	deg	1	180	Correction of phase difference between measured U_BUS and U_LINE
Minimum Syn time	0...60000	ms	10	0	Minimum time to accept synchronizing
Maximum Syn time	100...6000000	ms	10	2000	Maximum time to accept synchronizing
Energizing time	100...60000	ms	10	100	Time delay for energizing check
Closing time of CB	40...250	ms	10	60	Closing time of the breaker

Table 51. Tap changer control with voltage regulator (OLATCC)

Characteristic	Value
Operation accuracy[1)]	Depending on the frequency of the current measured: f_n ±2 Hz
	Differential voltage U_d = ± 0.5% of the measured value or ± 0.005 x U_n (in measured voltages < 2.0 x U_n) Operation value = ± 1.5% of the U_d for Us = 1.0 x U_n
Operate time accuracy in definite time mode[2)]	+ 4.0% / - 0% of the set value
Operate time accuracy in inverse time mode[2)]	+ 8.5% / - 0% of the set value (at theoretical B in range of 1.1…5.0) Also note fixed minimum operate time (IDMT) 1 s.
Reset ratio for control operation Reset ratio for analogue based blockings (except run back raise voltage blocking)	Typical 0.80 (1.20) Typical 0.96 (1.04)

1) Default setting values used
2) Voltage before deviation = set Band center voltage.

Table 52. On-load tap changer control with voltage regulator (OLATCC) main settings

Parameter	Function	Value (Range)	Step
Band center voltage	OLATCC	0.000...2.000 x Un	0.001
Control delay time 1	OLATCC	1000...300000 ms	100
Control delay time 2	OLATCC	1000...300000 ms	100
Line drop V Ris	OLATCC	0.0...25.0 %	0.1
Line drop V React	OLATCC	0.0...25.0 %	0.1
Load phase angle	OLATCC	-89...89 deg	1
Stability factor	OLATCC	0.0...70.0 %	0.1
Auto parallel mode	OLATCC	Auto master Auto follower NRP MCC	-
Operation mode	OLATCC	Manual Auto single Auto parallel Input control	-
Delay characteristics	OLATCC	Inverse time Definite time	-
LCT pulse time	OLATCC	500...10000 ms	100
Band width voltage	OLATCC	1.20...18.00 % Un	0.01
Custom Man blocking	OLATCC	1=Custom disabled 2=OC 3=UV 4=OC, UV 5=EXT 6=OC, EXT 7=UV, EXT 8=OC, UV, EXT	-
Load current limit	OLATCC	0.10...5.00 x In	0.01
Block lower voltage	OLATCC	0.10...1.20 x Un	0.01
Runback raise volt	OLATCC	0.80...2.40 x In	0.01
Cir current limit	OLATCC	0.10...5.00 x In	0.01
Lower block tap	OLATCC	-36...36	-
Raise block tap	OLATCC	-36...36	-

Table 52. On-load tap changer control with voltage regulator (OLATCC) main settings, continued

Parameter	Function	Value (Range)	Step
LDC limit	OLATCC	0.00...2.00 x Un	0.01
LDC enable	OLATCC	False True	-
Follower delay time	OLATTC	6...20 s	-

Measurement functions

Table 53. Three-phase current measurement (CMMXU)

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

Table 54. Current sequence components (CSMSQI)

Characteristic	Value
Operation accuracy	Depending on the frequency of the current measured: f/f_n = ±2 Hz
	±1.0% or ±0.002 x I_n at currents in the range of 0.01...4.00 x I_n
Suppression of harmonics	DFT: -50 dB at f = n x f_n, where n = 2, 3, 4, 5, …

Table 55. 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…1.15 x U_n
	±0.5% or ±0.002 x U_n
Suppression of harmonics	DFT: -50 dB at f = n x f_n, where n = 2, 3, 4, 5, … RMS: No suppression

Table 56. 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…1.15 x U_n
	±1.0% or ±0.002 x U_n
Suppression of harmonics	DFT: -50 dB at f = n x f_n, where n = 2, 3, 4, 5, …

