Relion® 615 series

Feeder protection and control REF615R Product guide

Power and productivity for a better world™

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1. Description

The REF615R is a dedicated feeder IED perfectly aligned for the protection, control, measurement, and supervision of utility substations and industrial power systems. The REF615R is designed for users looking for a 19" rack mount form of ABB's Relion® REF615. The REF615R utilizes the same form and fit as the DPU2000R relay and provides exact wire-alike matching rear terminals. This wire-alike feature makes the REF615R the ideal solution for upgrading to ABB's newest technologies. The REF615R is a member of ABB's Relion family and part of its 615 protection and control product series. The 615 series IEDs are characterized by their compact, withdrawable design. 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 of substation automation devices.

Unique REF615R features

- Four major ease of replacement benefits for ANSI and IEC DPU2000R users:
  - Same form and fit eliminates panel cutting or rack repositioning
  - Wire-alike I/O and CT/VT connections greatly reduce drawing modification time
  - Comparable protection and control plus more included
  - Near SCADA-alike for DNP3.0 points & Modbus registers
- Six setting groups
- Drawout design
- Underground, overhead cable fault detection (CFD) - optional
- High-speed (< 1 ms) outputs (Note: rewiring of IN7 and IN8 may be required) - optional
- Field selectable 1A or 5A CT inputs
- Advanced user programmable function blocks
- 16 Programmable pushbuttons
- High impedance (HIZ) fault detection - optional
- Arc flash detection (AFD) - optional
- Thermal overload protection of feeder cable
- Ring-lug terminals for all inputs and outputs
- Large, easy to read LCD screen
- Environmentally friendly design with RoHS compliance
- Web HMI
- PCM600 Software Tool

The REF615R provides main protection for overhead lines, cable feeders, and busbar systems of distribution substations. It can be applied for protection and control of grounded and ungrounded distribution systems.

The REF615R is the most powerful, advanced and simplest feeder protection relay in its class, perfectly offering time and instantaneous overcurrent, negative sequence overcurrent, phase discontinuity, breaker failure, thermal overload, and voltage metering and protection. The relay also features optional high impedance fault (HIZ) and sensitive earth fault (SEF) protection for grounded and ungrounded distribution systems. Also, the relay incorporates a flexible three-phase multi-shot auto-reclose function for automatic feeder restoration in temporary faults on overhead lines.

Enhanced with safety options, the relay offers a three-channel arc-fault detection system for supervision of the associated circuit. The REF615R also integrates basic control functionality, which facilitates the control of one circuit breaker via the relay's front panel human machine interface (HMI) or remote control system. To protect the relay from unauthorized access and to maintain the integrity of information, the relay has been provided with a four-level, role-based user authentication system, with individual passwords for the viewer, operator, engineer, and administrator levels. The access control system applies to the front panel HMI, embedded web browser based HMI, and the PCM600 relay setting and configuration tool.

REF615R supports the IEC 61850 standard for inter-device communication in substations. The relay also supports the industry standard DNP3.0 and Modbus® protocols.

2. Standard configurations

The REF615R relay main application is feeder protection and control and offers one standard configuration whose relay functions and features are based on the analog inputs ordered for that configuration. See Tables 1 and 2 for details.

One configuration tailored to meet and exceed these DPU2000R ANSI and IEC configurations:

– Standard: 587R... (ANSI); 687R...(IEC)
– Synch Check: 587C...(ANSI); 687C...(IEC)
– SEF: 587E...(ANSI); 687E...(IEC)

The REF615R includes standard metering, monitoring and control features and sequence of events, fault and digital waveform recording. Advanced Ethernet communications included standard with parallel support of DNP3.0 Level 2+*, Modbus and IEC61850 and SNTP over TCP/IP. Additional RS-232 and RS-485 serial communication ports are available as options that support user programmable DNP3.0 Level 2+* or Modbus protocols. Included with the optional serial communication ports is IRIG-B time synchronization.

* The DNP3.0 Level 2+ implementation includes some Level 3 functionality.

Table 1. Standard configurations

Standard configuration	Description
A	Directional phase and ground overcurrent, voltage and frequency protection, synch check, control and power system metering for one breaker

Table 2. Functions and Features

		Functional Application
Included = •, Optional = O		**A**
Protection	**ANSI Function Name**	
Phase overcurrent	51P, 50P	•
Phase long time overcurrent	51LT	•
Directional phase overcurrent	67P	•
Phase power directional	32P	•
Neutral overcurrents	51N, 50N	•
Ground overcurrents	51G, 50G	O
Directional neutral overcurrent	67N	•
Neutral power directional	32N	•
Sensitive earth fault (SEF)	50SEF	O
Negative sequence overcurrent	46	•
Load sheds and restorations	81LSH	•
Underfrequencies, overfrequencies, rate-of-changes	81	•
High impedance fault (HIZ)	HIZ	O
Thermal overload	49F	•
Phase discontinuity	46PD	•
Cold load inrush detection (seconds, minutes)	62CLD	•
Undercurrent	37	•
Restricted earth fault(REF), low impedance	REF	O
Phase undervoltage	27	•
Phase overvoltage	59	•
Phase sequence overvoltage	47	•
Ground overvoltage	59G	•
Neutral overvoltage	59N	•
Circuit breaker failure	50BF, 50NBF	•
Electrically latched/self-resetting trip digital outputs	86/94-1, 86/94-2	•
Arc flash detection via three lens sensors	AFD-1, AFD-2, AFD-3	O
Control		
Circuit breaker control	52	•
Autoreclose	79	•
Synchronism check	25	•

Table 2. Functions and Features (continued)

		Functional Application
Included = •, Optional = O		A
Monitoring and Supervision		
Trip circuit monitoring	TCM	•
Breaker condition monitoring	52CM	•
Fuse failure	60	•
Open CT secondary monitoring	CCM	•
Overexcitation (V/Hz)	24	•
Measurement		
Three-phase currents	IA, IB, IC	•
Sequence currents	I1, I2, I0	•
Ground current	IG	•
Demand phase currents		•
Maximum and minimum demand values		•
Three-phase voltages	VA, VB, VC	•
Sequence voltages	V1, V2, V0	•
Ground voltage	VG	•
Power and energy (1-phase, 3-phases) and power factor	P, E and PF	•
Fault location	FLO	•
Power quality	PQ	O
Cable fault detection (CFD) for underground and overhead feeder cables	CFD	O
Automation & Communications		
100Base-TX Ethernet (RJ45)		O
100Base-FX Ethernet(LC)		O
100Base-TX Ethernet(RJ45) + RS-485(1x4-wire or 2x2-wire) + IRIG-B		O
100Base-FX Ethernet(LC) + RS-485(1x4-wire or 2x2-wire) + IRIG-B		O
100Base-TX and -FX Ethernet (2 * LC, 1 * RJ45) + serial glass fiber (ST)		O
100Base-TX and -FX Ethernet (1 * LC, 2 * RJ45) + serial glass fiber (ST)		O
100Base-TX Ethernet (3 * RJ45) + serial glass fiber (ST)		O
Ethernet 100Base-TX (RJ45) + configurable RS232/RS485 + [RS485 or serial glass fiber (ST) + IRIG-B]		O
Records		
Sequence of events recorder	SER	•
Fault recorder	FLR	•
Digital fault (waveform) recorder	DFR	•
Load profile	LoadProf	•

3. Protection functions

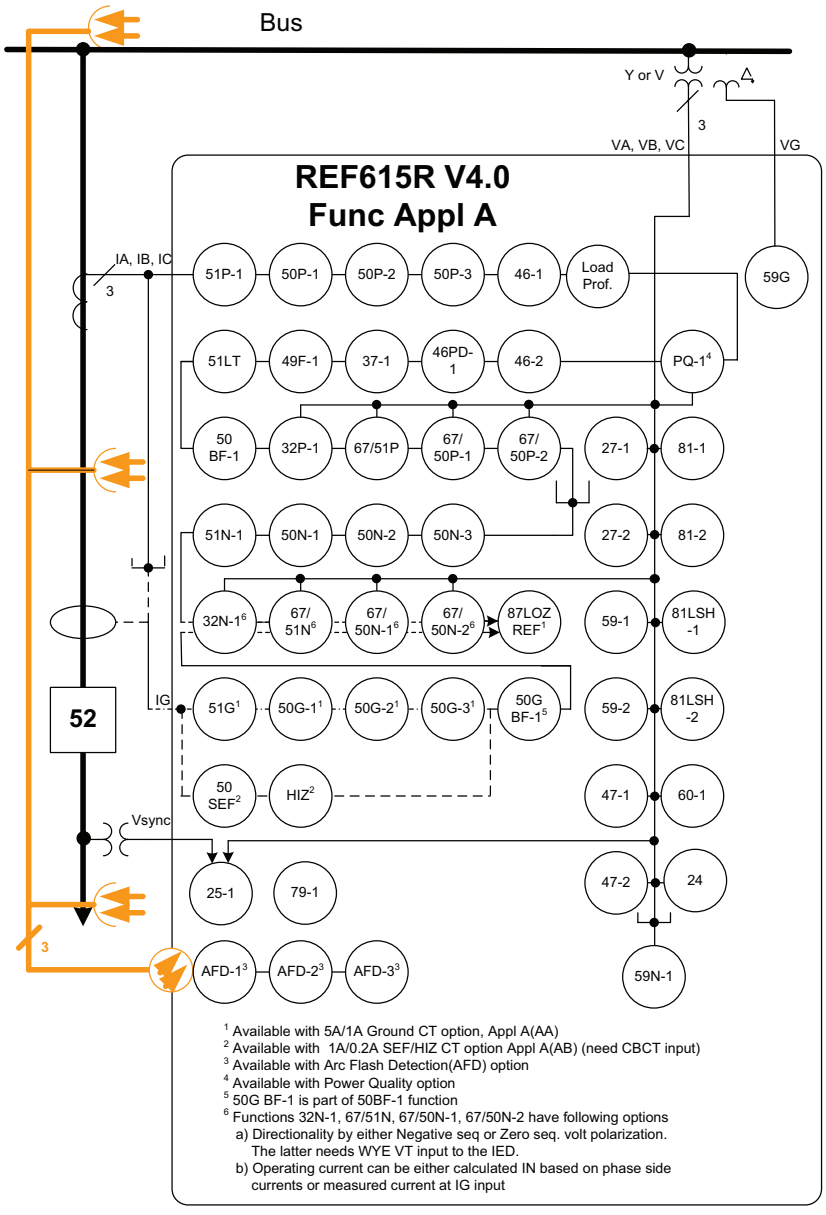
This IED provides non-directional phase and ground overcurrent, phase step distance, thermal overload, phase unbalance and phase discontinuity protection with sensitive earth fault (SEF), high impedance fault detection (HIZ), directional phase, ground and neutral overcurrent and phase, ground (residual), positive sequence and negative sequence undervoltage and overvoltage protection. The IED also provides three-pole multishot autoreclose function for utility overhead distribution feeders as a standard feature.

This IED provides non-directional phase and ground overcurrent, thermal overload, phase unbalance and phase discontinuity protection with optional sensitive earth fault (SEF), high impedance fault detection (HIZ), directional phase, ground and neutral overcurrent and phase, ground (residual), positive sequence and negative sequence undervoltage and overvoltage protection. Also, the IED offers a three-pole multishot autoreclose function for utility overhead distribution feeders.

Enhanced with an arc flash detection (AFD), the relay also features three light detection channels for arc fault detection of the circuit breaker, busbar and cable compartment of metal-enclosed switchgear.

The AFD sensor interface is optional and available in a variety of communication card options. Fast tripping increases personal safety and limits material damage within the switchgear in an arc fault situation.

Figure 1. Protection functions overview for standard configuration A



4. Application

The REF615R IED offers DPU2000R users a cost effective and convenient solution to upgrading and replacing existing ANSI or IEC DPU2000R relays. There is no need to change drawings, cut or change wire bundles, cut metal, or add adaptor plates when replacing a DPU2000R with an REF615R IED. In addition to the cost and time savings realized with this quick and easy replacement of DPU2000R relays, the REF615R is part of the Relion product family which has been designed to unleash the full potential of IEC61850 standard for communication and interoperability of substation devices. The REF615R also benefits new users who are looking for a 19" rack mount form of ABB's Relion 615 series.

The standard configuration of the REF615R includes the customer programmable phase and ground CT and, where applicable, VT secondary nominal settings plus wide protection setting ranges that increase the REF615R flexibility of application and eliminates the need for multiple different feeder relay order codes. Here is the description of the configuration available:

A: Directional phase and ground overcurrent, voltage and frequency protection, synch check, control and power system metering for one breaker

In addition to protection, control and metering, the REF615R includes many features standard for comprehensive utility and industrial distribution feeder schemes including graphical user-programmable logic, digital fault (waveform), sequence of events (SOE), reclosing and fault recording, monitoring, load profile and advanced Ethernet communications supporting IEC61850-8 with GOOSE (peer-to-peer) messaging and DNP3.0 Level 2+ and Modbus protocols over TCP/IP. Valuable options include serial communications supporting DNP3.0 Level 2+ and Modbus protocols, Power Quality, Spanish or Portuguese menu/WebHMI language, Arc Flash Detection safety feature and ABB's unique feeder Cable Fault Detection (CFD).

Costly bus differential protection and bus transfer control schemes due to dedicated CTs, I/O wiring and special communication cables are now affordable with the 615 series relays' standard Ethernet communications. Using peer-to-peer communications via IEC-61850's GOOSE messaging affords integration of high-speed monitoring and control applications.

