Relion® 615 series

Line Differential Protection and Control RED615
Product Guide

Power and productivity
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Contents

1. Description

RED615 is a phase-segregated two-end line differential protection and control IED (intelligent electronic device) designed for utility and industrial power systems, including looped and meshed distribution networks with or without decentralized power generation. RED615 is a member of ABB's Relion® family and its 615 protection and control product series. Re-engineered from the ground up, the 615 series has been guided by the IEC 61850 standard for communication and interoperability of substation automation equipment.

The IED provides unit type main protection for overhead lines and cable feeders in distribution networks. The IED also features current-based protection functions for remote back-up for down-stream protection IEDs and local back-up for the line differential main protection. Further, standard configurations B and C also include earth-fault protection.

The IED is adapted for the protection of overhead line and cable feeders in isolated neutral, resistance earthed, compensated (impedance earthed) and solidly earthed networks. Once the IED has been given the application-specific settings, it can directly be put into service.

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

2. Standard configurations

The line differential protection and control IED RED615 is available with three alternative standard configurations.

Table 1. Standard configurations

Description	Std. conf.
Line differential protection	A
Line differential protection with directional earth-fault protection	B
Line differential protection with non-directional earth-fault protection	C

Table 2. Supported functions

Functionality	A	B	C
Protection[1)]			
Line differential protection and related measurements, stabilized and instantaneous stages	●	●	●
Three-phase non-directional overcurrent, low stage, instance 1	●	●	●
Three-phase non-directional overcurrent, high stage, instance 1	●	●	●
Three-phase non-directional overcurrent, high stage, instance 2	●	●	●
Three-phase non-directional overcurrent, instantaneous stage, instance 1	●	●	●
Non-directional earth-fault protection, low stage (SEF), instance 1	-	-	●
Non-directional earth-fault protection, low stage, instance 2	-	-	●
Non-directional earth-fault protection, high stage, instance 1	-	-	●
Non-directional earth-fault protection, instantaneous stage, instance 1	-	-	●
Directional earth-fault protection, low stage (SEF), instance 1	-	●	-
Directional earth-fault protection, low stage, instance 2	-	●	-
Directional earth-fault protection, high stage, instance 1	-	●	-
Transient / intermittent earth-fault protection	-	●	-
Non-directional (cross-country) earth-fault protection, using calculated I_0	-	●	-
Negative sequence overcurrent protection, instance 1	●	●	●
Negative sequence overcurrent protection, instance 2	●	●	●
Phase discontinuity protection	-	●	●
Three-phase thermal protection for feeders, cables and distribution transformers	-	●	●
Binary signal transfer	●	●	●
Circuit-breaker failure protection	●	●	●
Three-phase inrush current detector	●	●	●
Master trip, instance 1	●	●	●
Master trip, instance 2	●	●	●
Control			
Circuit-breaker control with interlocking	●	●	●

Table 2. Supported functions, continued

Functionality	A	B	C
Disconnector position indication, instance 1	●	●	●
Disconnector position indication, instance 2	●	●	●
Disconnector position indication, instance 3	●	●	●
Earthing switch indication	●	●	●
Auto-reclosing	-	o	o
Condition monitoring			
Circuit-breaker condition monitoring	-	●	●
Trip circuit supervision, instance 1	●	●	●
Trip circuit supervision, instance 2	●	●	●
Current circuit supervision	●	●	●
Protection communication supervision	●	●	●
Measurement			
Disturbance recorder	●	●	●
Three-phase current measurement	●	●	●
Sequence current measurement	●	●	●
Residual current measurement	-	●	●
Residual voltage measurement	-	●	-

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

1) Note that all directional protection functions can also be used in non-directional mode.

3. Protection functions

The IED offers two-stage phase-segregated line differential protection, phase overcurrent protection, negative phase-sequence overcurrent protection and circuit-breaker failure protection. Depending on the standard configuration chosen, the basic functionality can be extended by thermal overload protection, directional or non-directional earth-fault protection, sensitive earth-fault protection, phase discontinuity protection, transient/intermittent earth-fault protection and three-pole multi-shot auto-reclose functions for overhead line feeders.

The line differential protection function includes a stabilized low stage and an instantaneous high stage. The stabilized low stage provides sensitive differential protection and remains stable during, for example, current transformer saturation conditions. The low-stage operation can be restrained using second harmonic detection if an out-of-zone power transformer is to be energized. The instantaneous high stage offers less sensitive differential protection but enables fast operation during high fault currents.

The operating time characteristic for the low stage can be set to definite time or inverse definite time mode. The direct inter-trip function ensures that both ends are always simultaneously tripped, independent of the fault current contribution.