Table 57. Three-phase power and energy (PEMMXU)

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

Table 58. 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 kΩ	
	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
		± 2.0% or ±1 Ω	±1°C 10 Ω copper: ±2°C
mA inputs	Supported current range	0…20 mA	
	Current input impedance	44 Ω ± 0.1%	
	Operation accuracy	Resistance	
		±0.5% or ±0.01 mA	

Table 59. Frequency measurement (FMMXU)

Characteristic	Value
Operation accuracy	±10 mHz (in measurement range 35 - 75 Hz)

Supervision functions

Table 60. Current circuit supervision (CCRDIF)

Characteristic	Value
Operate time[1)]	< 30 ms

1) Including the delay of the output contact.

Table 61. Current circuit supervision (CCRDIF) main settings

Parameter	Values (Range)	Unit	Description
Start value	0.05...0.20	x I_n	Minimum operate current differential level
Maximum operate current	1.00...5.00	x I_n	Block of the function at high phase current

Table 62. Fuse failure supervision (SEQRFUF)

Characteristic	Value	
Operate time[1)]		
• NPS function	U_{Fault} = 1.1 x set *Neg Seq voltage Lev*	< 33 ms
	U_{Fault} = 5.0 x set *Neg Seq voltage Lev*	< 18 ms
• Delta function	ΔU = 1.1 x set *Voltage change rate*	< 30 ms
	ΔU = 2.0 x set *Voltage change rate*	< 24 ms

1) Includes the delay of the signal output contact, f_n = 50 Hz, fault voltage with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements

20. 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.

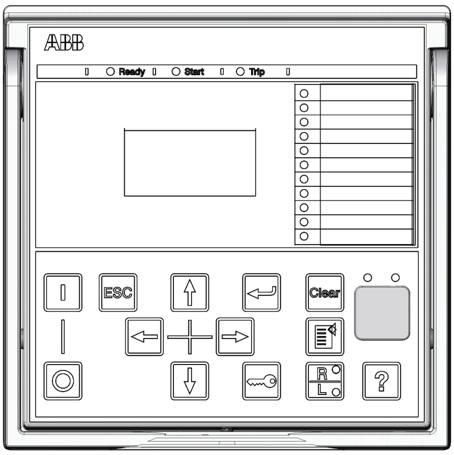

Figure 8. Small display

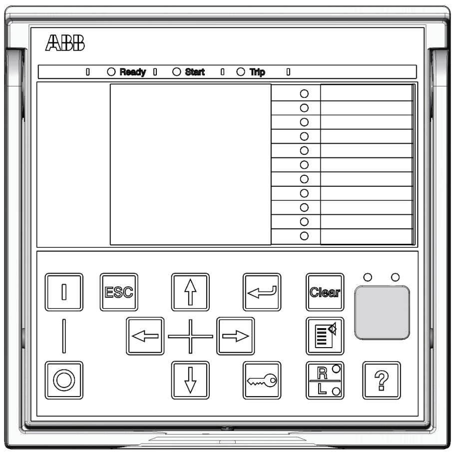

Figure 9. Large display

Table 63. 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 64. 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