Figure 2. Protection and control applications with standard configuration A

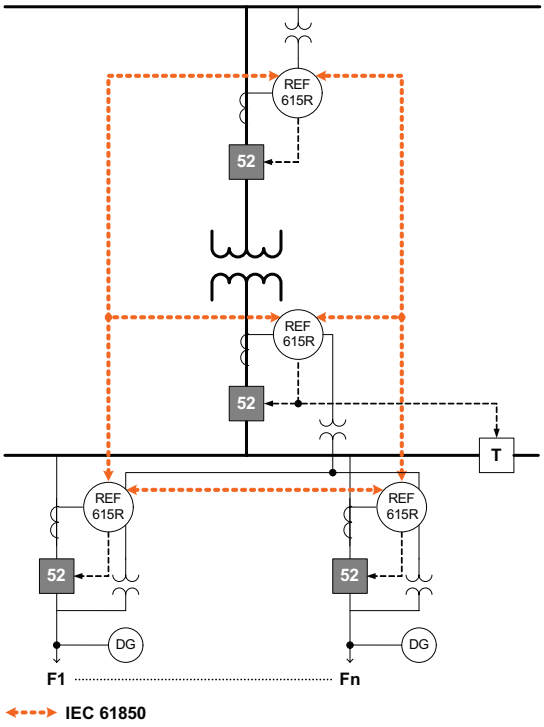


Figure 3. Peer-to-peer ‘open (cold) bus transfer’ control and high-speed bus overcurrent protection using IEC61850 GOOSE messaging

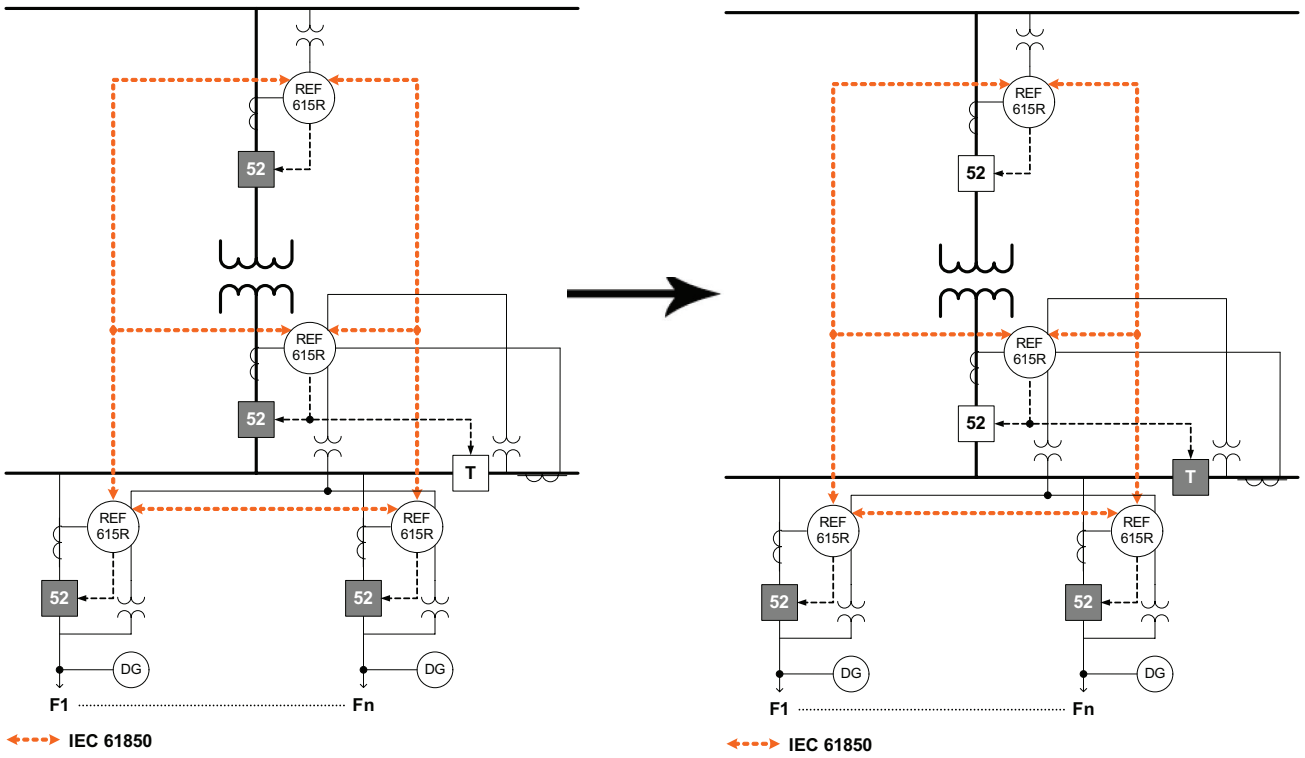
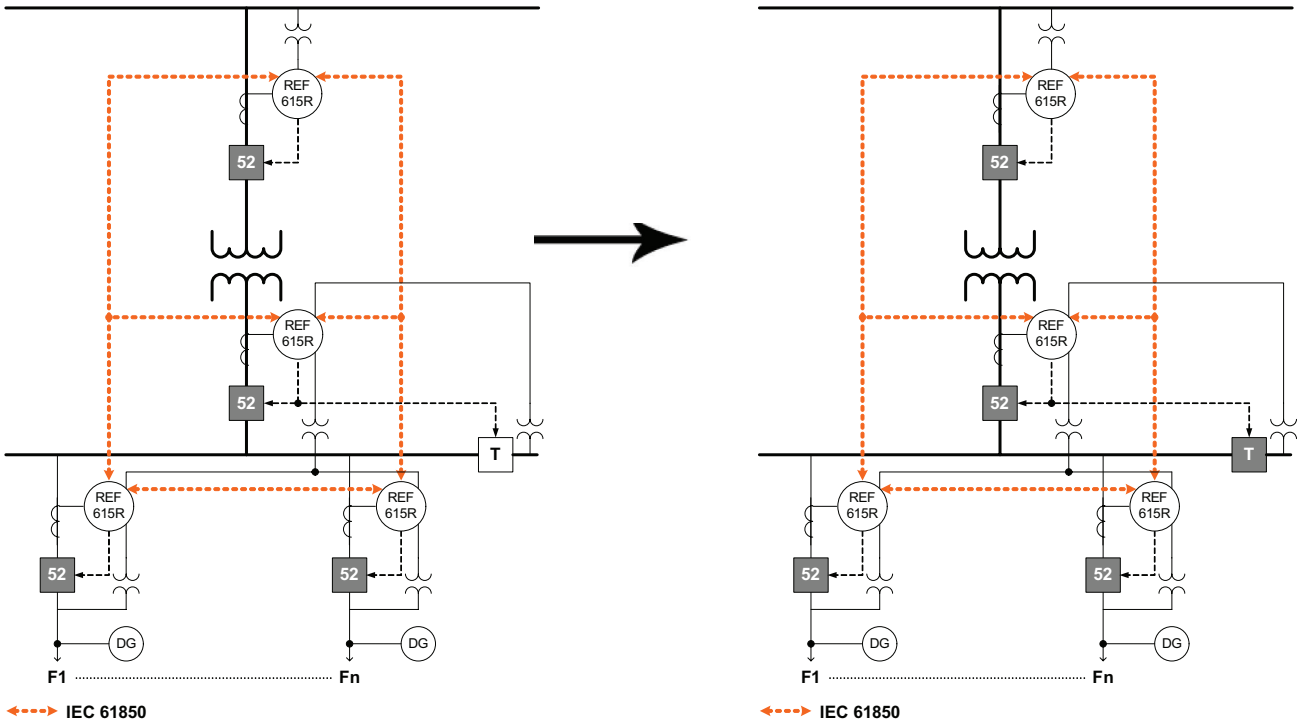


Figure 4. Peer-to-peer ‘closed (hot) bus transfer’ control and high-speed bus overcurrent protection using IEC61850 GOOSE messaging



5. Supported ABB solutions

ABB's 615 series protection and control IEDs together with the COM600 Grid Automation Controller 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 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 utilizes the data content of the design 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 design solutions. 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.

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	4.0 or later
MicroSCADA Pro	9.3 or later

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

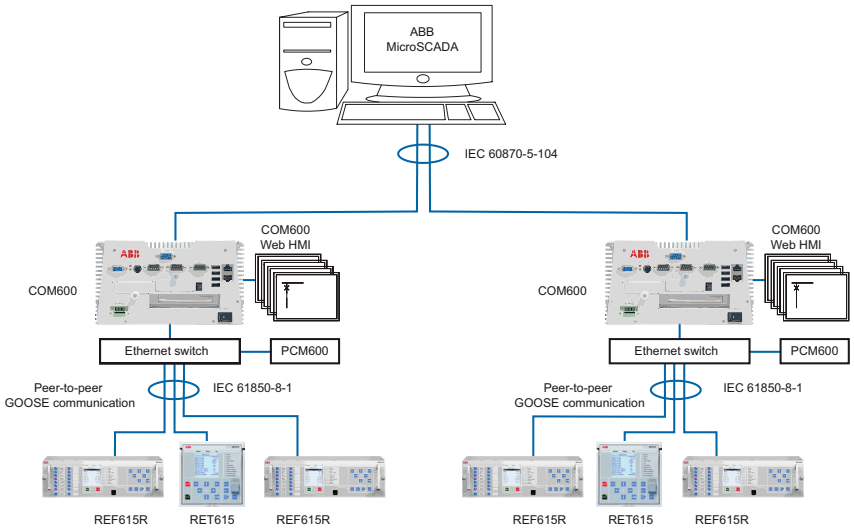
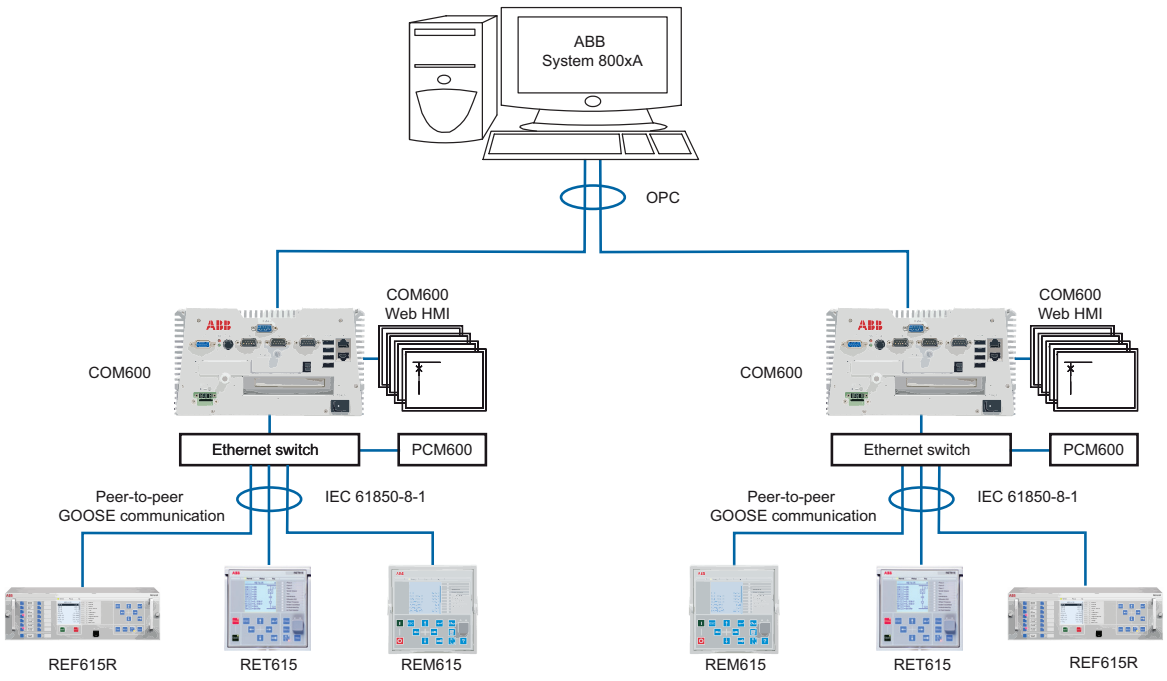


Figure 6. Industrial distribution network example using 615 series IEDs, Station Automation COM600 and System 800xA



6. Control

The relay offers status and control of one breaker with a set of push-buttons on the front panel local human machine interface (LHMI) for opening and closing a breaker. Flexible remote breaker control of select-before-trip (SBO) or direct trip is also available with each of the supported DNP3.0 Level 2+, Modbus and IEC 61850 communication protocols. Interlocking schemes required by the application are configured with the signal matrix tool in PCM600 by the application are configured with the Signal Matrix Tool (SMT) of the REF615R user tool PCM600.

7. Measurements

The relay continuously measures the phase currents and voltages, the sequence components and the residual current.

In addition, the relay calculates the demand and minimum and maximum demand currents over a user selectable pre-set time frame, the thermal overload of the protected object, and the phase unbalance value as a ratio between the negative sequence and positive sequence currents. Also voltage, power and energy (single-phase and three-phase quantities), power factor and frequency measurements and minimum and maximum demand watts and vars are available.

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

8. Digital fault recorder

The relay is provided with a digital fault recorder (DFR) featuring up to four analog and 64 binary signal channels. The analog channels record either the waveform or the trend of the currents 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 relay signals, e.g. the pickup or trip signals of the relay stages, or external blocking or control signals. Binary relay signals such as a protection pickup or trip signal, or an external relay control signal over a binary input can be set to trigger the recording. Phase and ground voltage waveforms would be available for inclusion in each digital recording.

9. Events recorder

The IED includes a sequence of events recorder (SER) that logs important event activity. The relay has the capacity to store in non-volatile memory the most recent 1024 events in a first-in-first-out (FIFO) buffer with each event date and time stamped to 1 ms resolution. The event log facilitates detailed pre- and post-fault analyses of feeder faults and disturbances.

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

10. Recorded data

The relay has the capacity to store in non-volatile memory the most recent 128 fault records for user post-fault analysis. Each record includes the current values, the Pickup times of the protection blocks, time stamp, etc. The fault recording can be triggered by the pickup signal or the trip signal of a protection block, or by both. The available measurement modes include DFT, RMS and peak-to-peak. All 128 fault records are retrievable and viewable via all protocols, the local HMI, web-based HMI and user tool PCM600.

Demand and minimum and maximum demand currents, watts and vars with date and time stamp are stored as separate recorded data. The power demand values include single-phase and three-phase quantities with wye- connected VTs and three-phase quantities with delta-connected VTs.

The Load Profile feature is included as a standard in the REF615R IED. This feature records demand currents, watts and vars and bus voltage quantities, depending on the specific settings, that present a clear view of bus stability and feeder loading. Such load profile is quite useful for system planners. The Load Profile data recording rate is set by the demand time interval setting and stored in non-volatile memory. For a demand time interval of 15 minutes and storing four currents and three voltages, approximately 40 days of data is recordable in a first-in first-out (FIFO) buffer. The profile data is retrievable via the relay user tool PCM600 and viewable through its COMTRADE viewing tool Wavewin.

11. Circuit-breaker condition monitoring

For continuous knowledge of the operational availability of the REF615R features, a comprehensive set of monitoring functions to supervise the relay health, the trip circuit and the circuit breaker health is included. The breaker monitoring can include checking the wear and tear of the circuit breaker, the spring charging time of the breaker operating mechanism and the gas pressure of the breaker chambers. The relay also monitors the breaker travel time and the number of circuit breaker (CB) operations to provide basic information for scheduling CB maintenance.

12. Trip-circuit monitoring

The trip-circuit monitoring logic continuously supervises the availability and operability of the trip circuit. It provides open-circuit monitoring both when the circuit breaker is in its closed position. It also detects loss of circuit-breaker control voltage.

Local and remote indication are programmable to ensure immediate notification so the necessary steps can be established to correct before the next fault event occurs.

13. Self diagnostics

The relay's built-in self-diagnostics system continuously monitors the state of the relay hardware and the operation of the relay software. Any fault or malfunction detected will be used for alerting the operator. A permanent relay fault will block the protection functions of the relay to prevent incorrect relay operation.

14. Fuse failure protection

The REF615R includes fuse failure supervision functionality. 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

The REF615R includes current circuit supervision. Current circuit supervision is used for detecting an open circuit in the current transformer secondary circuits. On detecting an open circuit, 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. Load profile recording

The relay includes a load profile recording feature standard. The load profile records demand currents, watts and vars at a rate equal to the user-selected demand time interval. With a 15 minute demand time interval, load profile data comprising at least 40 days is possible. This profile data is most useful to distribution system capacity planners.