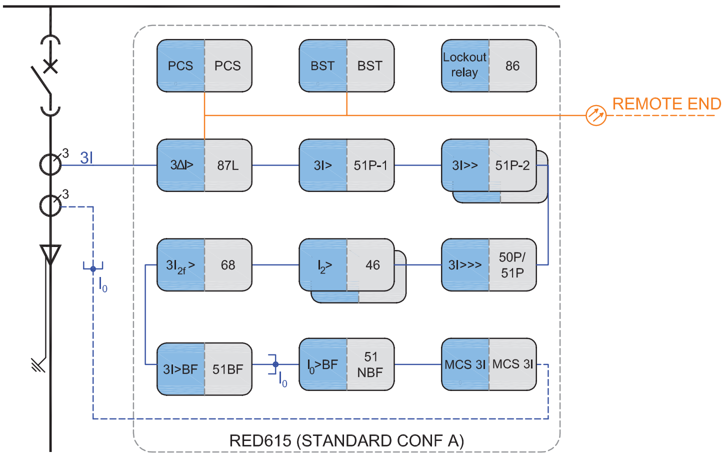


Figure 1. Protection function overview of standard configuration A

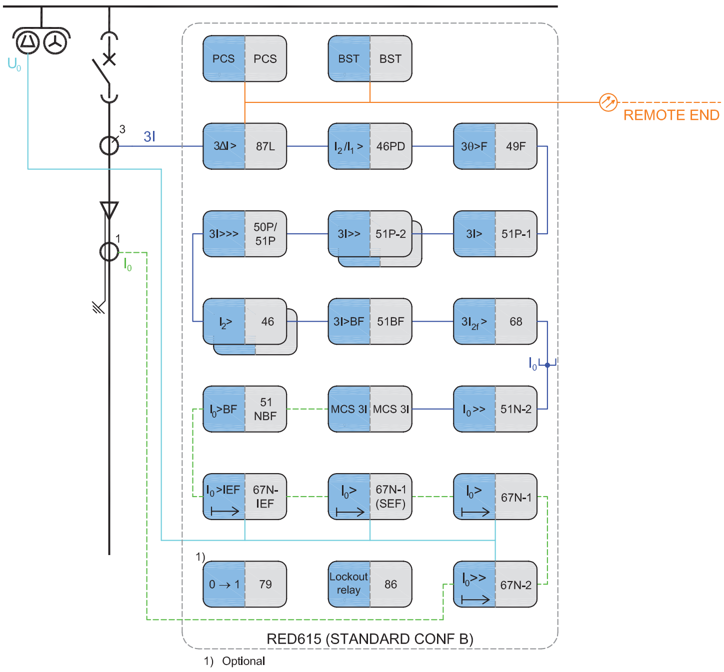
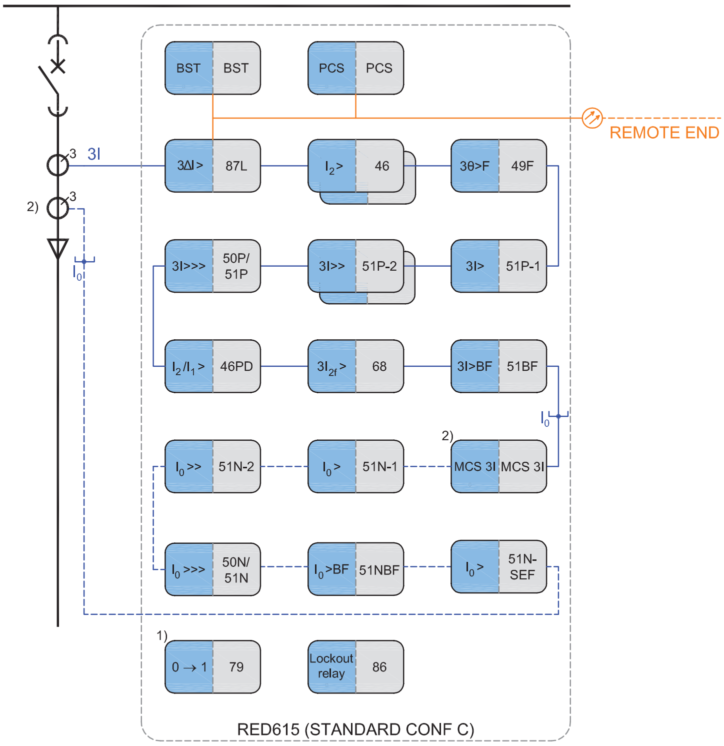


Figure 2. Protection function overview of standard configuration B



1) Optional
2) Separate CT-core mandatory only for MCS3I (Current circuit supervision)

Figure 3. Protection function overview of standard configuration C

4. Application

RED615 can be used in a variety of applications requiring an absolutely selective unit type protection system. The zone-of-protection of a line differential protection system is the feeder section defined by the location of the current transformers in the local and the remote substation.

Combining horizontal GOOSE communication over a station bus and binary signal transfer over the protection communication link offers new application possibilities beyond traditional line differential protection. One interesting application based on inter-substation signal transfer is loss-of-mains (LOM) protection in networks with distributed generation. The performance of the combination of binary signal transfer and horizontal GOOSE communication performance as to speed, selectivity and reliability are hard to match with conventional loss-of-mains protection.

RED615 is the ideal IED for the protection of feeders in network configurations containing closed loops. Under normal operating conditions the feeder loop is closed. The aim of the closed loop is to secure the availability of power for the end users. As a result of the closed loop configuration, any fault spot in the system will be fed with fault current from two directions. Using plain overcurrent protection, either directional or non-directional, it is difficult to obtain fast and selective short circuit protection. With RED615 line differential protection IEDs the faulty part of the network can be selectively isolated, thus securing power distribution to the healthy part of the network.

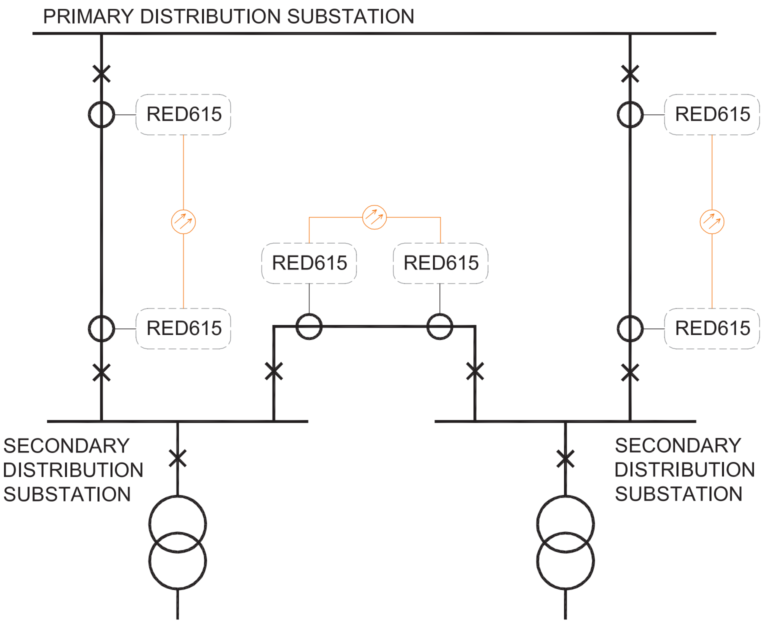


Figure 4. Closed loop network configuration with RED615 line differential protection and control IEDs

Under certain operational circumstances, such as maintenance of primary equipment or substation extension projects there will be a need for interconnecting network parts, which normally are separated. To avoid major re-parameterization of the protection devices of the network when the network topology is changed, line differential protection IEDs can be used to obtain absolutely selective feeder protection in looped networks.

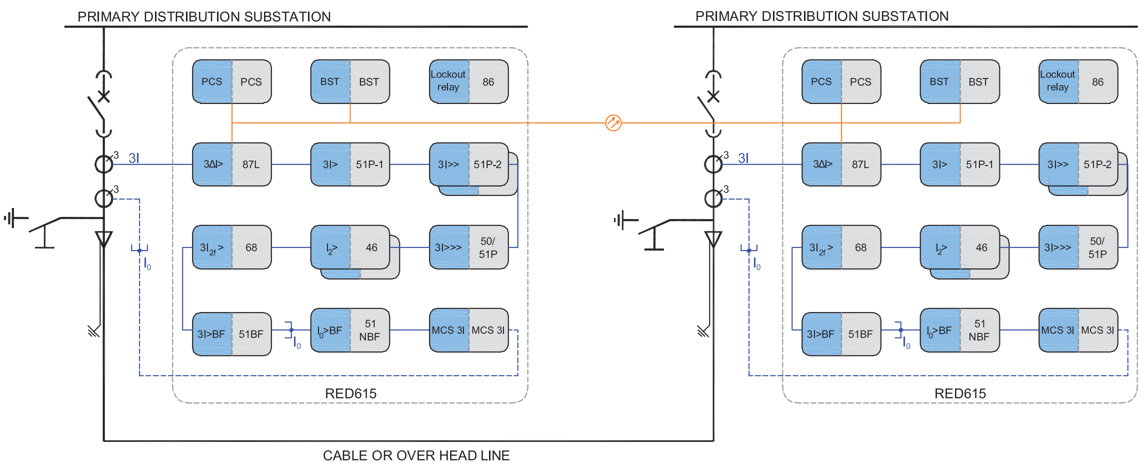


Figure 5. RED615 protecting an interconnecting feeder between two primary distribution substations