21. 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

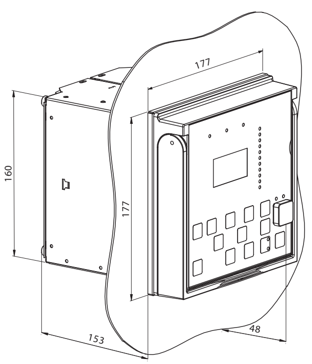

Figure 10. Flush mounting

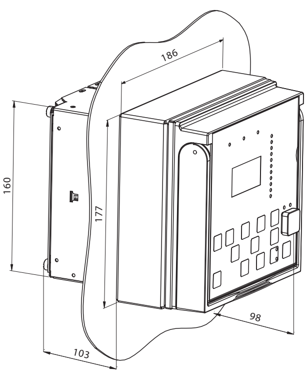

Figure 11. Semi-flush mounting

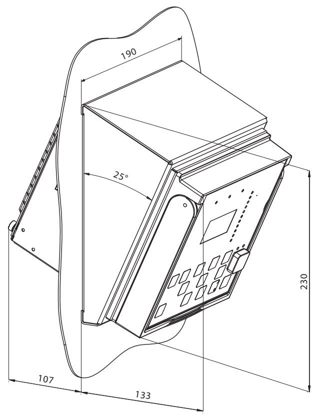

Figure 12. Semi-flush with a 25° tilt

22. 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.

23. Selection and ordering data

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

H B U B C C A H B C C 1 B B N 1 X D

#	DESCRIPTION	
1	**IED**	
	615 series IED (including case)	H
	615 series IED (including case) with test switch, wired and installed in a 19” equipment panel	K
	615 series IED (including case) with test switch, wired and installed in a mounting bracket for CombiFlex rack mounting (RGHT 19” 4U variant C)	L
2	**Standard**	
	IEC	B
3	**Main application**	
	Voltage protection and control	U

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

H B U **B C C A H** B C C 1 B B N 1 X D

#	DESCRIPTION	
4-8	**Standard configurations, analog and binary I/O options**	
	Standard configuration descriptions in short: **A** = Voltage and frequency based protection and measurement functions, synchro-check and load shedding **B** = Automatic voltage regulator	
	Std conf **A**: 5U + 12 BI + 10 BO	**AEAAD**
	Std conf **B**: 4I (Io 1/5 A) + 3U + 8 BI + 10 BO	**BCAAH**
	Std conf **B**: 4I (Io 1/5 A) + 3U + 14 BI + 13 BO	**BCABB**
	Std conf **B**: 4I (Io 1/5 A) + 3U + 6 RTD + 2 mA + 8 BI + 10 BO	**BCCAH**

The communication module hardware determines the available communication protocols.
Choose the hardware from one of the rows below to define the digits # 9-10.

H B U B C C A H **B C** C 1 B B N 1 X D

#	DESCRIPTION	
9 - 10	**Communication modules (Serial/Ethernet)**	
	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**
	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**
	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.

H B U B C C A H B C C 1 B B N 1 X D

#	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

H B U B C C A H B C C 1 B B N 1 X D

#	DESCRIPTION	
12	**Language**	
	English	1
	English and German	3
	English and Swedish	4
	English and Spanish	5
	English and Russian	6
	English and Portuguese (Brazilian)	8
13	**Front panel**	
	Small LCD	A
	Large LCD with single line diagram (SLD)	B
14	**Option 1**	
	Arc protection (only for std conf "A", 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	**Vacant digit**	
	Vacant	X
18	**Version**	
	Version 3.0	D

Example code: H B U B C C A H B C C 1 B B N 1 X D

Your ordering code:

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

Figure 13. Ordering key for complete IEDs

24. Accessories and ordering data

Table 65. 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 66. 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

25. 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 three different variants, that is PCM600, PCM600 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 or later). 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 67. Tools

Configuration and setting tools	Version
PCM600	2.3
Web-browser based user interface	IE 7.0 or later
REU615 Connectivity Package	3.0 or later

Table 68. Supported functions

Function	WebHMI	PCM600	PCM600 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	-	●	●	●

Table 68. Supported functions, continued

Function	WebHMI	PCM600	PCM600 Engineering	PCM600 Engineering Pro
Application configuration	-	-	●	●
IEC 61850 communication configuration, GOOSE (communication configuration)	-	-	-	●
Phasor diagram viewing	●	-	-	-
Event viewing	●	-	-	-
Saving of event data on the user's PC	●	-	-	-