17. Power quality

The ability to monitor and detect current and voltage harmonics and short duration system disturbances with the REF615R is possible through the optional power quality (PQ) function. This function enables studying system quality conditions, documenting cases and implementing new procedures to improve reliability of service. The PQ functions include these features per the IEEE 1159 standard:

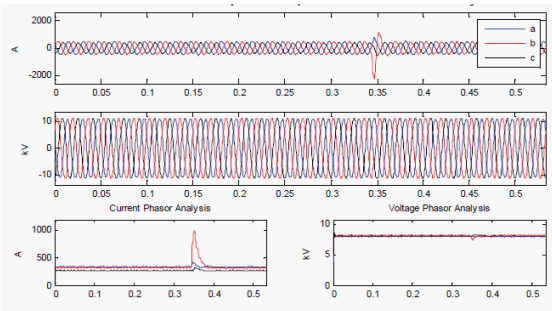
- Current total demand distortion (TDD)
- Voltage total harmonic distortion (THD)
- Sags(Dips), Swells and Interrupts
- Voltage unbalance

18. Single-line diagram (SLD)

The relay includes the ability for the user to design a unique single line diagram (SLD) view in the front panel LHMI LCD. An applicable default SLD view is provided for each standard configuration. The SLD flexible programming allows for showing a one-line drawing of the relay application, metering values and text strings specifying, e.g., specific feeder and breaker information. This reduces significantly time the substation personnel need to obtain this relevant information from smaller LCDs.

19. Cable fault detection (CFD)

The REF615R offers an option feeder cable fault detection (CFD) function that is able to real-time detect extremely short duration overhead and underground faults in feeders. This dedicated function is programmable to monitor and detect self-clearing and fuse-cleared faults. These short duration faults are typically undetectable by conventional protection where there is no operation of their substation breaker or feeder recloser. Where dispatchers gain knowledge of these events from customer calls, this real-time detection provides immediate indication to the dispatcher prior to the first customer call. Overall outage restoration times may be reduced having knowledge of such feeder event as soon as they happen improving a utility's reliability metrics.



20. 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 frontpanel user interface, the web-browser based user interface and the PCM600 tool.

21. Inputs and outputs

There are two separate selections that can be made in the selection of current (CT) and voltage (VT) analog inputs and binary inputs and outputs (I/O). Table 4 details the analog inputs order code characters.

The phase-current inputs are user programmable for 5 A or 1 A CT secondary nominal rating. The ground CT option is programmable for 5/1 A nominal rating, the SEF/HIZ CT option has a fixed 0.2 A nominal rating. The sensitive earth fault CT option provides SEF protection and includes a separate, independent HIZ protective function for detecting downed conductors.

The phase-current and ground current nominal rating of 5 A or 1 A are selected in the relay software. The nominal secondary voltage of the three-phase and ground VT inputs are user programmable.

The binary input turn-on thresholds are programmable from 18…176 V DC by adjusting the relay's parameter settings.

All binary input and output contacts are freely programmable with the signal matrix tool in PCM600 software user tool.

Relay analog input and binary input/output overview:
- Three phase-current inputs
- Standard ground current or optional SEF/HIZ ct current input
- Three-phase, synch check and ground VT inputs
- Eleven inputs

- Three/one outputs configurable NO or NC with standard/optional outputs
- High-speed outputs (HSO) optional
- Self-check alarm output, Form C

Table 4. Available Analog Inputs per REF615R Configuration

Standard configuration	Analog inputs	Analog inputs	
		CT	VT
A	AA	4[1, 3]	5
A	AB	4[2, 3]	5

[1] Ground CT (Inom = 5/1 A)
[2] SEF/HIZ CT (Inom = 0.2 A)
[3]For SEF DPU2000R units having IN and SEF CT inputs, the external wire-alike connections are routed internally to the one REF615R ground CT input.

Table 5. Available Binary Inputs and Outputs per REF615R Configuration

Standard configuration	Binary I/O	Binary inputs / binary outputs(type[1])				
		BI	BO(Power)	BO(High-speed)	BO(Trip)	BO(Signal)
A	AA	11	OUT3, OUT4, OUT5, OUT6	None	TRIP, OUT1, OUT2	Self-check alarm
A	A1	11	OUT1, OUT2, OUT3	OUT4, OUT5, OUT6	TRIP, OUT4, OUT5, OUT6	Self-check alarm

[1] Power: Power output (trip rated; high-current inductive break)
High-speed: High-speed power output (1 ms operate time; trip rated; high-current inductive break)
Trip: Trip output (trip rated; low-current inductive break)
Signal: Signal output (signal rated; low-current inductive break)

22. Communications

The relay (IED) supports a range of communication protocols including IEC 61850, Modbus® and DNP3.0 Level 2. Operational information and controls are available through these protocols. Certain communication functionality, e.g., horizontal communication between relays, 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 communication network 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, e.g., be employed for protection and interlocking-based protection schemes. The relay meets the GOOSE performance requirements for tripping applications in distribution substations, as defined by the IEC 61850 standard. Also, 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 network bus, thus facilitating, for example, sharing of RTD input values, such as surrounding temperature values, to other IED applications.

The IED offers an optional second Ethernet bus to enable the creation of a self-healing Ethernet ring topology. The IED communication module options include both galvanic and fiber-optic Ethernet combinations. The communication module including one fiber-optic LC port and two galvanic RJ-45 ports is used when the ring 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 network bus is based on CAT5 STP cabling.

The self-healing Ethernet ring solution enables a cost-effective communication ring solution 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 IEDs in the ring topology act as unmanaged switches forwarding unrelated data traffic. The Ethernet ring solution supports the connection of up to 30 ABB 615 series relays. 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 DNP3.0 Level 2 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 fiber-optic LC connector (100Base-FX). If connection to a serial bus is required, the 10-pin RS-485 screw-terminal or the fiber-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.

DNP3.0 Level 2 supports both serial and TCP modes for connection to one master. Additionally, 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) – primary and secondary SNTP servers supported

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
– DNP3.0 Level 2

Figure 7. Self-healing ring network topology example

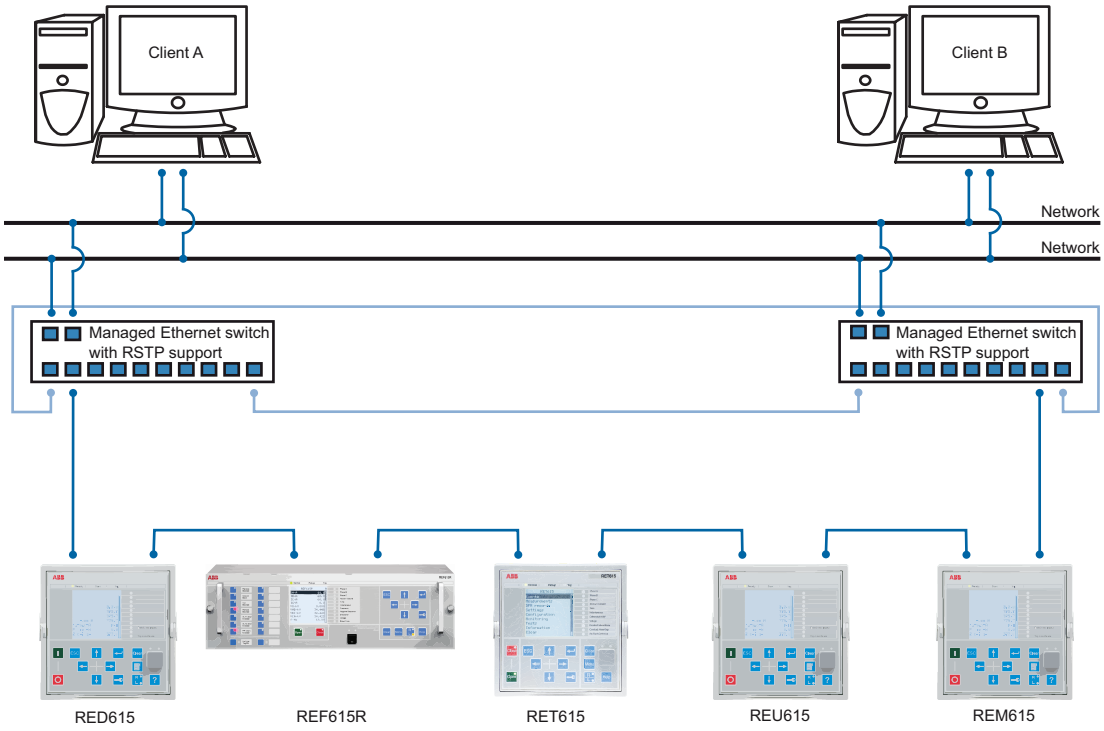


Table 6. Supported station communication interfaces and protocols

Interfaces/Protocols	Ethernet		Serial	
	100BASE-TX (RJ45)	100BASE-FX (LC)	RS-232/RS-485	Fiber-optic (ST)
DNP3.0 Level 2+ over TCP/IP	•	•	-	-
Modbus over TCP/IP	•	•	-	-
IEC 61850-8-1	•	•	-	-
SNTP	•	•	-	-
FTP	•	•	-	-
DNP3.0 Level 2+ serial	-	-	•	•
Modbus RTU/ASCII	-	-	•	•
IRIG-B time synchronization	-	-	•	•

• = supported

23. Technical data

Table 7. Product weight and dimensions

Description	Value
Width	19.0” (482.6 mm)
Height	5.22” (132.6 mm)
Depth	9.08” (230.66 mm)
Weight	Unboxed: 11.9 lb (5.4 kg) Boxed: 16.4 lb (7.44 kg)

Table 8. Power supply

Description	Type 1	Type 2
V nominal (V_n)	100, 110, 120, 220, 240 V AC, 60 and 50 Hz 48, 60, 110, 125, 220, 250 V DC	24, 30, 48, 60 V DC
V_n variation	38...110% of V_n (38...264 V AC) 80...120% of V_n (38.4...300 V DC)	50...120% of V_n (12...72 V DC)
Start-up threshold		19.2 V DC (24 V DC * 80%)
Burden of auxiliary voltage supply under quiescent (Pq)/operating condition	DC < 15 W (nominal) /< 20W (max) and AC < 17 W (nominal) /< 22 W (max)	DC < 15 W (nominal) /< 20 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 relay	50 ms at nominal voltage	50 ms at nominal voltage
Fuse type	T4A/250 V	

Table 9. Analog inputs

Description		Value	
Rated frequency		60/50 Hz	
Current inputs	Rated current, I_n	5/1 A[1)]	0.2/1 A[2)]
	Thermal withstand capability:		
	• Continuously	20 A	4 A
	• For 1 s	500 A	100 A
	Dynamic current withstand:		
	• Half-wave value	1250 A	250 A
	Input impedance	<20 mΩ	<100 mΩ
Voltage inputs	Rated voltage V_n	60...210 V AC (Parametrization)	
	Voltage withstand:		
	• Continuous	2 x V_n (240 V AC)	
	• For 10 s	3 x V_n (360 V AC)	
	Burden at rated voltage	<0.05 VA	

[1)] Ordering option for ground current input
[2)] Ground current and/or phase current

Table 10. Measuring range

Description	Value
Measured currents on phases IA, IB and IC as multiples of the rated currents of the analog inputs	0... 40 x I_n
Ground current as a multiple of the rated current of the analog input	0... 40 x I_n

Table 11. 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 mW
Threshold voltage	18...176 V DC
Reaction time	3 ms

Table 12. Trip-rated outputs for TRIP (X100:SO1) and OUT1 (X120:SO2), OUT2 (X120:SO1) on standard outputs option [Typical operation time: 5...8 ms]

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 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. Self-diagnostics alarm signal output (SO) [Typical operation time: 5...8 ms]

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 14. Trip-rated power outputs for OUT3-OUT6 (X100:PO1-PO4) and OUT1-OUT3 (X100: PO2-PO4) on standard and HSO output option, respectively [Typical operation time: 8...11 ms]

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 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. High-speed trip-rated power outputs for OUT4-OUT6 (X120:HSO1-HSO3) on HSO output option [Typical operation time: 1 ms]

Description	Value
Rated voltage	250 V AC/DC
Continuous contact carry	6 A
Make and carry for 3.0 s	15 A
Make and carry 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

Table 16. Communication interfaces

Ethernet interface	Protocol	Cable	Data transfer rate
Front RJ-45	TCP/IP	Standard Ethernet Cat5 cable with RJ-45 connector	10 MBits/s
Rear RJ-45 or LC	TCP/IP	Shielded twisted pair CAT 5e cable with RJ-45 connector or fiber-optic cable with LC connector	100 MBits/s
X5	Serial	10-pin counter connector Weidmuller BL 3.5/10/180F AU OR BEDR or 9-pin counter connector Weidmuller BL 3.5/9/180F AU OR BEDR1)[1]	115200 Bits/s
X16	Serial	9-pin D-sub connector DE-9	115200 Bits/s
X12	Serial	Optical ST-connector	115200 Bits/s

[1] Depending on the optional communication module.

Table 17. Network Ethernet ports specifications

Connector	Fibre type[1)]	Wave length	Max. distance	Permitted path attenuation[2)]
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 18. 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 19. Lens sensor and optical fibre for arc protection

Description	Value
Fiber-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	3.94 in (100 mm)

Table 20. Degree of protection of flush-mounted relay

Description	Value
Front side	IP 54[1]

[1)] This is achieved using the Bezel/cover kit as described on page 42.

Table 21. Environmental conditions

Description	Value
Operating temperature range	-25 C to +55° C
Short-term operating temperature range	-40 C to +85° C (<16 h) [1)2)]
Relative humidity	<93%, non-condensing
Atmospheric pressure	12.47...15.37 psi (86...106 kPa)
Altitude	Up to 6561 ft (2000 m)
Transport and storage temperature range	-40...+85°C

[1)] Degradation in MTBF and LHMI performance outside continuous operating temperature range
[2)] For relays with an LC communications interface, the maximum operating temperature is +70° C

Table 22. Environmental tests

Description	Type test value	Reference
Damp heat test	+55°C, Rh = 95%, 96 h	IEEE C37.90-2005
	6 test cycles (12 h + 12 h), +25… +55°C, Rh = 95% [1]	IEC 60068-2-30
Dry heat test	+85°C 12h [2, 3, 4]	IEEE C37.90-2005
	+85°C 16 h [3, 4] +55°C 96h	IEC 60068-2-2
Dry cold test	-40°C 12 h 2)3)	IEEE C37.90-2005
	-40°C 16 h 3) -25°C 96 h	IEC 60068-2-1
Storage temperature test	+85°C 96 h, -40°C 96 h	IEEE C37.90-2005 IEC 60068-2-1,-2
Change temperature test	5 test cycles (3 h + 3 h) at -25°C and +55°C 5)	IEC 60068-2-14

[1] For relays with an LC communication interface the maximum operating temperature is +70° C
[2] The auxiliary voltage was disconnected during the first 5 cycles of the test. The auxiliary voltage was switched on during the sixth cycle when the temperature was +55°C and the humidity 95% Rh.
[3] LCD may be unreadable, but the IED is still operational.
[4] For IEDs with an LC communication interface, the maximum operating temperature is +70°C.
[5] IED was energiazed.