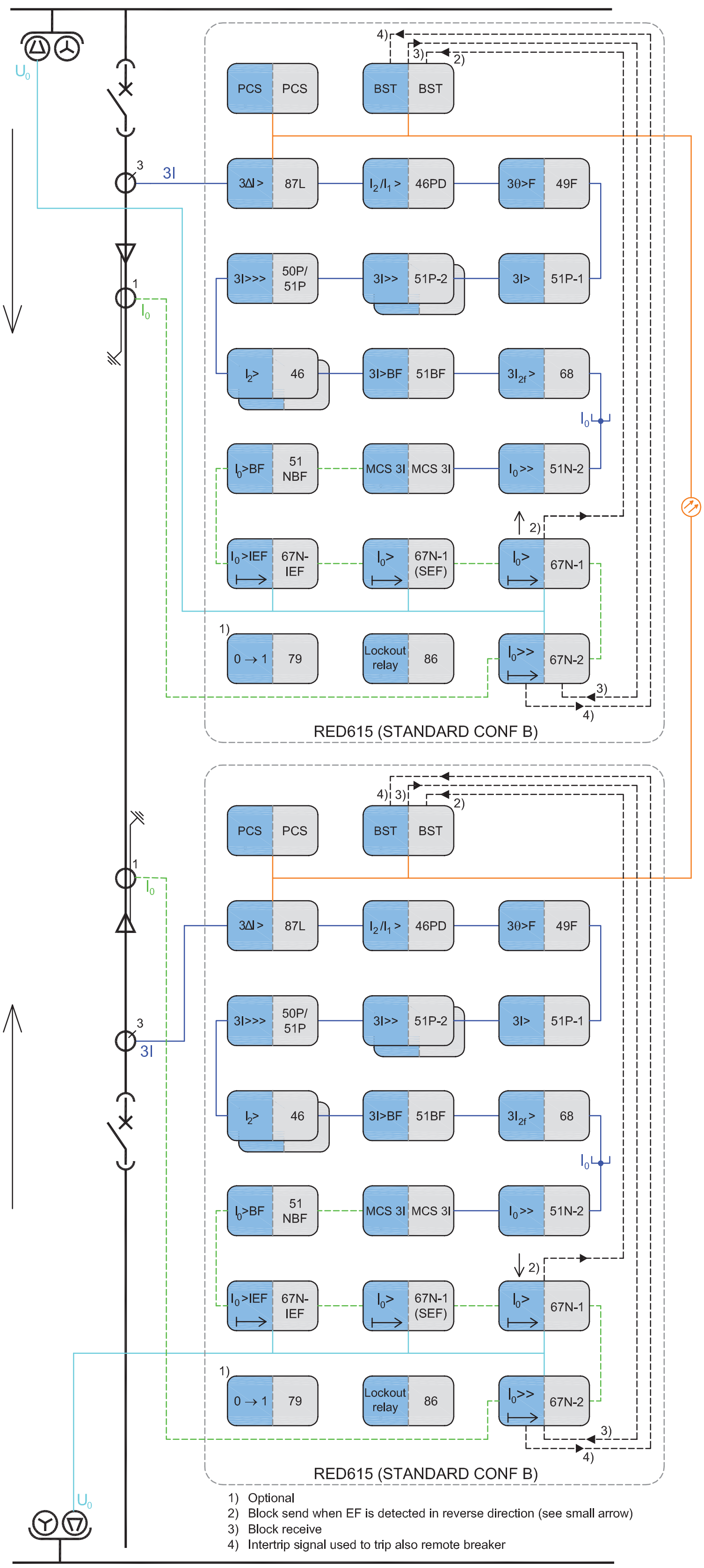

U0
3I
I0
PCS PCS
BST BST
3ΔI> 87L
I2/I1> 46PD
3θ>F 49F
3I>>> 50P/51P
3I>> 51P-2
3I> 51P-1
I2> 46
3I>BF 51BF
3I2f> 68
I0>BF 51NBF
MCS 3I MCS 3I
I0>> 51N-2
I0>IEF 67N-IEF
I0> 67N-1 (SEF)
I0> 67N-1
0 → 1 79
Lockout relay 86
I0>> 67N-2
RED615 (STANDARD CONF B)
PCS PCS
BST BST
3ΔI> 87L
I2/I1> 46PD
3θ>F 49F
3I>>> 50P/51P
3I>> 51P-2
3I> 51P-1
I2> 46
3I>BF 51BF
3I2f> 68
I0>BF 51NBF
MCS 3I MCS 3I
I0>> 51N-2
I0>IEF 67N-IEF
I0> 67N-1 (SEF)
I0> 67N-1
0 → 1 79
Lockout relay 86
I0>> 67N-2
RED615 (STANDARD CONF B)
1) Optional
2) Block send when EF is detected in reverse direction (see small arrow)
3) Block receive
4) Intertrip signal used to trip also remote breaker

Figure 6. Line differential protection of an overhead line feeder using RED615 with the standard configuration B. Selectivity of earth-fault protection is ensured using binary signal transfer (BST) between the directional E/F protection stages of the local and remote end. The lowest directional E/F stages are not used for tripping purposes, but set to detect earth-faults in the reverse direction. Upon detection of an out-of-zone earth-fault, a blocking signal is sent to the remote end directional E/F protection stage preventing tripping of the circuit breaker. If the earth-fault is within the protected zone, no blocking signal will be issued, and the internal fault is cleared by the tripping stages of the directional E/F protection. To ensure simultaneous tripping of the local and remote end circuit breakers, BST is also used for sending an intertrip signal to the remote end during earth-fault situations within the protected zone.