● = Supported

26. Terminal diagrams

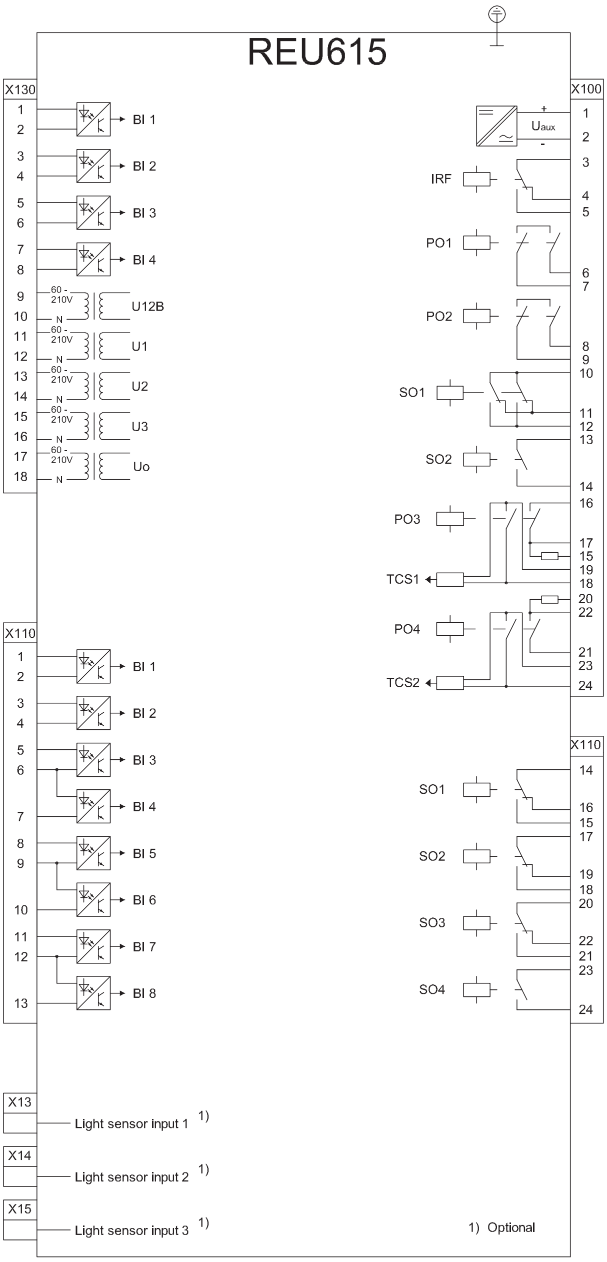

Figure 14. Terminal diagram of standard configuration A

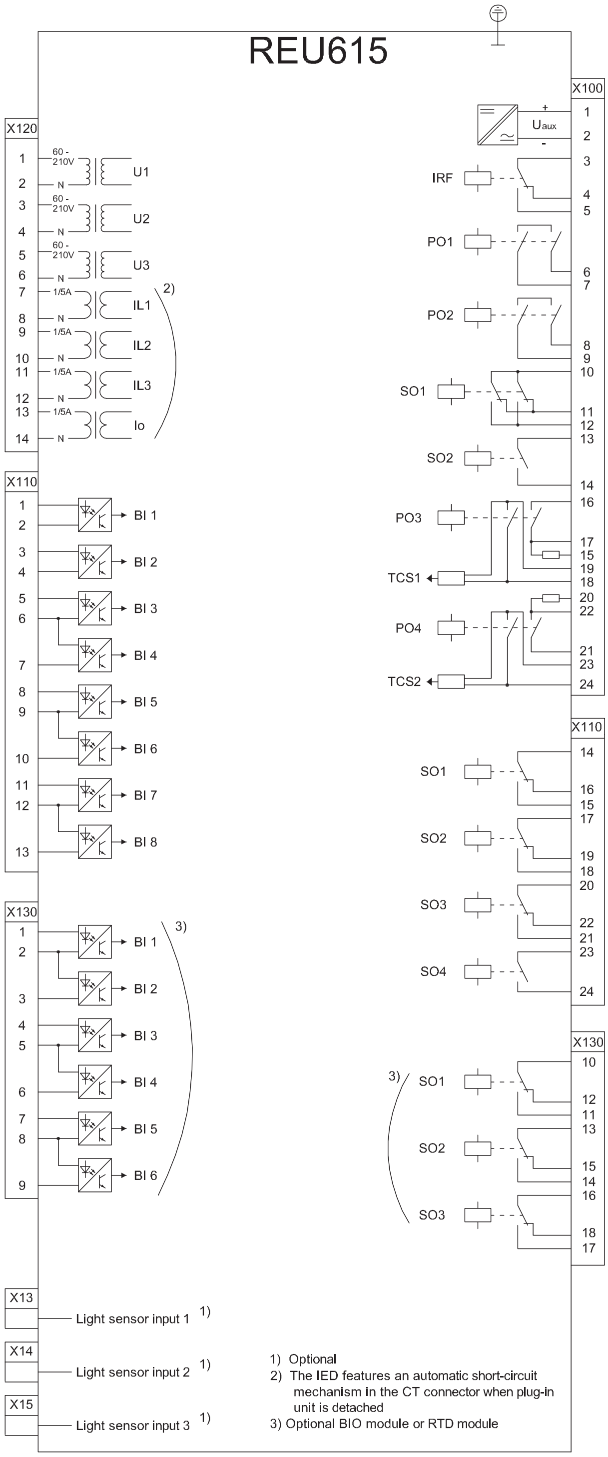

Figure 15. Terminal diagram of standard configuration B

27. 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 REU615 protection IED on the product page.

The download area on the right hand side of the web page contains the latest product documentation, such as technical reference manual, installation manual, operators manual, etc. The selection tool on the web page helps you find the documents by the document category and language.

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

28. Functions, codes and symbols

Table 69. REU615 Functions, codes and symbols

Function	IEC 61850	IEC 60617	IEC-ANSI
Protection			
Three-phase non-directional overcurrent protection, low stage, instance 1	PHLPTOC1	3I> (1)	51P-1 (1)
Three-phase non-directional overcurrent protection, high stage, instance 1	PHHPTOC1	3I>> (1)	51P-2 (1)