Table 23. Electromagnetic compatibility tests

The EMC immunity test level meets the requirements listed below:		
Description	**Type test value**	**Reference**
1 MHz burst disturbance test, class III:		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	
Electrostatic discharge test		IEC 61000-4-2 IEC 60255-22-2, Class 4 IEEE C37.90.3-2001
- Contact discharge	±8 kV	
- Air discharge	±15 kV	
Description	**Type test value**	**Reference**
Radio frequency interference tests:		
	10 V/m (rms) f=80-2700 MHz (sweep and keying test)	IEC 61000-4-3 IEC 60255-22-3, class III
	20 V/m (rms) f=80-1000 MHz (sweep and keying test)	IEEE C37.90.2-2004
Fast transient disturbance tests:		IEC 61000-4-4 IEC 60255-22-4, Class A IEEE C37.90.1-2002
- Common mode/differential mode	±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:		IEC 61000-4-8
- > 300 s	300 A/m	
- 3 s	1000 A/m	
Voltage dips and short interruptions	30%/10 ms 60%/100 ms 60%/1000 ms >95%/5000 ms	According to IEC 61000-4-11

Table 23. Electromagnetic compatibility tests (continued)

The EMC immunity test level meets the requirements listed below:		
Power frequency immunity test:	Binary inputs only	
- Common mode	300 V rms	IEC 60255-22-7, class A
- Differential mode	150 V rms	IEC 61000-4-16
3 MHz/10 MHz/30 MHz burst disturbance test, all ports		IEC 61000-4-18, Level 3
- Common mode	±2.5 kV	
Emission tests:		EN 55011, class A IEC 60255-25
- Conducted		
0.15-0.50 MHz	< 79 dB(µV) quasi peak < 66 dB(µV) average	
0.5-30 MHz	< 73 dB(µV) quasi peak < 60 dB(µV) average	
- Radiated		
30-230 MHz	< 40 dB(µV/m) quasi peak, measured at 10 m distance	
230-1000 MHz	< 47 dB(µV/m) quasi peak, measured at 10 m distance	
Pulse magnetic field immunity test	100 A/m (test level) 6.4 / 16µs (pulse waveform)	IEC 61000-4-9
Damped oscillatory magnetic field immunity test	400 transients/s at 1 MHz (repitition rate) 100 A/m for 2 s	IEC 61000-4-10

Table 24. Insulation tests

Description	Type test value	Reference
Dielectric tests:	According to IEC 60255-5	
- Test voltage	208 kV DC, 1 min 700 V, DC, 1 min for signal circuit and communication	IEEE C37.90-2005 IEC 60255-5
Impulse voltage test:		IEC 60255-5 and IEC 60255-27
- Test voltage	5 kV, 1.2/50 µs, 0.5 J	
Insulation resistance measurements		IEC 60255-5 and IEC 60255-27
- Isolation resistance	>100 MΩ, 500 V DC	
Protective bonding resistance		IEC 60255-27
- Resistance	<0.1 Ω (60 s)	

Table 25. Mechanical tests

Description		Value
Vibration tests (sinusoidal)	IEC 60255-21-1	Class 2
Shock and bump test	IEC 60255-21-2	Class 2
Seismic test	IEC 60255-21-3	Class 2
Mechanical durability	IEEE C37.90-2005	• 200 withdrawls and insertions of the plug-in unit • 200 adjustments of relay setting controls

Table 26. Product safety

Description	Reference
LV directive	2006/95/EC
Standards	EN 60255-27 (2005), EN 60255-6 (1994)

Table 27. EMC Compliance

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

Table 28. RoHS compliance

Description
Complies with the RoHS directive 2002/95/EC

Protection functions

Table 29. Three-phase non-directional overcurrent protection (50P, 51P)

Characteristic		Value		
Pickup accuracy		Depending on the frequency of the current measured: f_n ±2Hz		
	51P	±1.5% of the set value or ±0.002 x I_n		
	50P-1, 50P-2 and 50P-3	±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)		
Pickup time [1) 2)]		Minimum	Typical	Maximum
	50P-3: I_{Fault} = 2 x set Pickup value	15 ms	16 ms	17 ms
	50P-3: I_{Fault} = 10 x set Pickup value	12 ms	13 ms	14 ms
	50P-1, 50P-2 and 51P: I_{Fault} = 2 x set Pickup value	23 ms	25 ms	28 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Retardation time		< 30 ms		
Trip time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Trip time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms [3)]		
Suppression of harmonics		RMS: No suppression DFT: -50dB 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 = ANSI definite time, Measurement mode = default (depends on stage), current before fault = 0.0 x In, 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)] Maximum Pickup value = 2.5 x I , Pickup value multiples in range of 1.5 to 20

Table 30. Three-phase non-directional overcurrent protection (50P, 51P) main settings

Parameter	Function	Value (Range)	Step
Pickup value	51P	0.05...5.00 x I_n	0.01
	50P-1, 50P-2	0.10...40.00 x I_n	0.01
	50P-3	1.00...40.00 x I_n	0.01
Time multiplier	51P	0.05...15.0	0.01
	50P-1, 50P-2	0.05...15.00	0.01
Definite time delay	51P	40...200000 ms	10
	50P-1, 50P-2	40...200000 ms	10
	50P-3	20...200000 ms	10
Operating curve type [1]	51P	Definite or inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
	50P-1, 50P-2	Definite or inverse time Curve type: 1, 3, 5, 9, 10, 12, 15, 17	
	50P-3	Definite time	

[1] For further reference please refer to the Operating characteristics table at the end of the Technical data chapter

Table 31. Three-phase directional overcurrent protection (67/51P, 67/50P)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the current/voltage measured: fn ±2Hz		
	67/51P	Current: ±1.5% of the set value or ±0.002 x I_n Voltage: ±1.5% of the set value or ±0.002 x V_n Phase angle: ±2°		
	67/50P-1, 67/50P-2	Current: ±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 set value (at currents in the range of 10…40 x I_n) Voltage: ±1.5% of the set value or ±0.002 x V_n Phase angle: ±2°		
Pickup time [1] [2]		Minimum	Typical	Maximum
	I_{Fault} = 2.0 x set Pickup value	37 ms	40 ms	42 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Retardation time		< 35 ms		
Trip time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Trip time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms [3]		
Suppression of harmonics		DFT: -50dB at f = n x fn, where n = 2, 3, 4, 5,…		

1) Measurement mode and Pol quantity = default, current before fault = 0.0 x I_n, voltage before fault 1.0 x U_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) Maximum Pickup value = 2.5 x I_n, Pickup value multiples in range of 1.5 to 20

Table 32. Three-phase directional overcurrent protection (67/51P, 67/50P) main settings

Parameter	Function	Value (Range)	Step
Pickup value	67/51P	0.05...5.00 x I_n	0.01
	67/50P-1, 67/50P-2	0.10...40.00 x I_n	0.01
Time multiplier	67/51P, 67/50P-1, 67/50P-2	0.05...15.00	0.01
Definite time delay	67/51P, 67/50P-1, 67/50P-2	40...200000 ms	10
Directional mode	67/51P, 67/50P-1, 67/50P-2	1 = Non-directional 2 = Forward 3 = Reverse	
Characteristic angle	67/51P, 67/50P-1, 67/50P-2	-179...180 degrees	1
Operating curve type [1)]	67/51P	Definite or inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
	67/50P-1, 67/50P-2	Definite or inverse time Curve type: 1, 3, 5, 9, 10, 12, 15, 17	

[1)] For further reference please refer to the Operating characteristics table at the end of the Technical data chapter

Table 33. Non-directional ground fault protection (51N, 51G, 50N, 50G, SEF)

Characteristic		Value		
Pickup accuracy		Depending on the frequency of the current measured: fn ±2Hz		
	51N, 51G, SEF	±1.5% of the set value or ±0.002 x I_n		
	50N-1, 50N-2, 50G-1, 50G-2 and 50N-3, 50G-3	±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)		
Pickup time 1) 2)		Minimum	Typical	Maximum
	50N-3, 50G-3: I_{Fault} = 2 x set Pickup value I_{Fault} = 10 x set Pickup value	 15 ms 12 ms	 16 ms 13 ms	 17 ms 14 ms
	50N-1, 50N-2, 50G-1, 50G-2 and 51N, 51G, SEF: I_{Fault} = 2 x set Pickup value	23 ms	25 ms	28 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Retardation time		< 30 ms		
Trip time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Trip time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms 3)		
Suppression of harmonics		RMS: No suppression DFT: -50dB at f = n x fn, where n = 2, 3, 4, 5,… Peak-to-Peak: No suppression		

[1)] Measurement mode = default (depends on stage), current before fault = 0.0 x In, fn = 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 Pickup value = 2.5 x In, Pickup value multiples in range of 1.5 to 20

Table 34. Non-directional ground fault protection (51N, 51G, 50N, 50G) main settings

Parameter	Function	Value (Range)	Step
Pickup value	51N/51G	0.010...5.000 x I_n	0.005
	50N-1, 50N-2, 50G-1, 50G-2	0.10...40.00 x I_n	0.01
	50N-3, 50G-3	1.00...40.00 x I_n	0.01
Time multiplier	51N/51G	0.05...15.00	0.01
	50N-1, 50N-2, 50G-1, 50G-2	0.05...15.00	0.01
Definite time delay	51N/51G	40...200000 ms	10
	50N-1, 50N-2, 50G-1, 50G-2	40...200000 ms	10
	50N-3, 50G-3	20...200000 ms	10
Operating curve type [1]	51N/51G	Definite or inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
	50N-1, 50N-2, 50G-1, 50G-2	Definite or inverse time Curve type: 1, 3, 5, 9, 10, 12, 15, 17	
	50N-3, 50G-3	Definite time	

[1] For further reference please refer to the Operating characteristics table at the end of the Technical data chapter

Table 35. Directional ground fault protection (67/51N, 67/50N)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the current measured: fn ±2Hz		
	67/51N	Current: ±1.5% of the set value or ±0.002 x I_n Voltage: ±1.5% of the set value or ±0.002 x V_n Phase angle: ±2°		
	67/50N-1, 67/50N-2	Current: ±2% of the set value or ±0.003 x In (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) Voltage: ±1.5% of the set value or ±0.01 x V_n Phase angle: ±2°		
Pickup time [1] [2]		Minimum	Typical	Maximum
	67/50N-1, 67/50N-2: I_{Fault} = 2 x set Pickup value	42 ms	45 ms	49 ms
	67/51N-1: I_{Fault} = 2 x set Pickup value	62 ms	65 ms	69 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Retardation time		< 30 ms		
Trip time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Trip time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms 3)		
Suppression of harmonics		RMS: No suppression DFT: -50dB at f = n x fn, where n = 2, 3, 4, 5,… Peak-to-Peak: No suppression		

[1] Set Definite time delay = 0,06 s, Inverse-time (IDMT) and definite-time (DT) curves = ANSI definite time, Measurement mode = default (depends on stage), current before fault = 0.0 x 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 Pickup value = 2.5 x I_n, Pickup value multiples in range of 1.5 to 20

Table 36. Directional ground fault protection (67/51N, 67/50N) main settings

Parameter	Function	Value (Range)	Step
Pickup value	67/51N	0.010...5.000 x In	0.005
	67/50N-1, 67/50N-2	0.10...40.00 x In	0.01
Directional mode	67/51N, 67N/ 50N-1 and 67/50N-2	1=Non-directional 2=Forward 3=Reverse	
Time multiplier	67/51N	0.05...15.00	0.01
	67/50N-1, 67/50N-2	0.05...15.00	0.01
Definite time delay	67/51N	60...200000 ms	10
	67/50N-1, 67/50N-2	60...200000 ms	10
Operating curve type 1)	67/51N	Definite or inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
	67/50N-1, 67/50N-2	Definite or inverse time Curve type: 1, 3, 5, 15, 17	
Operation mode	67/51N, 67/50N-1 and 67/50N-2	1=Phase angle 2=I_0Sin 3=I_0Cos 4=Phase angle 80 5=Phase angle 88	

Table 37. Three-phase non-directional long time overcurrent protection (51LT)

Characteristic		Value		
Operation accuracy	51LT	Depending on the frequency of the current measured: f_n ±2Hz ±1.5% of the set value or ±0.002 x I_n		
Pickup time 1) 2)	51LT: I_{Fault} = 2 x set Pickup value	Minimum 23 ms	Typical 25 ms	Maximum 28 ms
Reset time		< 50 ms		
Reset ratio		Typical 0.96		
Retardation time		< 30 ms		
Trip time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Trip time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms 4)		
Suppression of harmonics		RMS: No suppression DFT: -50dB 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 = ANSI definite time, Measurement mode = default (depends on element), current before fault = 0.0 x I_n, f_n = 60 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
4) Maximum Pickup value = 2.5 x I_n, Pickup value multiples in range of 1.5 to 20

Table 38. Three-phase non-directional long time overcurrent protection (51LT) main settings

Parameter	Function	Value (Range)	Step
Pickup value	51LT	0.05 - 5.00 x I_n	0.01
Time multiplier	51LT	0.10...15.00[1]	0.10
Definite time delay	51LT	0.020...200.001 s	0.001
Operating curve type	51LT	Definite or inverse-time curve type: 6, 7, 14, 15, 17	

[1] Embedded 10x factor in time multiplier to achieve 'very long-time' curve characteristic

Table 39. Three-phase overvoltage protection (59)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the voltage measured: f_n ±2Hz ±1.5% of the set value or ±0.002 x V_n		
Pickup time [1) 2)]	V_{Fault} = 1.1 x set Pickup value	Minimum	Typical	Maximum
		23 ms	27 ms	30 ms
Reset time		< 40 ms		
Reset ratio		Depends on the Relative hysteresis		
Retardation time		< 35 ms		
Trip time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Trip time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms [3)]		
Suppression of harmonics		DFT: -50dB at f = n x f_n, where n = 2, 3, 4, 5,…		

[1)] Pickup 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 frequence injected from random phase angle, results based on statistical distribution of 1000 measurements
[2)] Includes the delay of the signal output contact
[3)] Maximum Pickup value = 1.20 x U_n, Pickup value multiples in range of 1.10 to 2.00

Table 40. Three-phase overvoltage protection (59) main settings

Parameter	Function	Value (Range)	Step
Pickup value	59	0.05…1.60 x V_n	0.01
Time multiplier	59	0.05…15.00	0.01
Definite time delay	59	40…300000 ms	10
Operating curve type [1)]	59	Definite or inverse time Curve type: 5, 15, 17, 18, 19, 20	

[1)] For further reference please refer to the Operating characteristics table at the end of the Technical data chapter

Table 41. Three-phase undervoltage protection (27)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the voltage measured: f_n ±2Hz ±1.5% of the set value or ±0.002 x V_n		
Pickup time [1) 2)]	V_{Fault} = 0.9 x set Pickup value	Minimum	Typical	Maximum
		62 ms	66 ms	69 ms
Reset time		< 40 ms		
Reset ratio		Depends on the set Relative hysteresis		
Retardation time		< 35 ms		
Trip time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Trip time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms [3)]		
Suppression of harmonics		DFT: -50dB at f = n x f_n, where n = 2, 3, 4, 5,…		

[1)] Pickup 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 frequence injected from random phase angle, results based on statistical distribution of 1000 measurements
[2)] Includes the delay of the signal output contact
[3)] Minimum Pickup value = 0.50, Pickup value multiples in range of 0.90 to 0.20