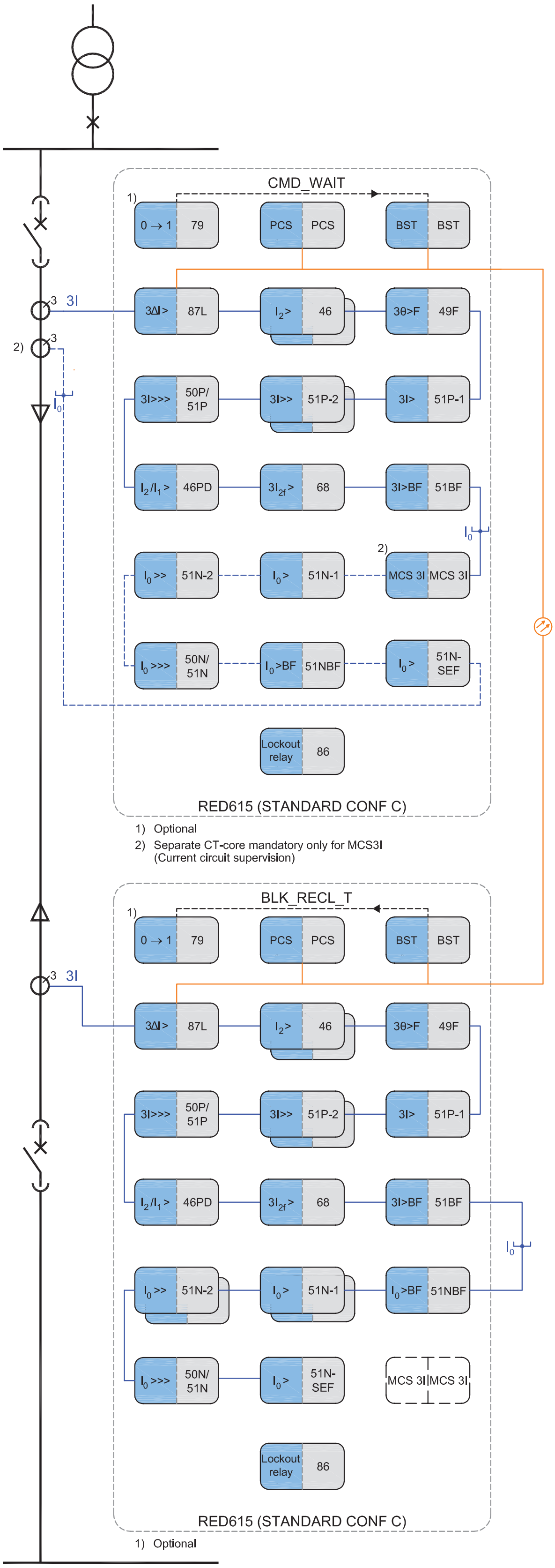

CMD_WAIT
1)
0 → 1
79
PCS
PCS
BST
BST
3I
2)
3ΔI>
87L
I2>
46
3θ>F
49F
I0
3I>>>
50P/
51P
3I>>
51P-2
3I>
51P-1
I2/I1>
46PD
3I2f>
68
3I>BF
51BF
I0
2)
I0>>
51N-2
I0>
51N-1
MCS 3I
MCS 3I
I0>>>
50N/
51N
I0>BF
51NBF
I0>
51N-
SEF
Lockout
relay
86
RED615 (STANDARD CONF C)
1) Optional
2) Separate CT-core mandatory only for MCS3I
(Current circuit supervision)
BLK_RECL_T
1)
0 → 1
79
PCS
PCS
BST
BST
3I
3ΔI>
87L
I2>
46
3θ>F
49F
3I>>>
50P/
51P
3I>>
51P-2
3I>
51P-1
I2/I1>
46PD
3I2f>
68
3I>BF
51BF
I0
I0>>
51N-2
I0>
51N-1
I0>BF
51NBF
I0>>>
50N/
51N
I0>
51N-
SEF
MCS 3I
MCS 3I
Lockout
relay
86
RED615 (STANDARD CONF C)
1) Optional

Figure 7. Line differential protection of an overhead line feeder using RED615 with the standard configuration C and auto-reclosing option. By means of binary signal transfer (BST) uncoordinated auto-reclosing attempts are prevented. During the auto-reclosing sequence a "wait" command is sent to the auto-reclosing function of the lower circuit breaker and thereby blocking the function. The upper circuit breaker is thereafter closed by its auto-reclosing function. This blocking signal is reset after successful auto-reclosing of the upper circuit breaker, enabling the lower breaker to be closed by its auto-reclosing function.

5. Supported ABB solutions

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

The 615 series IEDs offer native support for the IEC 61850 standard also including 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 bay level IEDs to offer enhanced substation level functionality. COM600 features a web-browser based HMI providing a customizable graphical display for visualizing single line mimic diagrams for switchgear bay solutions. 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	3.3 or later
MicroSCADA Pro	9.2 SP1 or later

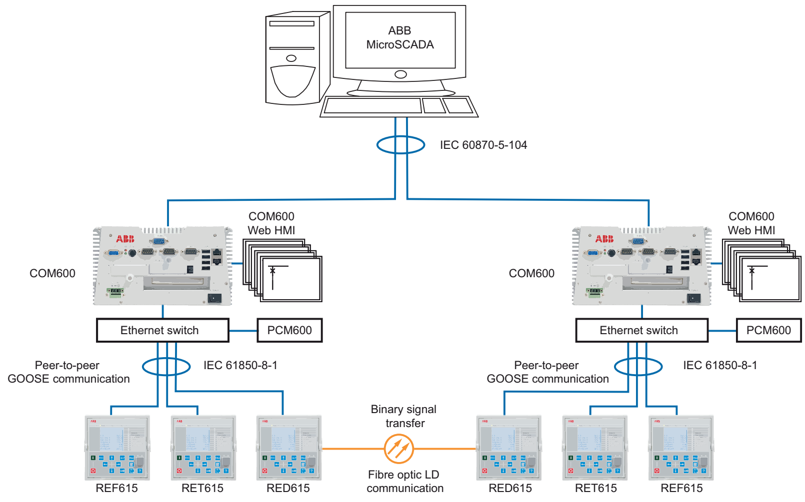


Figure 8. Utility power distribution network example using 615 series IEDs, Station Automation COM600 and MicroSCADA Pro

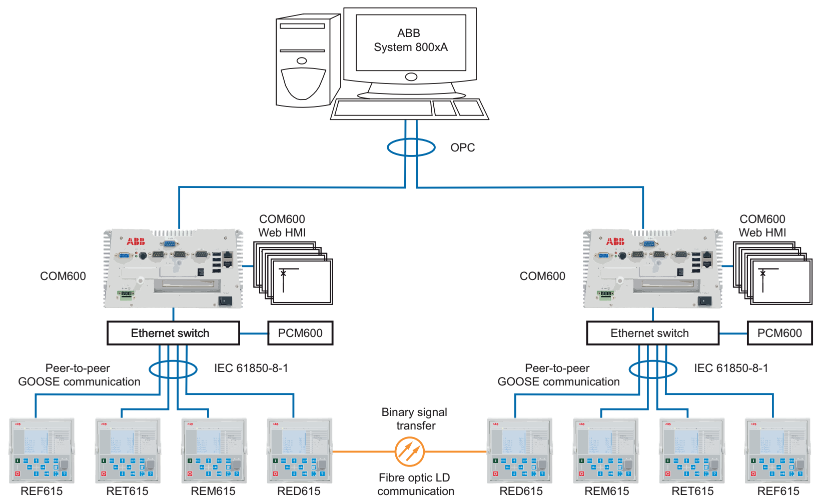


Figure 9. Industrial power system example using 615 series IEDs, Station Automation COM600 and System 800xA

6. Control

The IED offers control of one circuit breaker with dedicated push-buttons for opening and closing. Interlocking schemes required by the application are configured with the signal matrix in PCM600.

7. Measurement

The IED continuously measures the phase currents, the symmetrical components of the currents and the residual current. If the IED includes voltage measurements it also measures the residual voltage. In addition, the IED calculates the demand value of current over a userselectable pre-set time frames, the thermal overload of the protected object, and the phase unbalance value based on the ratio between the negative sequence and positive sequence current.

Further, the IED monitors the phase differential, bias and remote end phase currents.

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

8. Disturbance recorder

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

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

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

9. Event log

To collect sequence-of-events (SoE) information, the IED incorporates a non-volatile memory with a capacity of storing 50 event codes with associated time stamps. The non-volatile memory retains its data also in case the IED temporarily loses its auxiliary supply. The event log facilitates detailed pre- and post-fault analyses of feeder faults and disturbances.

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

10. Recorded data

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

11. Trip-circuit supervision

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

12. Self-supervision

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

13. Current circuit supervision

The IED includes current circuit supervision. Current circuit supervision is used for detecting faults in the current transformer secondary circuits. On detecting of a fault the current circuit supervision function activates an alarm LED and blocks the line differential protection and negative sequence overcurrent 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

14. Protection communication and supervision

The communication between the IEDs is enabled by means of a dedicated fibre-optic communication channel. 1300 nm multi-mode or single-mode fibres with LC connectors are used for line differential communication. The channel is used for transferring the phase segregated current value data between the IEDs. The current phasors from the two IEDs, geographically located apart from each other, must be time coordinated so that the current differential algorithm can be executed correctly. The so called echo method is used for time synchronization. No external devices such as GPS clocks are thereby needed for the line differential protection communication.