Three-phase non-directional overcurrent protection, instantaneous stage, instance 1	PHIPTOC1	3I>>> (1)	50P/51P (1)
Residual overvoltage protection, instance 1	ROVPTOV1	Uo> (1)	59G (1)
Residual overvoltage protection, instance 2	ROVPTOV2	Uo> (2)	59G (2)
Residual overvoltage protection, instance 3	ROVPTOV3	Uo> (3)	59G (3)
Three-phase undervoltage protection, instance 1	PHPTUV1	3U< (1)	27 (1)
Three-phase undervoltage protection, instance 2	PHPTUV2	3U< (2)	27 (2)
Three-phase undervoltage protection, instance 3	PHPTUV3	3U< (3)	27 (3)
Three-phase overvoltage protection, instance 1	PHPTOV1	3U> (1)	59 (1)
Three-phase overvoltage protection, instance 2	PHPTOV2	3U> (2)	59 (2)
Three-phase overvoltage protection, instance 3	PHPTOV3	3U> (3)	59 (3)
Positive-sequence undervoltage protection, instance 1	PSPTUV1	U1< (1)	47U+ (1)
Positive-sequence undervoltage protection, instance 2	PSPTUV2	U1< (2)	47U+ (2)
Negative-sequence overvoltage protection, instance 1	NSPTOV1	U2> (1)	47O- (1)