Table 42. Three-phase undervoltage protection (27) main settings

Parameter	Function	Value (Range)	Step
Pickup value	27	0.05…1.20 x V_n	0.01
Time multiplier	27	0.05…15.00	0.01
Definite time delay	27	60…300000 ms	10
Operating curve type [1)]	27	Definite or inverse time Curve type: 5, 15, 21, 22, 23	

[1)] For further reference please refer to the Operating characteristics table at the end of the Technical data chapter

Table 43. Negative sequence overvoltage protection (47)

Characteristic		Value		
Pickup accuracy		Depending on the frequency of the voltage measured: fn ±2Hz ±1.5% of the set value or ±0.002 x Vn		
Pickup time 1) 2)		Minimum	Typical	Maximum
	VFault = 1.1 x set Pickup value	33 ms	35 ms	38 ms
	VFault = 2.0 x set Pickup value	25 ms	27 ms	30 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Retardation time		< 35 ms		
Trip time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Suppression of harmonics		DFT: -50dB at f = n x fn, where n = 2, 3, 4, 5,…		

1) Negative sequence voltage before fault 0.0 x U_n, f_n = 50 Hz, negative sequence overvoltage with nominal frequence injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact

Table 44. Negative sequence overvoltage protection (47) main settings

Parameter	Function	Value (Range)	Step
Pickup value	47	0.010...1.000 x V_n	0.001
Definite time delay	47	40...120000 ms	1

Table 45. Ground overvoltage protection (59G)

Characteristic		Value		
Pickup accuracy		Depending on the frequency of the voltage measured: f_n ±2Hz ±1.5% of the set value or ±0.002 x V_n		
Pickup time 1) 2)		Minimum	Typical	Maximum
	V_{Fault} = 1.1 x set Pickup value	55 ms	57 ms	60 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Retardation time		< 35 ms		
Trip time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Suppression of harmonics		DFT: -50dB 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 46. Ground overvoltage protection (59G) main settings

Parameter	Function	Value (Range)	Step
Pickup value	59G	0.010...1.000 x V_n	0.001
Definite time delay	59G	40...300000 ms	1

Table 47. Negative sequence overcurrent protection (46)

Characteristic		Value		
Pickup Accuracy		Depending on the frequency of the current measured: fn = ±2Hz		
		±1.5% of the set value or ±0.002 x I_n		
Pickup time 1) 2)		Minimum	Typical	Maximum
	I_{Fault} = 2 x set Pickup value	22 ms	25 ms	27 ms
	I_{Fault} = 10 x set Pickup value	14 ms	17 ms	19 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Retardation time		< 35 ms		
Trip time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Trip time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms 3)		
Suppression of harmonics		DFT: -50dB at f = n x fn, where n = 2, 3, 4, 5,…		

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 Pickup value = 2.5 x I_n, Pickup value multiples in range of 1.5 to 20

Table 48. Negative sequence overcurrent protection (46) main settings

Parameter	Function	Value (Range)	Step
Pickup value	46	0.01...5.00 x I_n	0.01
Time multiplier	46	0.05...15.00	0.01
Definite time delay	46	40...200000 ms	10
Operating curve type 1)	46	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 at the end of the Technical data chapter

Table 49 Phase discontinuity protection (46PD)

Characteristic	Value
Pickup Accuracy	Depending on the frequency of the current measured: fn ±2Hz
	±2% of the set value
Pickup time	< 70 ms
Reset time	< 40 ms
Reset ratio	Typical 0.96
Retardation time	< 35 ms
Trip time accuracy in definite time mode	±1.0% of the set value or ±20 ms
Suppression of harmonics	DFT: -50dB at f = n x fn, where n = 2, 3, 4, 5,…

Table 50. Phase discontinuity protection (46PD) main settings

Parameter	Function	Value (Range)	Step
Pickup value (Current ratio setting I_2/I_1)	46PD	10...100 %	1
Definite time delay	46PD	100...30000 ms	1
Min phase current	46PD	0.05...0.30 x In	0.01

Table 51. Circuit breaker failure protection (50BF, 50NBF, 50GBF)

Characteristic	Value
Operation accuracy	Depending on the frequency of the current measured: fn ±2Hz
	±1.5% of the set value or ±0.002 x I_n
Trip time accuracy	±1.0% of the set value or ±20 ms

Table 52. Circuit breaker failure protection (50BF, 50NBF, 50GBF) main settings

Parameter	Function	Value (Range)	Step
Current value (Operating phase current)	50BF, 50NBF, 50GBF	0.05...2.00 x I_n	0.05
Current value Res (Operating residual current)	50BF, 50NBF, 50GBF	0.05...1.00 x I_n	0.05
CB failure mode (Operating mode of function)	50BF, 50NBF, 50GBF	1=Current 2=Breaker status 3=Both	
CB fail trip mode	50BF, 50NBF, 50GBF	1=Off 2=Without check 3=Current check	
Retrip time	50BF, 50NBF, 50GBF	0...60000 ms	10
CB failure delay	50BF, 50NBF, 50GBF	0...60000 ms	10
CB fault delay	50BF, 50NBF, 50GBF	0...60000 ms	10

Table 53. Three-phase thermal overload (49F)

Characteristic	Value
Pickup Accuracy	Depending on the frequency of the current measured: fn ±2Hz
	Current measurement: ±1.5% or ±0.002 x I_n (at currents in the range of 0.01...4.00 x I_n)
Trip time accuracy	±2.0% or ±0.50 s

Table 54. Three-phase thermal overload (49F) main settings

Parameter	Function	Value (Range)	Step
Env temperature Set (Ambient temperature used when the AmbSens is set to Off)	49F	-50...100°C	1
Current multiplier (Current multiplier when function is used for parallel lines)	49F	1...5	1
Current reference	49F	0.05...4.00 x I_n	0.01
Temperature rise (End temperature rise above ambient)	49F	0.0...200.0°C	0.1
Time constant (Time constant of the line in seconds)	49F	60...60000 s	1
Maximum temperature (temperature level for trip)	49F	20.0...200.0°C	0.1
Alarm value (Temperature level for start (alarm))	49F	20.0...150.0°C	0.1
Reclose temperature (Temperature for reset of block reclose after trip)	49F	20.0...150.0°C	0.1
Initial temperature (Temperature raise above ambient temperature at startup)	49F	-50.0...100.0 °C	0.1

Table 55. Three-phase inrush current detection (INR)

Characteristic	Value
Operation accuracy	At the frequency f=f_n
	Current measurement: ±1.5% of set value or ±0.002 x In Ratio I2f/I1f measurement: ±5.0% of set value
Reset time	+35 ms / -0 ms
Reset ratio	Typical 0.96
Trip time accuracy	+20 ms / -10 ms

Table. 56. Three-phase inrush current detection (INR) main settings

Parameter	Function	Value (Range)	Step
Pickup value (Ratio of the 2nd to the 1st harmonic leading to restraint)	INR	5...100 %	1
Definite time delay	INR	20...60000 ms	1

Table 57. Arc protection (AFD)

Characteristic		Value		
Pickup Accuracy		±3% of the set value or ±0.01 x In		
Trip 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 Pickup value = 1.0 x In, current before fault = 2.0 x set Phase Pickup value, fn = 50Hz, fault with nominal frequency, results based on statistical distribution 200 measurements
[2)] Includes the delay of the heavy-duty output contact

Table 58. Arc protection (AFD) main settings

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

Table 59. Operating characteristics

Parameter	Values (Range)
Inverse-time and definite-time curve types (overcurrent protection)	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
Inverse-time and definite-time curve types (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

Table 60. Restricted earth fault, low impedance (REF)

Characteristic		Value		
Pickup accuracy		Depending on the frequency of the voltage measured: f_n ±2Hz ±2.5% of the set value or ±0.002 x I_n		
Pickup time [1) 2)]		Minimum	Typical	Maximum
	I_{Fault} = 2.0 x set Trip value	37 ms	40ms	45 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Retardation time		< 35 ms		
Trip time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Suppression of harmonics		DFT: -50dB at f = n x f_n, where n = 2, 3, 4, 5,…		

[1)] Pickup 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 frequence injected from random phase angle, results based on statistical distribution of 1000 measurements
[2)] Includes the delay of the signal output contact
[3)] Maximum Pickup value = 1.20 x U_n, Pickup value multiples in range of 1.10 to 2.00

Table 61. Restricted earth fault, low impedance (REF) main settings

Parameter	Function	Value (Range)	Step
Trip value	REF	5…50 %	1
Restraint mode	REF	None 2nd harmonic	-
Pickup value 2.H	REF	10…50 %	1
Minimum trip time	REF	40…300000 ms	1
Operation	REF	Off On	

Table 62. Single-phase undercurrent protection (37)

Characteristic	Value
Pickup Accuracy	Depending on the frequency of the current measured: f_n ±2Hz ±1.5% of the set value or ±0.002 x I_n
Pickup time	Typical < 55 ms
Reset time	< 40 ms
Reset ratio	Typical 1.04
Retardation time	< 35 ms
Trip time accuracy in definite time mode	±1.0% of the set value or ±20 ms

Table 63. Single-phase undercurrent protection (37) main settings

Parameter	Function	Value (Range)	Step
Pickup value	37	0.01...1.00 x I_n	0.01
Current block value	37	0.00...0.50 x I_n	0.01
Definite time delay	37	50...200000 ms	10
Operation	37	Off On	

Control functions

Table 64. Autoreclose (79)

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

Table 65. Autoreclose (79) main settings

Parameter	Function	Value (Range)	Step
Reset time	79	0.10...1800.000 s	0.001
Reclose attempts	79	0...5	1
Reclose time	79	0.000...300.00 s	0.001
Enable/disable protection	79	Programmable per reclose attempt	

Table 66. Overexcitation protection (24)

Characteristic	Value
Operation accuracy	Depending on the frequency of the voltage measured: fn+/- 2 Hz +=2.5% of the set value or 0.01 x Ub/f
Pickup time 1), 2)	Frequency change: Typical 200 ms (+/- 20 ms) Voltage change: Typical 100 ms (+/- 20 ms)
Reset time	< 60 ms
Reset ratio	Typical 0.96
Retardation time	< 45 ms
Trip time accuracy in definite-time mode	± 1.0% of the set value or + 20 ms
Trip time accuracy in inverse-time mode	± 5.0% of the theoretical value or + 50 ms

[1] Results based on statistical distribution of 1000 measurements
[2] Includes the delay of the signal output contact

Table 67. Overexcitation protection (24) main settings

Parameter	Function	Value (Range)	Step
Pickup value	24	100...200%	1
Curve type	24	Definite-time or Inverse-time curves	-
Time multiplier	24	0.1...100 .0	0.1
Trip delay time	24	200...200000 ms	10

Table 68. Frequency protection (81)

Characteristic		Value
Operation accuracy	81O/81U	±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)
Pickup time	81O/81U	< 80 ms
	df/dt	< 120 ms
Reset time		< 150 ms
Trip time accuracy		±1.0% of the set value or ±30 ms

Table 69. Frequency protection (81) main settings

Parameter	Function	Value (range)	Step
Operation mode	81	1=81U 2=81O 3=df/dt 4=81U + df/dt 5=81O + df/dt 6=81U or df/dt 7=81O or df/dt	
Pickup value 81O	81	0.900...1.200 x F_n	0.001
Pickup value 81U	81	0.800...1.100 x F_n	0.001
Pickup value df/dt	81	-0.200...0.200 x F_n /s	0.005
Trip time 81O/81U	81	80...200000 ms	10
Trip time df/dt	81	120...200000 ms	10

Table 70. Load shed and restoration (81LSH)

Characteristic		Value
Pickup accuracy	81U	±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	81U	< 80 ms
	df/dt	< 120 ms
Reset time		< 150 ms
Trip time accuracy		±1.0% of the set value or ±30 ms

Table 71. Load shed and restoration (81LSH) main settings

Parameter	Function	Value (Range)	Step
Load shed mode	81LSH	Freq< Freq< AND df/dt Freq< OR df/dt	-
Restore mode	81LSH	Disabled Auto Manual	-
Pickup value 81U	81LSH	0.800...1.200 x Fn	0.001
Pickup value df/dt	81LSH	-0.200...-0.005 x Fn	0.005
Trip time 81U	81LSH	80...200000 ms	10
Trip time df/dt	81LSH	120...200000 ms	10
Restore pickup value	81LSH	0.800...1.200 x Fn	0.001
Restore delay time	81LSH	80...200000 ms	10

Table 72. Synchronism check (25)

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

Table 73. Synchronism check (25) main settings

Parameter	Function	Value (Range)	Description
Live dead mode	25	-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	Energizing check mode
Difference voltage	25	0.01...0.50 xUn	Maximum voltage difference limit
Difference frequency	25	0.001...0.100 xFn	Maximum frequency difference limit
Difference angle	25	5...90 deg	Maximum angle difference limit
Synchrocheck mode	25	1=Off 2=Synchronous 3=Asynchronous	Synchrocheck operation mode
Control mode	25	1=Continuous 2=Command	Selection of the synchrocheck command or continuous control mode
Dead line value	25	0.1...0.8 xUn	Voltage low limit line for energizing check
Live line value	25	0.2...1.0 xUn	Voltage high limit line for energizing check
Close pulse	25	200...60000 ms	Breaker closing pulse duration
Max energizing V	25	0.50...1.15 xUn	Maximum voltage for energizing
Phase shift	25	-180...180 deg	Correction of phase difference between measured V_BUS and V_LINE
Minimum Syn time	25	0...60000 ms	Minimum time to accept synchronizing
Maximum Syn time	25	100...6000000 ms	Maximum time to accept synchronizing
Energizing time	25	100...60000 ms	Time delay for energizing check
Closing time of CB	25	40...250 ms	Closing time of the breaker

Measurement functions

Table 74. Three-phase current measurements (IA, IB, IC)

Characteristic	Value
Measurement accuracy	Depending on the frequency of the current measured: f_n ±2Hz at currents in the range of 0.01…40 x In
	Current: + 0.5% or + 0.002 x I_n
	Phase angle: ± 2.5°
Suppression of harmonics	DFT: -50dB at f = n x f_n, where n = 2, 3, 4, 5,…
	RMS: No suppression

Table 75. Current sequence components (I1, I2, I0)

Characteristic	Value
Measurement accuracy	Depending on the frequency of the current measured: f/f_n = ±2Hz
	±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: -50dB at f = n x f_n, where n = 2, 3, 4, 5,…

Table 76. Three-phase voltage measurements (VA, VB, VC)

Characteristic	Value
Measurement accuracy	Depending on the frequency of the voltage measured: f_n ±2Hz
	(at voltages in range 0.01…1.15 x V_n)
	Voltage: ± 0.5% or + 0.002 x V_n
	Phase angle: ± 2.5°
Suppression of harmonics	DFT: -50dB at f = n x f_n, where n = 2, 3, 4, 5,…
	RMS: No suppression

Table 77. Voltage sequence components (V1, V2, V0)

Characteristic	Value
Measurement accuracy	Depending on the frequency of the voltage measured: f_n ±2Hz at voltages in the range of 0.01…1.15 x V_n
	±1.0% or ±0.002 x U_n
Suppression of harmonics	DFT: -50dB at f = n x f_n, where n = 2, 3, 4, 5,…

Table 78. Ground current measurement (IG)

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

Table 79. Ground voltage measurement (VG)

Characteristic	Value
Measurement accuracy	Depending on the frequency of the current measured: f/f_n = ±2Hz
	±0.5% or ±0.002 x V_n
Suppression of harmonics	DFT: -50dB at f = n x f_n, where n = 2, 3, 4, 5,…
	RMS: No suppression

Table 80. Three-phase and single-phase power and energy (P, SP, E, SE)

Characteristic	Value
Measurement 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 V_n At the frequency f_n ±1Hz 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: -50dB at f = n x f_n, where n = 2, 3, 4, 5,…

Table 81. Frequency measurement (f)

Description		Value
RTD inputs	Operation accuracy	±10 mHz (in measurement range 35 - 75 Hz)

Table 82. Power quality sag (dip), swell, interruption measurements (PQSS)

Characteristic	Value
Pickup accuracy	±1.5% of the set value or ±0.2% of the reference voltage
Reset ratio	Typical 0.96 (Swell), 1.04 (Sag (dip), Interruption)

Supervision functions

Table 83. Current circuit supervision (CCM)

Characteristic	Value
Trip time [1]	< 30 ms

Table 84. Current circuit supervision (CCM) main settings

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

Table 85. Fuse failure supervision (60)

Characteristic	Value	
Trip 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

24. Display

The relay's local HMI includes a large LCD screen standard. The large LCD display offers full front-panel user-interface functionality with menu navigation and menu views.