The communication channel is further used for binary signal transfer (BST), transferring of user configurable binary information, between the IEDs. There are a total of eight BST signals available for user definable purposes. The BST signals can originate from the IED's binary inputs or internal logics, and be assigned to the remote IED's binary outputs or internal logics.

The protection communication supervision continuously monitors the protection communication link. The IED immediately blocks the line differential protection function in case that severe interference in the communication link, risking the correct operation of the function, is detected. An alarm signal will eventually be issued if the interference, indicating permanent failure in the protection communication, persists. The two high-set stages of the overcurrent protection are further by default released.

15. Access control

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

16. Inputs and outputs

Depending on the standard configuration selected, the IED is equipped with three phase-current inputs and one residual-current input for non-directional earth-fault protection and current circuit supervision, or three phase-current inputs, one residual-current input and one residual voltage input for directional earth-fault protection and current circuit supervision.

The phase-current inputs are rated 1/5 A. Two optional residual-current inputs are available, i.e. 1/5 A or 0.2/1 A. The 0.2/1 A input is normally used in applications requiring sensitive earth-fault protection and featuring core-balance current transformers. The residual-voltage input covers the rated voltages 100, 110, 115 and 120 V.

The phase-current input 1 A or 5 A, the residual-current input 1 A or 5 A, alternatively 0.2 A or 1 A, and the rated voltage of the residual voltage input are selected in the IED software. In addition, the binary input thresholds 18…176 V DC are selected by adjusting the IED's parameter settings.

All binary input and output contacts are freely configurable with the signal matrix in PCM600.

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

Table 4. Input/output overview

Standard configuration	Analog inputs		Binary inputs/outputs	
	CT	VT	BI	BO
A	4	-	12 (18)[1]	10 (13)[1]
B	4	1	11 (17)[1]	10 (13)[1]
C	4	-	12 (18)[1]	10 (13)[1]

1) With optional binary I/O module ()

17. Station communication

The IED supports a range of communication protocols including IEC 61850, IEC 60870-5-103, Modbus® and DNP3. Operational information and controls are available through these protocols.

The IEC 61850 communication implementation supports all monitoring and control functions. Additionally, parameter setting and disturbance file records can be accessed using the IEC 61850 protocol. Disturbance files are available to any Ethernet-based application in the standard COMTRADE format. Further, the IED can send and receive binary signals from other IEDs (so called horizontal communication) using the IEC61850-8-1 GOOSE profile. The IED meets the GOOSE performance requirements for tripping applications in distribution substations, as defined by the IEC 61850 standard. The IED can simultaneously report events to five different clients on the station bus.

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). If connection to a RS-485 network is required, a 9-pin screw-terminal connector, an optional 9-pin D-sub connector or an optional ST-type glass-fibre 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. If required, both IEC 61850 and serial Modbus protocols can be run simultaneously.

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

DNP3 supports both serial and TCP modes for connection to one master.

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

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

Ethernet based:

• SNTP (Simple Network Time Protocol)

With special time synchronization wiring:

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

Remote-end station time reference:

• Line differential

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

• Modbus
• DNP3
• IEC 60870-5-103

Remote-end station time reference:

• Line differential

Table 5. Supported station communication interfaces and protocols

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

● = Supported

18. Technical data

Table 6. Dimensions

Description	Value	
Width	frame	179.8 mm
	case	164 mm
Height	frame	177 mm (4U)
	case	160 mm
Depth		194 mm (153 + 41 mm)
Weight	IED	3.5 kg
	spare unit	1.8 kg

Table 7. Power supply

Description	Value
U_{aux}nominal	100, 110, 120, 220, 240 V AC, 50 and 60 Hz
	48, 60, 110, 125, 220, 250 V DC
U_{aux}variation	38...110% of U_n (38...264 V AC)
	80...120% of U_n (38.4...300 V DC)
Burden of auxiliary voltage supply under quiescent (P_q)/operating condition	250 V DC ~ 8.9 W (nominal)/~ 15.2 W (max) 240 VAC ~ 10.6 W (nominal)/~ 17.0 W (max)
Ripple in the DC auxiliary voltage	Max 12% of the DC value (at frequency of 100 Hz)
Maximum interruption time in the auxiliary DC voltage without resetting the IED	110 V DC: 84 ms 110 V AC: 124 ms
Fuse type	T4 A/250 V

Table 8. Energizing inputs

Description		Value	
Rated frequency		50/60 Hz ± 5 Hz	
Current inputs	Rated current, I_n		1/5 A[1]
	Thermal withstand capability: • Continuously • For 1 s	 4 A 100 A	 20 A 500 A
	Dynamic current withstand: • Half-wave value	 250 A	 1250 A
	Input impedance	<100 mΩ	<20 mΩ
Voltage inputs	Rated voltage	100 V AC/ 110 V AC/ 115 V AC/ 120 V AC (Parametrization)	
	Voltage withstand: • Continuous • For 10 s	 2 x U_n (240 V AC) 3 x U_n (360 V AC)	
	Burden at rated voltage	<0.05 VA	

1) Residual current and/or phase current

Table 9. Binary inputs

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

Table 10. Signal outputs and IRF output

Description	Value
Rated voltage	250 V AC/DC
Continuous contact carry	5 A
Make and carry for 3.0 s	10 A
Make and carry 0.5 s	15 A
Breaking capacity when the control-circuit time constant L/R<40 ms, at 48/110/220 V DC	1 A/0.25 A/0.15 A
Minimum contact load	100 mA at 24 V AC/DC

Table 11. Double-pole power output relays with TCS function

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

Table 12. Single-pole power output relays

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

Table 13. Degree of protection of flush-mounted IED

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

Table 14. Environmental conditions

Description	Value
Operating temperature range	-25...+55°C (continuous)
Short-time service temperature range	-40...+70°C (<16h)[1)2)]
Relative humidity	<93%, non-condensing
Atmospheric pressure	86...106 kPa
Altitude	Up to 2000 m
Transport and storage temperature range	-40...+85°C

1) Degradation in MTBF and HMI performance outside the temperature range of -25...+55 °C
2) For IEDs with an LC communication interface the maximum operating temperature is +70 °C

Table 15. Environmental tests

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

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

Table 16. Electromagnetic compatibility tests

Description	Type test value	Reference
1 MHz burst disturbance test:		IEC 61000-4-18 and IEC 60255-22-1, level 3
• Common mode	2.5 kV	
• Differential mode	1.0 kV	
Electrostatic discharge test:		IEC 61000-4-2, IEC 60255-22-2 and IEEE C37.90.3.2001
• Contact discharge	8 kV	
• Air discharge	15 kV	
Radio frequency interference tests:		IEC 61000-4-6 and IEC 60255-22-6, level 3
• Conducted, common mode	10 V (rms), f=150 kHz...80 MHz	
• Radiated, amplitude-modulated	10 V/m (rms), f=80...2700 MHz	IEC 61000-4-3 and IEC 60255-22-3, level 3
• Radiated, pulse-modulated	10 V/m, f=900 MHz	ENV 50204 and IEC 60255-22-3, level 3
Fast transient disturbance tests:		IEC 61000-4-4 and IEC 60255-22-4, class A
• All ports	4kV	
Surge immunity test:		IEC 61000-4-5 and IEC 60255-22-5, level 4/3
• Binary inputs	4 kV, line-to-earth 2 kV, line-to-line	
• 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, level 5
• Continuous	300 A/m	