Table 69. REU615 Functions, codes and symbols, continued

Function	IEC 61850	IEC 60617	IEC-ANSI
Negative-sequence overvoltage protection, instance 2	NSPTOV2	U2> (2)	47O- (2)
Frequency protection, instance 1	FRPFRQ1	f>/f<,df/dt (1)	81 (1)
Frequency protection, instance 2	FRPFRQ2	f>/f<,df/dt (2)	81 (2)
Frequency protection, instance 3	FRPFRQ3	f>/f<,df/dt (3)	81 (3)
Frequency protection, instance 4	FRPFRQ4	f>/f<,df/dt (4)	81 (4)
Frequency protection, instance 5	FRPFRQ5	f>/f<,df/dt (5)	81 (5)
Frequency protection, instance 6	FRPFRQ6	f>/f<,df/dt (6)	81 (6)
Three-phase thermal overload protection for power transformers, two time constants	T2PTTR1	3Ith>T	49T
Master trip, instance 1	TRPPTRC1	Master Trip (1)	94/86 (1)
Master trip, instance 2	TRPPTRC2	Master Trip (2)	94/86 (2)
Arc protection, instance 1	ARCSARC1	ARC (1)	50L/50NL (1)
Arc protection, instance 2	ARCSARC2	ARC (2)	50L/50NL (2)
Arc protection, instance 3	ARCSARC3	ARC (3)	50L/50NL (3)
Multi-purpose protection, instance 1[1)]	MAPGAPC1	MAP (1)	MAP (1)
Multi-purpose protection, instance 2[1)]	MAPGAPC2	MAP (2)	MAP (2)
Multi-purpose protection, instance 3[1)]	MAPGAPC3	MAP (3)	MAP (3)
Load shedding and restoration, instance 1	LSHDPFRQ1	UFLS/R (1)	81LSH (1)
Load shedding and restoration, instance 2	LSHDPFRQ2	UFLS/R (2)	81LSH (2)
Load shedding and restoration, instance 3	LSHDPFRQ3	UFLS/R (3)	81LSH (3)
Load shedding and restoration, instance 4	LSHDPFRQ4	UFLS/R (4)	81LSH (4)
Load shedding and restoration, instance 5	LSHDPFRQ5	UFLS/R (5)	81LSH (5)
Control			

Table 69. REU615 Functions, codes and symbols, continued

Function	IEC 61850	IEC 60617	IEC-ANSI
Circuit-breaker control	CBXCBR1	I <-> O CB	I <-> O CB
Disconnector position indication, instance 1	DCSXSWI1	I <-> O DC (1)	I <-> O DC (1)
Disconnector position indication, instance 2	DCSXSWI2	I <-> O DC (2)	I <-> O DC (2)
Disconnector position indication, instance 3	DCSXSWI3	I <-> O DC (3)	I <-> O DC (3)
Earthing switch indication	ESSXSWI1	I <-> O ES	I <-> O ES
Tap changer position indication	TPOSSLTC1	TPOSM	84M
Tap changer control with voltage regulator	OLATCC1	COLTC	90V
Synchronism and energizing check	SECRSYN1	SYNC	25
Condition monitoring			
Trip circuit supervision, instance 1	TCSSCBR1	TCS (1)	TCM (1)
Trip circuit supervision, instance 2	TCSSCBR2	TCS (2)	TCM (2)
Current circuit supervision	CCRDIF1	MCS 3I	MCS 3I
Fuse failure supervision	SEQRFUF1	FUSEF	60
Measurement			
Disturbance recorder	RDRE1	-	-
Three-phase current measurement, instance 1	CMMXU1	3I	3I
Sequence current measurement	CSMSQI1	I1, I2, I0	I1, I2, I0
Three-phase voltage measurement	VMMXU1	3U	3U
Residual voltage measurement	RESVMMXU1	Uo	Vn
Sequence voltage measurement	VSMSQI1	U1, U2, U0	U1, U2, U0

Table 69. REU615 Functions, codes and symbols, continued

Function	IEC 61850	IEC 60617	IEC-ANSI
Three-phase power and energy measurement, including power factor	PEMMXU1	P, E	P, E
RTD/mA measurement	XRGGIO130	X130 (RTD)	X130 (RTD)
Frequency measurement	FMMXU1	f	f

1) Multi-purpose protection is used for, for example, RTD/mA based protection.

29. Document revision history

Document revision/ date	Product version	History
A/2010-06-11	3.0	First release

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