The large display offers increased front-panel usability with less menu scrolling and improved information overview than with smaller LCD screens. The large display is well-suited for all relay installations providing an easy viewing interface.

Table 86. Large display

Character size	Rows in the view	Characters per row
Large, variable width (13x14pixels)	10	20 or more

Language options are English, English and Spanish or English and Portugese.

25. Local HMI

The REF615R local HMI includes a large LCD screen, 11 programmable LEDs and 16 programmable control pushbuttons standard. The large display offers increased front-panel usability with less menu scrolling and improved information overview than with smaller LCD screens. In addition, the large display includes a user configurable single line diagram (SLD) with position indication for the associated primary equipment. The standard configuration of the IED displays, apart from the primary equipment position, the related measuring values. Thus all necessary measurement can be viewed without scrolling through the IED menu. The SLD view can also be accessed using the web-browser based user interface. The default SLD can be modified according to user requirements 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 local mode the IED can only be operated using the local front panel user interface. When the IED is in 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 local mode during maintenance work and that the recloser/circuit breakers cannot be operated remotely from the network control centre.

The large display is well-suited for all IED's installations providing an easy viewing interface.

The IED provides sixteen user configurable push buttons that are used for easy and quick operations, thus eliminating need for traditional external control switches. These pushbuttons are accessible in the IED for making any user defined logic. For each push button different operation modes such as pulsed, toggled are available. Each push button includes imbedded LED and configuration labels template is provided.

By eleven user configurable LEDs, traditional annunciation panel can be replaced. The indication color, red or green, for each LED can be selected individually with the PCM 600. Each indication LED on the IED can be set individually to operate in four different sequences (based on application): two as follow type and two as latch type. The light from the LEDs can be steady or flickering. LED label template is provided to suit your protection and control scheme.

Fig. 8: Large display standard

26. Mounting methods

The REF615R can be rack mounted, semi-flush mounted and panel mounted. A mounting kit must be ordered for rack mounting and can be provided with or without a cover.

Mounting methods:

- Flush mounting
- Semi-flush mounting
- Rack mounting
- Panel mounting with or without bezel/cover kit

Rack mounting:

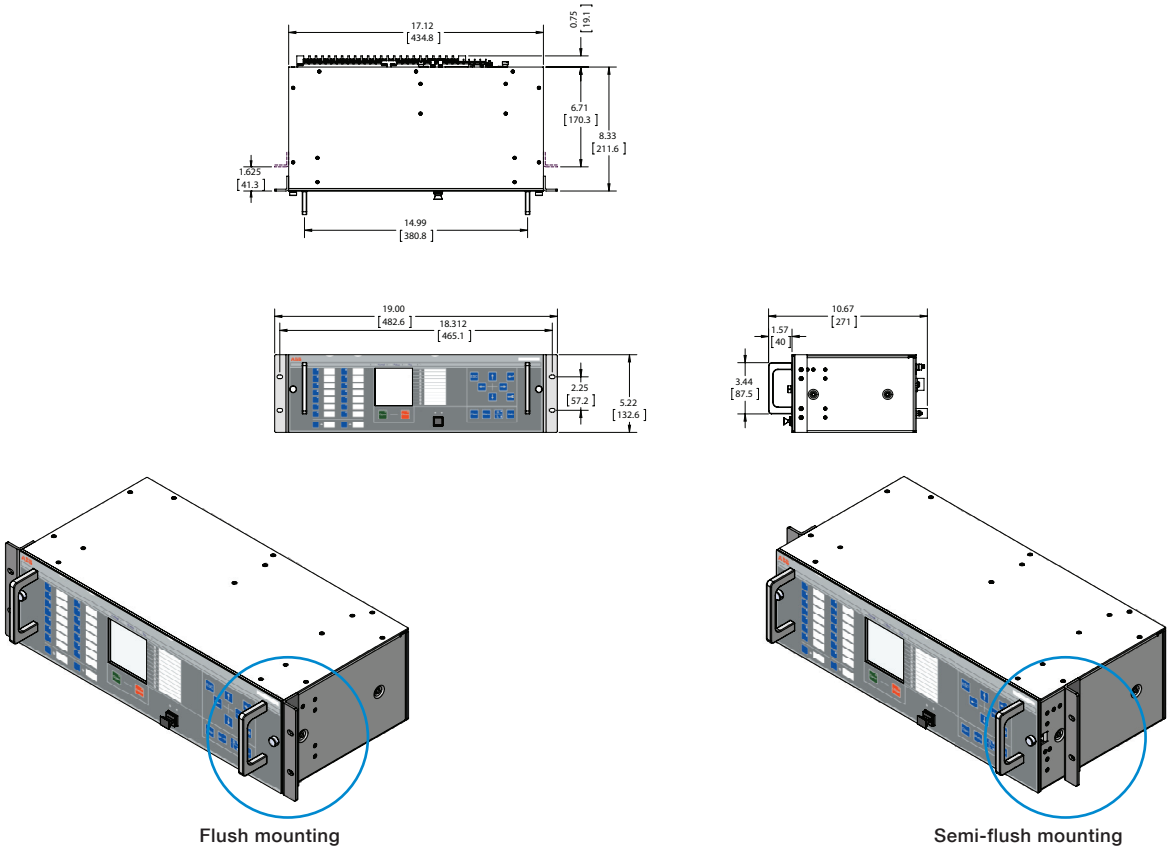
The REF615R is design to be installed on standard EIA 19" rack. Can be mounted flush or semi-flush.

Dimensions: WxDxH 19 x 9.08 x 5.22" (Depth is front to back including terminals).

Table 87. Dimensions

Description	Value
Cutout	With bezel: width 17.5" (444.50 mm)
	With bezel: height 5.63" (143.00 mm)
Width	With mounting ears: 19" (482.6 mm)
	Without mounting ears: 17.12" (434.8 mm)
Height	5.22" (132.6 mm)
Depth	9.08" (230.7 mm)
Weight	Completed IED: 11.9 lb (5.4 kg)
	Plug-in unit only: 5.1 lb (2.31 kg)
Shipping weight	16.4 lb (7.44 kg)

Figure 9. Rack mounting



Flush mounting

Semi-flush mounting

27. Relay case and drawout unit

The relay type and serial number label identifies the protection relay. The label is placed above the HMI on the upper part of the draw-out unit. An order number label is placed on the side of the draw-out unit as well as inside the case.

The order number consists of a string of alphanumeric characters generated from the hardware and software modules of the relay.

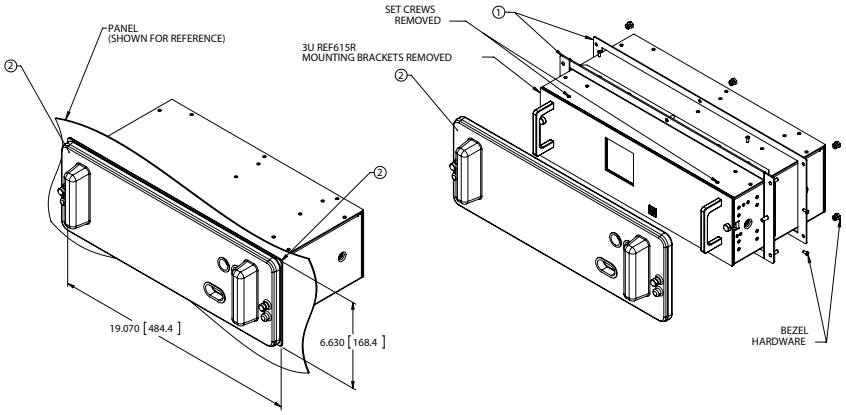
Use the ordering key information in Fig. 10 to generate the order number when ordering complete protection relays.

Figure 10. Panel mounting

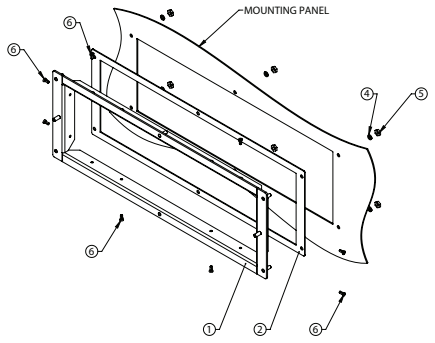
Panel Mounting Bezel Kit (2RGA019342) is required;
Note: Mounting brackets must be removed when using panel mounting kit
Dimensions:
Bezel Frame: WxH 19.07 x 6.63”
Relay case: WxDxH 17.12 x 9.08 x 5.22”

Pos.	Title	Qty.
1	PANEL MOUNTING BEZEL	1
2	DUST COVER ASSEMBLY	1

Pos.	Title	Qty.
1	PANEL MOUNT BEZEL	1
2	BEZEL GASKET ABB #613641	1
4	#10, LOCK WASHER, MEDIUM SPLIT, SSTL, ANSI B18.21.1	6
5	10-32 HEX NUT, UNC, SSTL, ANSI B18.6.3	6
6	6-32 X 3/8 Flat Hd Phillips Mach Screw, 82°, 18-8 SS, B18.6.3	8

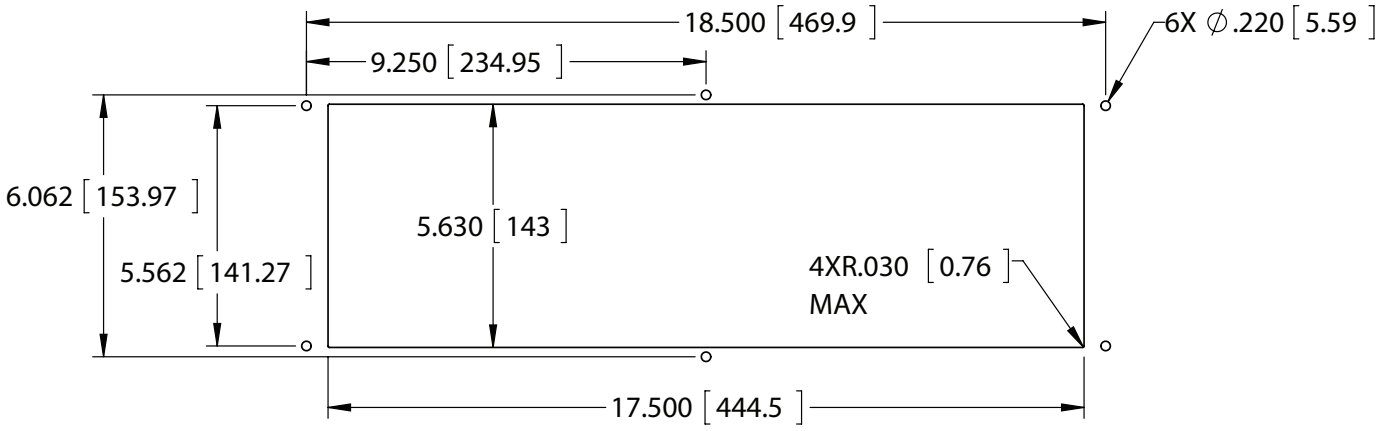


Panel mounting bezel kit with cover



Panel mounting bezel kit without cover

Figure 11. Bezel cutout for panel mounting



NOTE:
DIMENSIONS ARE IN [MM]

28. Accessories and ordering data

REF615R order codes

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Ex: HWFAAAAANBE1BAN1XE	H	W	F	A	A	A	A	A	N	B	E	1	B	B	A	1	X	E
Digit	**Description**																		
1) Product Series	H: 3U 19" rack-mount 615 series (Inner chassis and case)	H																	
	J: 3U 19" rack-mount 615 series plug-in unit (no case)	J																	
	R: 3U 19" rack-mount 615 series case (no inner chassis)	R																	
2) Standard	W: ANSI 3U 19" rack		W																
3) Main Appl	F: Feeder protection and control			F															
4) Functional application	A: Directional phase, neutral and ground or SEF overcurrent, voltage and frequency protection, synch check, optional HIZ and power system metering for one breaker				A														
5-6) Analog Inputs	A: 3 CT + Ground CT + 5 VT + Reclosing (Applicable for DPU2000R models with Catalog # 587R..., 587C..., 687R... and 687C...)					A	A												
	A: 3 CT + SEF/HIZ CT + 5 VT + Reclosing (Applicable for DPU2000R models with Catalog # 587E... and 687E...)					A	B												
7-8) Binary I/O[1)]	A: 11 BI + 7 BO (Plus additional BO for self-check alarm.)							A	A										
	A: 11 BI + 4 BO + 3 HSO (Plus additional BO for self-check alarm.)							A	1										
9-10) Communication Ports[2)]	One port: Ethernet 100FX (LC)									N	A								
	One port: Ethernet 10/100BaseT (RJ45)									N	B								
	Two/three ports: [Ethernet 100 FX (LC) + RS485 (1x4-wire or 2x2-wire)] + IRIG-B									A	A								
	Two/three ports: [Ethernet 10/100BaseT (RJ45) + RS485 (1x4-wire or 2x2-wire)] + IRIG-B									A	B								
	Four ports: [Ethernet 2 * 100FX (LC) + 10/100BaseT (RJ45) + serial glass fiber (ST)]									A	H								
	Four ports: [Ethernet 100FX (LC) + 2 * Ethernet 10/100BaseT (RJ45) + serial glass fiber (ST)]									A	K								
	Four ports: [Ethernet 3 * 10/100BaseT (RJ45) + serial glass fiber (ST)]									A	L								
	Three ports: Ethernet 10/100BaseT (RJ45) + configurable RS232/RS485 + [RS485 or serial glass fiber (ST)] + IRIG-B									3	3								
	One port: Ethernet 100FX (LC) + Arc Flash Detection									N	F								
	One port: Ethernet 10/100BaseT (RJ45) + Arc Flash Detection									N	G								
	Two/three ports: [Ethernet 100 FX (LC) + RS485 (1x4-wire or 2x2-wire)] + IRG-B + Arc Flash Detection									F	F								
	Two/three ports: [Ethernet 10/100BaseT (RJ45) + RS485 (1x4-wire or 2x2-wire)] + IRIG-B + Arc Flash Detection									F	G								
	Four ports: [Ethernet 2 * 100FX (LC) + 10/100BaseT (RJ45) + serial glass fiber (ST)] + Arc Flash Detection									F	H								
	Four ports: [Ethernet 100FX (LC) + 2 * Ethernet 10/100BaseT (RJ45) + serial glass fiber (ST)] + Arc Flash Detection									F	K								
	Four ports: [Ethernet 3 * 10/100BaseT (RJ45) + serial glass fiber (ST)] + Arc Flash Detection									F	L								
11) Protocols	IEC61850 + DNP3.0 L2 + Modbus											E							
12) Language	English												1						
	English + Spanish												5						
	English + Portuguese												8						
13) Front Panel	Large LCD, Horizontal ANSI standard (Applicable for ANSI DPU2000R models with the standard OCI option)													A					
	Large LCD, Horizontal ANSI advanced (Applicable for ANSI DPU2000R models with the Enhanced OCI option)													B					
	Large LCD, Horizontal IEC standard (Applicable for IEC DPU2000R models with the standard OCI option)													C					
	Large LCD, Horizontal IEC advanced (Applicable for IEC DPU2000R models with the Enhanced OCI option)													D					
14) Option 1	Power quality														B				
	None														N				

REF615R order codes (continued)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Ex: HWFAAAAANBE1BAN1XE	H	W	F	A	A	A	A	A	N	B	E	1	B	B	A	1	X	E
Digit	**Description**																		
15) Option 2	Cable Fault Detection															A			
	None															N			
16) Power Supply	48-250 Vdc; 48-240 Vac																1		
	24-60 Vdc																2		
17) SW Version	SW Version 4.0																	X	
18) HW Version	HW																		E

Notes:
1) There is a separate Form C self-check alarm contact available standard that is excluded from the BO count.
2) SNTP is available for time-sync with all Ethernet options. IRIG-B is available for time-sync with all RS-485 options. Both SNTP and IRIG-B are available for time-sync when both Ethernet and RS-485 options are available.