Table 16. Electromagnetic compatibility tests, continued

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

Table 17. Insulation tests

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

Table 18. Mechanical tests

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

Table 19. EMC compliance

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

Table 20. Product safety

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

Table 21. RoHS compliance

Description
Complies with RoHS directive 2002/95/EC

Table 22. Front port Ethernet interfaces

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

Table 23. Protection communication link, fibre-optic

Connector	Fibre type1)	Wave length	Max. distance	Permitted path attenuation2)
LC	MM 62.5/125 μm glass fibre core	1300 nm	2 km	<8 dB
LC	SM 9/125 μm	1300 nm	2-20 km	<8 dB
ST	MM 62.5/125 μm glass fibre core	820-900 nm	1 km	<11 dB

1) (MM) multi-mode fibre, (SM) single-mode fibre
2) Maximum allowed attenuation caused by connectors and cable together

Protection functions

Table 24. Line differential protection (LNPLDF)

Characteristics	Value		
Operation accuracy [1]	Depending on the frequency of the current measured: f_n ±2 Hz		
	Low stage	±2.5% of the set value	
	High stage	±2.5% of the set value	
	Minimum	Typical	Maximum
High stage, operate time [2][3]	22 ms	25 ms	29 ms
Reset time	< 40 ms		
Reset ratio	Typical 0.96		
Retardation time (Low stage)	< 40 ms		
Operate time accuracy in definite time mode	±1.0% of the set value or ±20 ms		
Operate time accuracy in inverse time mode	±5.0% of the set value or ±20 ms [4]		

1) With the symmetrical communication channel (as when using dedicated fiber optic).
2) Without additional delay in the communication channel (as when using dedicated fiber optic).
3) Including the delay of the output contact. When differential current = 2 x *High operate value* and f_n = 50 Hz.
4) *Low operate value* multiples in range of 1.5 to 20.

Table 25. Line differential protection (LNPLDF) main settings

Parameter	Values (Range)	Unit	Description
High operate value	200...4000	% I_n	Instantaneous stage operate value
Low operate value	10...200	% I_n	Basic setting for the stabilized stage start
Operate delay time	45...200000	ms	Operate delay time for stabilized stage
Operate curve type	1=ANSI Ext. inv. 3=ANSI Norm. inv. 5=ANSI Def. Time 9=IEC Norm. inv. 10=IEC Very inv. 12=IEC Ext. inv. 15=IEC Def. Time		Selection of time delay curve for stabilized stage
Time multiplier	0.05...15.00		Time multiplier in IDMT curves
Start value 2.H	10...50	%	The ratio of the 2. harmonic component to fundamental component required for blocking
CT ratio correction	0.200...5.000		Remote phase current transformer ratio correction

Table 26. Binary signal transfer (BSTGGIO)

Characteristic	Value
Signalling delay	< 5 ms

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

Characteristic		Value		
Operation accuracy		Depending on the frequency of the current measured: f_n ±2Hz		
	PHLPTOC	±1.5% of the set value or ±0.002 x I_n		
	PHHPTOC and PHIPTOC	±1.5% of set value or ±0.002 x I_n (at currents in the range of 0.1…10 x I_n) ±5.0% of the set value (at currents in the range of 10…40 x I_n)		
Start time [1)2)]		Minimum	Typical	Maximum
	PHIPTOC: I_{Fault} = 2 x set *Start value* I_{Fault} = 10 x set *Start value*	16 ms 11 ms	19 ms 12 ms	23 ms 14 ms
	PHHPTOC and PHLPTOC: I_{Fault} = 2 x set *Start value*	22 ms	24 ms	25 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Retardation time		< 30 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms [3)]		
Suppression of harmonics		RMS: No suppression DFT: -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* = IEC definite time, *Measurement mode* = default (depends on stage), current before fault = 0.0 x In, fn = 50 Hz, fault current in one phase with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Includes the delay of the heavy-duty output contact

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

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

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

Table 29. Non-directional EF protection (EFxPTOC)

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

1) *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 *Start value* = 2.5 x I_n, *Start value* multiples in range of 1.5 to 20

Table 30. Non-directional EF protection (EFxPTOC) main settings

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

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

Table 31. Directional EF protection (DEFxPDEF)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the current measured: f_n ±2Hz		
	DEFLPDEF	Current: ±1.5% of the set value or ±0.002 x I_n Voltage ±1.5% of the set value or ±0.002 x U_n Phase angle: ±2°		
	DEFHPDEF	Current: ±1.5% of the 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) Voltage: ±1.5% of the set value or ±0.002 x U_n Phase angle: ±2°		
Start time [1)2)]		Minimum	Typical	Maximum
	DEFHPDEF and DEFLPTDEF: I_{Fault} = 2 x set *Start value*	61 ms	64 ms	66 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Retardation time		< 30 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms [3)]		
Suppression of harmonics		RMS: No suppression DFT: -50dB at f = n x f_n, where n = 2, 3, 4, 5, … Peak-to-Peak: No suppression		

1) Set *Operate delay time* = 0.06 s,*Operate curve type* = IEC 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 *Start value* = 2.5 x I_n, *Start value* multiples in range of 1.5 to 20

Table 32. Directional EF protection (DEFxPDEF) main settings

Parameter	Function	Value (Range)	Step
Start Value	DEFLPDEF	0.01...5.00 x I_n	0.005
	DEFHPDEF	0.10...40.00 x I_n	0.01
Directional mode	DEFLPDEF and DEFHPDEF	1=Non-directional 2=Forward 3=Reverse	
Time multiplier	DEFLPDEF	0.05...15.00	0.05
	DEFHPDEF	0.05...15.00	0.05
Operate delay time	DEFLPDEF	60...200000 ms	10
	DEFHPDEF	60...200000 ms	10
Operating curve type[1)]	DEFLPDEF	Definite or inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
	DEFHPDEF	Definite or inverse time Curve type: 1, 3, 5, 15, 17	
Operation mode	DEFLPDEF and DEFHPDEF	1=Phase angle 2=I_0Sin 3=I_0Cos 4=Phase angle 80 5=Phase angle 88	

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

Table 33. Transient/intermittent earth-fault protection (INTRPTEF)

Characteristic	Value
Operation accuracy (U_0 criteria with transient protection)	Depending on the frequency of the current measured: f_n ±2Hz
	±1.5% of the set value or ±0.002 x U_n
Operate time accuracy	±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

Table 34. Transient/intermittent earth-fault protection (INTRPTEF) main settings

Parameter	Function	Value (Range)	Step
Directional mode	INTRPTEF	1=Non-directional 2=Forward 3=Reverse	
Operate delay time	INTRPTEF	40...1200000 ms	10
Voltage start value (voltage start value for transient EF)	INTRPTEF	0.01...0.50 x U_n	0.01
Operation mode	INTRPTEF	1=Intermittent EF 2=Transient EF	
Peak counter limit (Min requirement for peak counter before start in IEF mode)	INTRPTEF	2...20	

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

Characteristic		Value		
Operation accuracy		Depending on the frequency of the current measured: f_n ±2Hz		
		±1.5% of the set value or ±0.002 x I_n		
Start time [1)2)]		Minimum	Typical	Maximum
	I_{Fault} = 2 x set *Start value* I_{Fault} = 10 x set *Start value*	22 ms 14 ms	24 ms 16 ms	25 ms 17 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Retardation time		< 35 ms		
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Operate 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) Negative sequence current before fault = 0.0, f_n = 50 Hz, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Maximum *Start value* = 2.5 x I_n, *Start value* multiples in range of 1.5 to 20

Table 36. Negative phase-sequence overcurrent protection (NSPTOC) main settings

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

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

Table 37. Phase discontinuity protection (PDNSPTOC)

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

Table 38. Phase discontinuity protection (PDNSPTOC) main settings

Parameter	Function	Value (Range)	Step
Start value (Current ratio setting I_2/I_1)	PDNSPTOC	10...100 %	1
Operate delay time	PDNSPTOC	100...30000 ms	1
Min phase current	PDNSPTOC	0.05...0.30 x I_n	0.01

Table 39. Circuit breaker failure protection (CCBRBRF)

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

Table 40. Circuit breaker failure protection (CCBRBRF) main settings

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

Table 41. Three-phase thermal overload (T1PTTR)

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

1) Overload current > 1.2 x Operate level temperature

Table 42. Three-phase thermal overload (T1PTTR) main settings

Parameter	Function	Value (Range)	Step
Env temperature Set (Ambient temperature used when the AmbSens is set to Off)	T1PTTR	-50...100°C	1
Current multiplier (Current multiplier when function is used for parallel lines)	T1PTTR	1...5	1
Current reference	T1PTTR	0.05...4.00 x I_n	0.01
Temperature rise (End temperature rise above ambient)	T1PTTR	0.0...200.0°C	0.1
Time constant (Time constant of the line in seconds)	T1PTTR	60...60000 s	1
Maximum temperature (temperature level for operate)	T1PTTR	20.0...200.0°C	0.1
Alarm value (Temperature level for start (alarm))	T1PTTR	20.0...150.0°C	0.1
Reclose temperature (Temperature for reset of block reclose after operate)	T1PTTR	20.0...150.0°C	0.1
Initial temperature (Temperature raise above ambient temperature at startup)	T1PTTR	-50.0...100.0°C	0.1

Table 43. Three-phase inrush current detection (INRPHAR)

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

Table 44. Three-phase inrush detection (INRPHAR) main settings

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

Table 45. Operation characteristics

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

Supervision functions

Table 46. Current circuit supervision (CCRDIF)

Characteristic	Value
Operate time[1)]	< 30 ms

1) Including the delay of the output contact.

Table 47. Current circuit supervision (CCRDIF) main settings

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

Control functions

Table 48. Autoreclosure (DARREC)

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

Measurement functions

Table 49. Three-phase current measurement (CMMXU)

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

Table 50. Current sequence components (CSMSQI)

Characteristic	Value
Operation 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 51. Residual current measurement (RESCMMXU)

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

Table 52. Residual voltage measurement (RESVMMXU)

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

19. Display options

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

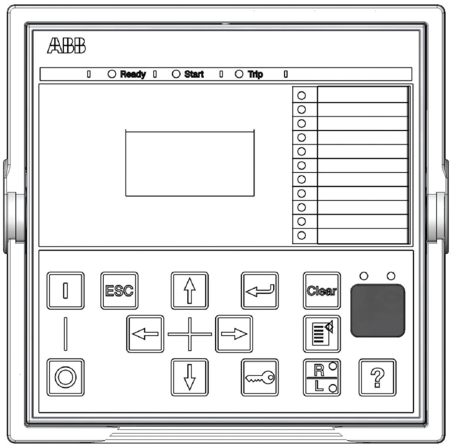


Figure 10. Small display

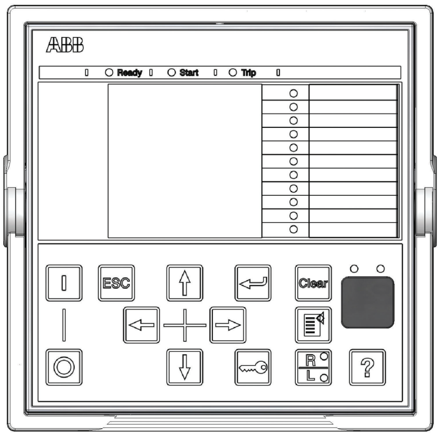


Figure 11. Large display

Table 53. Small display

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

1) Depending on the selected language

Table 54. Large display

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

1) Depending on the selected language

20. Mounting methods

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

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

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

Mounting methods:

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

Panel cut-out for flush mounting:

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

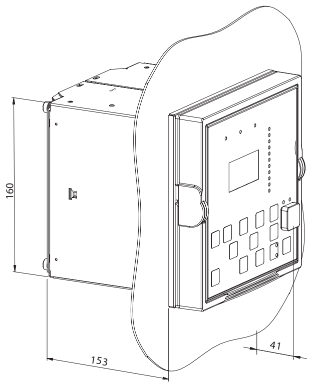


Figure 12. Flush mounting

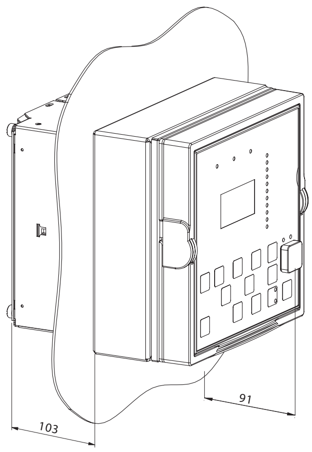


Figure 13. Semi-flush mounting

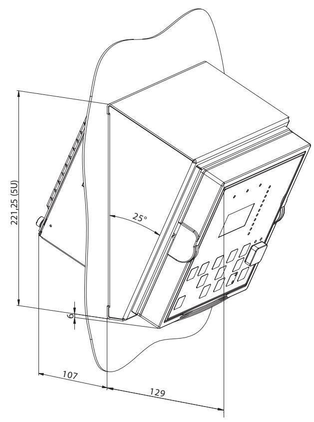


Figure 14. Semi-flush with a 25° tilt

21. IED case and IED plug-in unit

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

22. Selection and ordering data

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

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

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

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

The standard configuration determines the I/O hardware and available options. Choose the digits from one of the blue standard configuration rows below to define the corect digits for # 4-8. The example below shows standard configuration “C” with chosen options.

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

#	DESCRIPTION		
4-8	**Standard configuration descriptions in short:** **A** = Line differential protection **B** = Line differential protection and dir. E/F protection **C** = Line differential protection and non-dir. E/F protection		
	Std. conf. # 4	**Available analog inputs options # 5-6**	**Available binary inputs/output options # 7-8**
	A	**AC** = 4 I (I_0 1/5 A)	**AD** = 12 BI + 10 BO or **AF** = 18 BI + 13 BO
	B	**AA** = 4 I + U_0 (I_0 1/5 A) or **AB** = 4 I + U_0 (I_0 0.2/1 A)	**AC** = 11 BI + 10 BO or **AE** = 17 BI + 13 BO
	C	**AC** = 4 I (I_0 1/5 A)	**AD** = 12 BI + 10 BO or **AF** = 18 BI + 13 BO

The communication module harware determines the available communication protocols. Choose the digits from one of the blue communication rows below to define the corect digits for digits 9-11. Note that the communication options are not dependant on the chosen standard configuration.