Table 88 Accessories and ordering data.

Item	Order Number
Tools	
PCM600 V2.5 user tool	PCM600-25
Cables	
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
Mounting accessories	
Bezel/cover kit for panel mounting	2RGA018542A0001
Bezel kit w/o cover for panel mounting	2RGA019342A0002
Spare parts	
RJ45 plug	2RGA019358P0001
Test switches	
FT-1, FT-14, and FT-19 Flexitest switches	See Descriptive bulletins DB 41-077 and DB 41-078 on www.abb.com/substationautomation

29. Tools

The relay 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 (WHMI) or the PCM600 tool in combination with the relay specific connectivity package (CP).

PCM600 offers extensive relay configuration functions such as application configuration, signal matrix, communication management, graphical display editor, and IEC 61850 communication configuration including horizontal relay-to-relay communication, GOOSE.

When the web-browser based user interface is used, the relay can be accessed either locally or remotely using a web browser (IE 6.0 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.

Table 89. Tools

Configuration, setting and SA system tools	Version
PCM600	2.5 or later
Web-browser based user interface	IE7 and IE8 and IE9
REF615R Connectivity Package	4.0 ANSI or later
COM600 substation product	4.0 or later
MicroSCADA Pro Substation Automation system	9.3 or later

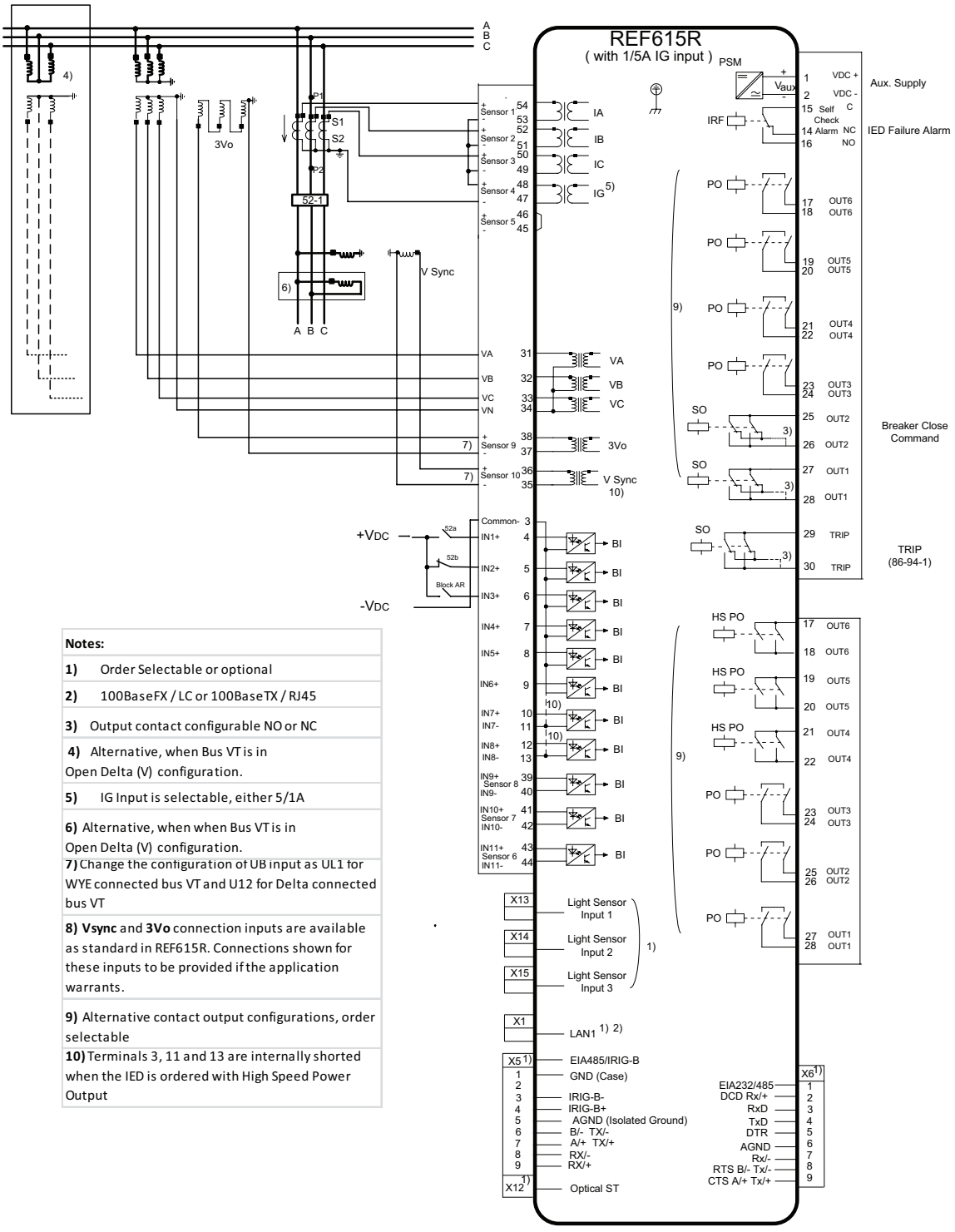
Table 90. Supported functions

Function	WebHMI	PCM600
Relay matrix and graphical programmable logic tools	-	•
IEC 61850 communication configuration, GOOSE (communication configuration tool)	-	•
Modbus® communication configuration (communication management tool)	-	•[1)]
DNP3.0 Level 2+ communication configuration (communication management tool)	-	•
Relay parameter setting	•	•
Saving of relay parameter settings in the relay	•	•
Saving of relay parameter settings in the tool	-	•
Signal monitoring	•	•
Digital fault recorder (DFR) handling	•	•
Digital fault record analysis	-	•
Event viewing	•	•
Saving of event data on the user's PC	•	-
Alarm LED viewing	•	•
Phasor diagram viewing	•	-
Access control management	•	•
LCD graphical display configuration	-	•
LCD graphical display viewing	•	-
Online monitoring	-	•
IED compare	-	•

• = Supported

1) Analog and digital values pre-mapped to registers for easy individual or grouped register retrieval by Modbus driver

Figure 12. REF615R typical connections for standard Ground CT option



Notes:
1) Order Selectable or optional
2) 100BaseFX / LC or 100BaseTX / RJ45
3) Output contact configurable NO or NC
4) Alternative, when Bus VT is in Open Delta (V) configuration.
5) IG Input is selectable, either 5/1A
6) Alternative, when when Bus VT is in Open Delta (V) configuration.
7) Change the configuration of UB input as UL1 for WYE connected bus VT and U12 for Delta connected bus VT
8) Vsync and **3Vo** connection inputs are available as standard in REF615R. Connections shown for these inputs to be provided if the application warrants.
9) Alternative contact output configurations, order selectable
10) Terminals 3, 11 and 13 are internally shorted when the IED is ordered with High Speed Power Output

Figure 13. REF615R typical connections for distribution bus application

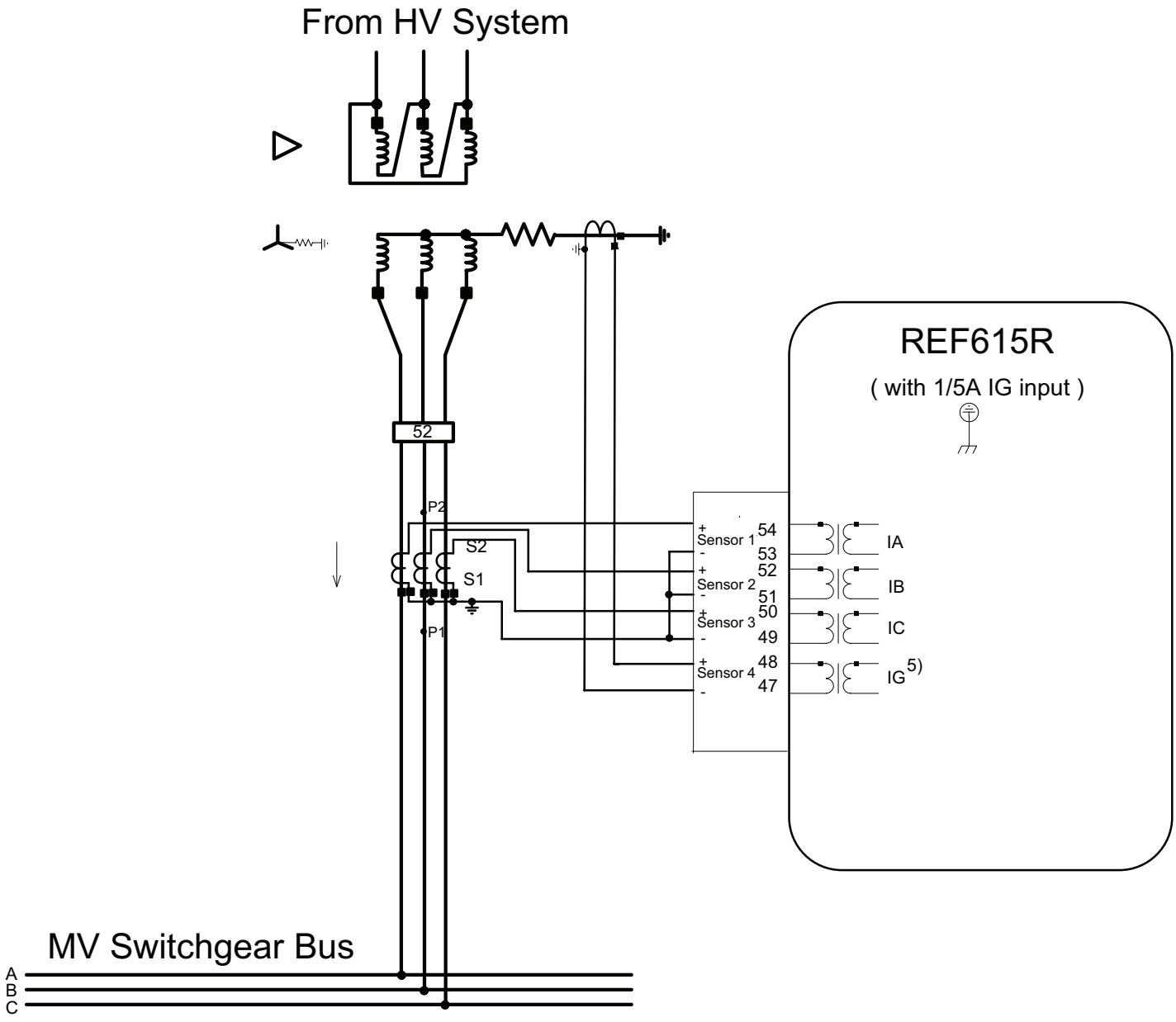
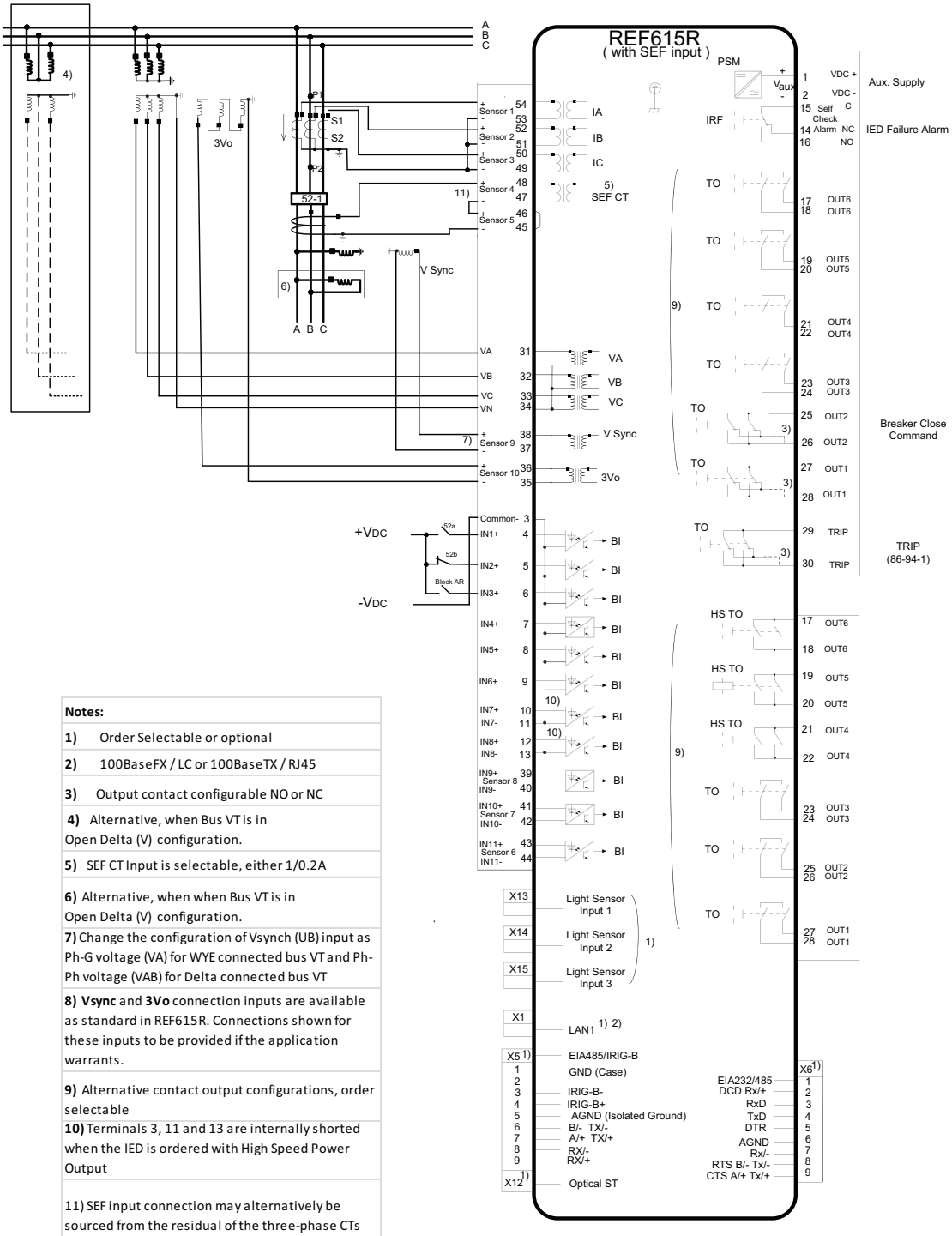
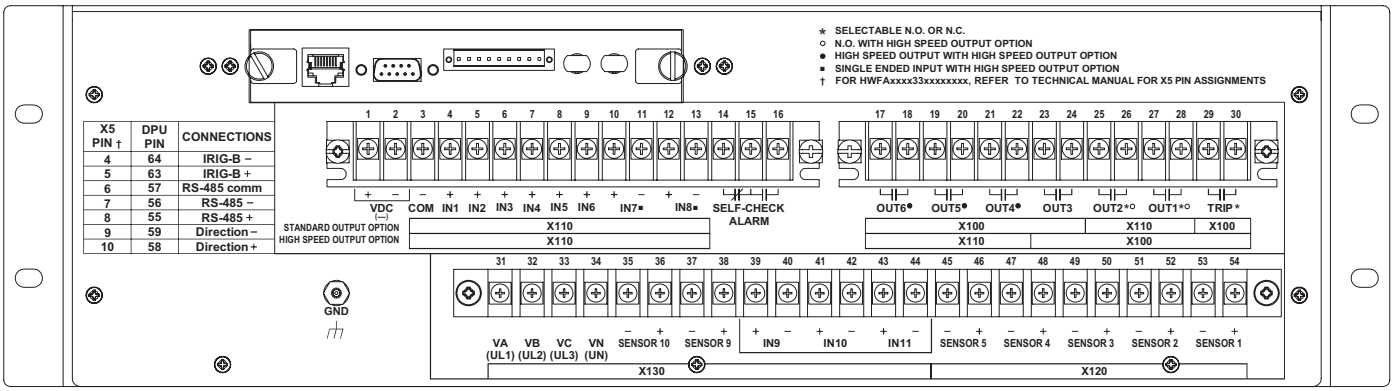


Figure 14. REF615R typical connections for SEF/HIZ CT option



Notes:
1) Order Selectable or optional
2) 100BaseFX / LC or 100BaseTX / RJ45
3) Output contact configurable NO or NC
4) Alternative, when Bus VT is in Open Delta (V) configuration.
5) SEF CT Input is selectable, either 1/0.2A
6) Alternative, when when Bus VT is in Open Delta (V) configuration.
7) Change the configuration of Vsynch (UB) input as Ph-G voltage (VA) for WYE connected bus VT and Ph-Ph voltage (VAB) for Delta connected bus VT
8) Vsync and **3Vo** connection inputs are available as standard in REF615R. Connections shown for these inputs to be provided if the application warrants.
9) Alternative contact output configurations, order selectable
10) Terminals 3, 11 and 13 are internally shorted when the IED is ordered with High Speed Power Output
11) SEF input connection may alternatively be sourced from the residual of the three-phase CTs

Figure 15. Rear terminal connection



31. Certificates

KEMA has issued an IEC 61850 Certificate Level A1 for REF615R. Certificate number: 30710144-Consulting 08-0115

The REF615R is a UL Listed product, UL File/Sec. E103204/2/2.

32. References

The www.abb.com/substationautomation portal offers you information about the distribution automation product and service range. From this website you will be able to download technical manuals, installation and operators manuals in addition to product brochures, product guides, and other relevant documentation.

The Relion website www.abb.com/relion offers a direct link to the Relion portfolio where all documentation can be downloaded.

You will find the latest relevant information on the REF615R protection relay on the product page of either websites noted above.

Table 91. REF615R Functions, codes and symbols

Function	IEC 61850	IEC 60617	ANSI C37.2
Protection			
Three-phase non-directional overcurrent protection, low stage, instance 1	PHLPTOC1	3I> (1)	51P-1
Three-phase non-directional overcurrent protection, high stage, instance 1	PHHPTOC1	3I>> (1)	50P-1
Three-phase non-directional overcurrent protection, high stage, instance 2	PHHPTOC2	3I>> (2)	50P-2
Three-phase non-directional overcurrent protection, instantaneous stage, instance 1	PHIPTOC1	3I>>> (1)	50P-3
Three-phase non-directional long time overcurrent protection, low stage, instance 1	PHLTPTOC1	3I> (3)	51LT
Three-phase directional overcurrent protection, low stage, instance 1	DPHLPDOC1	3I> -> (1)	67/51P
Three-phase directional overcurrent protection, high stage, instance 1	DPHHPDOC1	3I>> -> (1)	67/50P-1
Three-phase directional overcurrent protection, high stage, instance 2	DPHHPDOC2	3I>> -> (2)	67/50P-2
Non-directional earth-fault protection, low stage, instance 1	EFLPTOC1	Io> (1)	51G
Non-directional earth-fault protection, low stage, instance 2	EFLPTOC2	Io> (2)	51N-1
Non-directional earth-fault protection, low stage, instance 4	EFLPTOC4	Io> (4)	50SEF
Non-directional earth-fault protection, high stage, instance 1	EFHPTOC1	Io>> (1)	50G-1
Non-directional earth-fault protection, high stage, instance 2	EFHPTOC2	Io>> (2)	50G-2
Non-directional earth-fault protection, high stage, instance 3	EFHPTOC3	Io>> (3)	50N-1
Non-directional earth-fault protection, high stage, instance 4	EFHPTOC4	Io>> (4)	50N-2
Non-directional earth-fault protection, instantaneous stage, instance 1	EFIPTOC1	Io>>> (1)	50G-3
Non-directional earth-fault protection, instantaneous stage, instance 2	EFIPTOC2	Io>>> (2)	50N-3
Directional earth-fault protection, low stage, instance 1	DEFLPDEF1	Io> -> (1)	67/51N
Directional earth-fault protection, high stage, instance 1	DEFHPDEF1	Io>> -> (1)	67/50N-1
Directional earth-fault protection, high stage, instance 2	DEFHPDEF2	Io>> -> (2)	67/50N-2
Three phase directional power protection, instance 1	DPSRDIR1	I1-> (1)	32P-1
Ground directional power protection, instance 1	DNZSRDIR1	I2 ->, Io-> (1)	32N-1
Negative-sequence overcurrent protection, instance 1	NSPTOC1	I2> (1)	46-1
Negative-sequence overcurrent protection, instance 2	NSPTOC2	I2> (2)	46-2
Phase discontinuity protection	PDNSPTOC1	I2/I1>	46PD
Residual overvoltage protection, instance 1	ROVPTOV1	Uo> (1)	59G
Residual overvoltage protection, instance 2	ROVPTOV2	Uo> (2)	59N-1
Three-phase undervoltage protection, instance 1	PHPTUV1	3U< (1)	27-1
Three-phase undervoltage protection, instance 2	PHPTUV2	3U< (2)	27-2
Three-phase overvoltage protection, instance 1	PHPTOV1	3U> (1)	59-1
Three-phase overvoltage protection, instance 2	PHPTOV2	3U> (2)	59-2
Negative-sequence overvoltage protection, instance 1	NSPTOV1	U2> (1)	47-1
Negative-sequence overvoltage protection, instance 2	NSPTOV2	U2> (2)	47-2
Frequency protection, instance 1	FRPFRQ1	f>/f<,df/dt (1)	81-1
Frequency protection, instance 2	FRPFRQ2	f>/f<,df/dt (2)	81-2
Voltage per hertz protection, instance 1	OEPVPH1	U/f> (1)	24
Three-phase thermal protection for feeders, cables and distribution transformers, Instance 1	T1PTTR1	3Ith>F (1)	49F-1
Numerical stabilized low impedance restricted earth-fault protection	LREFPNDF1	dIoLo>	87LOZREF
Circuit breaker failure protection, instance 1	CCBRBRF1	3I>/Io>BF (1)	50BF-1
Three-phase inrush detector, instance 1	INRPHAR1	3I2f> (1)	INR-1
Master trip, instance 1	TRPPTRC1	Master Trip (1)	86/94-1
Master trip, instance 2	TRPPTRC2	Master Trip (2)	86/94-2
Arc protection, instance 1	ARCSARC1	ARC (1)	AFD-1
Arc protection, instance 2	ARCSARC2	ARC (2)	AFD-2
Arc protection, instance 3	ARCSARC3	ARC (3)	AFD-3
High impedance fault detection	PHIZ1	PHIZ1	HIZ
Load shedding and restoration, instance 1	LSHDPFRQ1	UFLS/R (1)	81LSH-1
Load shedding and restoration, instance 2	LSHDPFRQ2	UFLS/R (2)	81LSH-2
Loss of phase, instance 1	PHPTUC1	3I< (1)	37-1
Control			
Circuit-breaker control, instance 1	CBXCBR1	I <-> O CB (1)	52-1
Auto-reclosing	DARREC1	O -> I	79
Synchronism and energizing check	SECRSYN1	SYNC	25

Table 91. REF615R Functions, codes and symbols (continued)

Function	IEC 61850	IEC 60617	ANSI C37.2
Condition Monitoring			
Circuit-breaker condition monitoring, instance 1	SSCBR1	CBCM (1)	52CM-1
Current circuit supervision	CCRDIF1	MCS 3I	CCM
Fuse failure supervision, intance 1	SEQRFUF1	FUSEF (1)	60-1
Cable fault detection	RCFD1	RCFD	CFD
Measurement			
Three-phase current measurement, instance 1	CMMXU1	3I	IA, IB, IC
Sequence current measurement, instance 1	CSMSQI1	I1, I2, I0	I1, I2, I0
Residual current measurement, instance 1	RESCMMXU1	Io	IG
Three-phase voltage measurement, instance 1	VMMXU1	3U	VA, VB, VC
Residual voltage measurement, instance 1	RESVMMXU1	Uo	VG
Sequence voltage measurement, instance 1	VSMSQI1	U1, U2, U0	V1, V2, V0
Single-phase power and energy measurement, instance 1	SPEMMXU1	SP, SE	SP, SE-1
Three-phase power and energy measurement, instance 1	PEMMXU1	P, E	P, E-1
Current total demand distortion, instance 1	CMHAI1	PQM3I	PQI-1
Voltage total harmonic distortion, instance 1	VMHAI1	PQM3U	PQVPH-1
Voltage variation, instance 1	PHQVVR1	PQ 3U<>	PQSS-1
Voltage unbalance, instance 1	VSQVUB1	PQMUBU(1)	PQVUB-1
Load profile	LDPMSTA1	-	LoadProf
Frequency measurement, instance 1	FMMXU1	f	f
Other			
Minimum pulse timer (2 pcs), instance 1	TPGAPC1	TP (1)	TP (1)
Minimum pulse timer (2 pcs), instance 2	TPGAPC2	TP (2)	TP (2)
Minimum pulse timer (2 pcs), instance 3	TPGAPC3	TP (3)	TP (3)
Minimum pulse timer (2 pcs), instance 4	TPGAPC4	TP (4)	TP (4)
Minimum pulse timer (2 pcs, second resolution), instance 1	TPSGAPC1	TPS (1)	62CLD-1
Minimum pulse timer (2 pcs, minute resolution), instance 1	TPMGAPC1	TPM (1)	62CLD-2
Pulse timer (8 pcs), instance 1	PTGAPC1	PT (1)	PT-1
Pulse timer (8 pcs), instance 2	PTGAPC2	PT (2)	PT-2
Time delay off (8 pcs), instance 1	TOFGAPC1	TOF (1)	TOF-1
Time delay off (8 pcs), instance 2	TOFGAPC2	TOF (2)	TOF-2
Time delay on (8 pcs), instance 1	TONGAPC1	TON (1)	TON -1
Time delay on (8 pcs), instance 2	TONGAPC2	TON (2)	TON -2
Set reset (8 pcs), instance 1	SRGAPC1	SR (1)	SR-1
Set reset (8 pcs), instance 2	SRGAPC2	SR (2)	SR-2
Set reset (8 pcs), instance 3	SRGAPC3	SR (3)	SR-3
Set reset (8 pcs), instance 4	SRGAPC4	SR (4)	SR-4
Move (8 pcs), instance 1	MVGAPC1	MV (1)	MV-1
Move (8 pcs), instance 2	MVGAPC2	MV (2)	MV-2
Move (8 pcs), instance 3	MVGAPC3	MV (3)	MV-3
Move (8 pcs), instance 4	MVGAPC4	MV (4)	MV-4
Move (8 pcs), instance 5	MVGAPC5	MV (5)	MV-5
Move (8 pcs), instance 6	MVGAPC6	MV (6)	MV-6
Move (8 pcs), instance 7	MVGAPC7	MV (7)	MV-7
Move (8 pcs), instance 8	MVGAPC8	MV (8)	MV-8
Generic control points, instance 1	SPCGGIO1	SPC(1)	CNTRL-1
Generic control points, instance 2	SPCGGIO2	SPC(2)	CNTRL-2
Generic control points, instance 3	SPCGGIO3	SPC(3)	CNTRL-3
Remote Generic control points, instance 1	SPCRGGIO1	SRCR(1)	RCNTRL-1
Local Generic control points, instance 1	SPCLGGIO1	SPCL(1)	LCNTRL-1
Programmable buttons (16 buttons), instance 1	FKEYGGIO1	FKEY	FKEY
Generic Up-Down Counters, instance 1	UDFCNT1	CTR(1)	CTR-1
Generic Up-Down Counters, instance 2	UDFCNT2	CTR(2)	CTR-2
Generic Up-Down Counters, instance 3	UDFCNT3	CTR(3)	CTR-3

Table 91. REF615R Functions, codes and symbols (continued)

Function	IEC 61850	IEC 60617	ANSI C37.2
Other			
Shift register, instance 1	SHFTGAPC1	SHFT(1)	SHFT-1
Shift register, instance 2	SHFTGAPC1	SHFT(2)	SHFT-2
Shift register, instance 2	SHFTGAPC1	SHFT(3)	SHFT-3
Logging functions			
Disturbance recorder	RDRE1	-	DFR
Fault recorder	FLMSTA1	-	FR
Sequence event recorder	SER	-	SER
Fault location	DRFLO1	FLO	FLO
Protocols			
IEC 61850			x
MODBUS			x
DNP 3.0 Level 2			x

33. Document revision history

Table 92. Document revision history

A / October 1, 2013	V4.0	Initial product version release

34. Notes

Contact us

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www.abb.com/relion

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