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

#	DESCRIPTION		
9 - 11	**Communication descriptions in short:** Substation communication (serial) options #9 Protection and substation communication (Ethernet) options #10 Communication protocol options #11		
	Serial options # 9	**Ethernet options # 10**	**Protocol options # 11**
	A = RS-485 (incl. IRIG-B)	**A** = Line differential, multi mode fibre (LC) or **B** = Line differential, single mode fibre (LC)	**B** = Modbus or **D** = IEC 60870-5-103 or **E** = DNP3
	A = RS-485 (incl. IRIG-B)	**G** = Ethernet 100Base TX (RJ-45) and line differential, multi mode fibre (LC) or **H** = Ethernet 100Base TX (RJ-45) and line differential, single mode fibre (LC) or **J** = 2 x Ethernet 100Base TX (RJ-45) and line differential, multi mode fibre (LC) or **K** = 2 x Ethernet 100Base TX (RJ-45) and line differential, single mode fibre (LC)	**A** = IEC 61850 or **B** = Modbus or **C** = IEC 61850 and Modbus or **D** = IEC 60870-5-103 or **E** = DNP3
	B = Glass fibre (ST Rx/Tx, incl. IRIG-B)	**A** = Line differential, multi mode fibre (LC) or **B** = Line differential, single mode fibre (LC)	**B** = Modbus or **D** = IEC 60870-5-103 or **E** = DNP3
	B = Glass fibre (ST Rx/Tx, incl. IRIG-B)	**G** = Ethernet 100Base TX (RJ-45) and line differential, multi mode fibre (LC) or **H** = Ethernet 100Base TX (RJ-45) and line differential, single mode fibre (LC) or **J** = 2 x Ethernet 100Base TX (RJ-45) and line differential, multi mode fibre (LC) or **K** = 2 x Ethernet 100Base TX (RJ-45) and line differential, single mode fibre (LC)	**A** = IEC 61850 or **B** = Modbus or **C** = IEC 61850 and Modbus or **D** = IEC 60870-5-103 or **E** = DNP3
	N = None	**A** = Line differential, multi mode fibre (LC) or **B** = Line differential, single mode fibre (LC)	**A** = IEC 61850
	N = None	**G** = Ethernet 100Base TX (RJ-45) and line differential, multi mode fibre (LC) or **H** = Ethernet 100Base TX (RJ-45) and line differential, single mode fibre (LC) or **J** = 2 x Ethernet 100Base TX (RJ-45) and line differential, multi mode fibre (LC) or **K** = 2 x Ethernet 100Base TX (RJ-45) and line differential, single mode fibre (LC)	**A** = IEC 61850 or **B** = Modbus or **C** = IEC 61850 and Modbus or **D** = IEC 60870-5-103 or **E** = DNP3

In addition to a serial communication option for station bus communication to gateways and SCADA systems, an Ethernet communication option can be chosen. This enables the use of an Ethernet based service bus for PCM600 and the WebHMI. However, this requires that an Ethernet communication option is chosen in addition to the serial communication (digit #10 = RJ-45 or LC).

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

#	DESCRIPTION	
12	**Language**	
	English	1
	English and German	3
	English and Spanish	5
	English and Russian	6
	English and Portugese (Brasilian)	8
13	**Front panel**	
	Small LCD	A
	Large LCD	B
14	**Option 1**	
	Auto-reclosing [1]	A
	None	N
15	**Option 2**	
	None	N
16	**Power supply**	
	48...250 V DC, 100...240 V AC	1
17	**Vacant digit**	
	Vacant	X
18	**Version**	
	Version 2.0	C

[1] Only available in combination with standard configuration B or C

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

Your ordering code:

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

Figure 15. Ordering key for complete IEDs

23. Accessories and ordering data

Table 55. Cables

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

Table 56. Mounting accessories

Item	Order number
Semi-flush mounting kit	1MRS050696
Wall mounting kit	1MRS050697
Inclined semi-flush mounting kit	1MRS050831
19” rack mounting kit with cut-out for one IED	1MRS050694
19” rack mounting kit with cut-out for two IEDs	1MRS050695
Mounting bracket for one IED with test switch RTXP in 4U Combiflex (RHGT 19” variant C)	2RCA022642P0001
Mounting bracket for one IED in 4U Combiflex (RHGT 19” variant C)	2RCA022643P0001
19” rack mounting kit for one IED and one RTXP18 test switch (the test switch is not included in the delivery)	2RCA021952A0003
19” rack mounting kit for one IED and one RTXP24 test switch (the test switch is not included in the delivery)	2RCA022561A0003

24. Tools

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

PCM600 offers extensive IED configuration functions such as IED signal configuration using the signal matrix, and IEC 61850 communication configuration including horizontal peer-to-peer communication, GOOSE.

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

The IED connectivity package is a collection of software and specific IED information, which enable system products and tools to connect and interact with the IED. The connectivity packages reduce the risk of errors in system integration, minimizing device configuration and set-up times.

Table 57. Tools

Configuration and setting tools	Version
PCM600	2.0 SP2 or later
Web-browser based user interface	IE 7.0 or later
RED615 Connectivity Package	2.5 or later

Table 58. Supported functions

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

● = Supported

25. Terminal diagrams

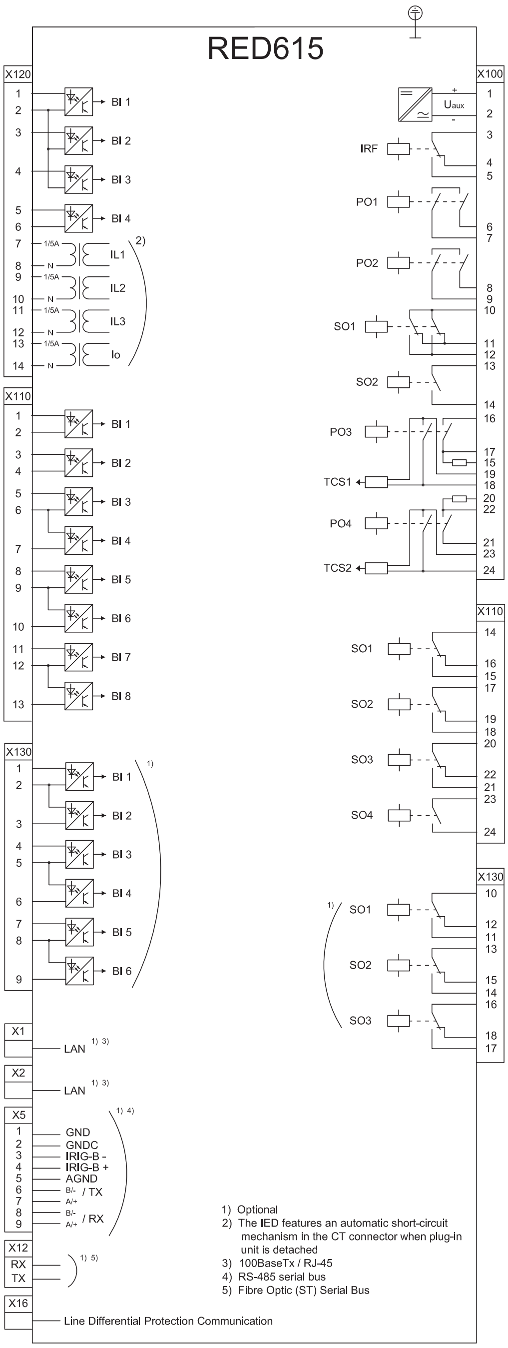


Figure 16. Terminal diagram for configuration A and C

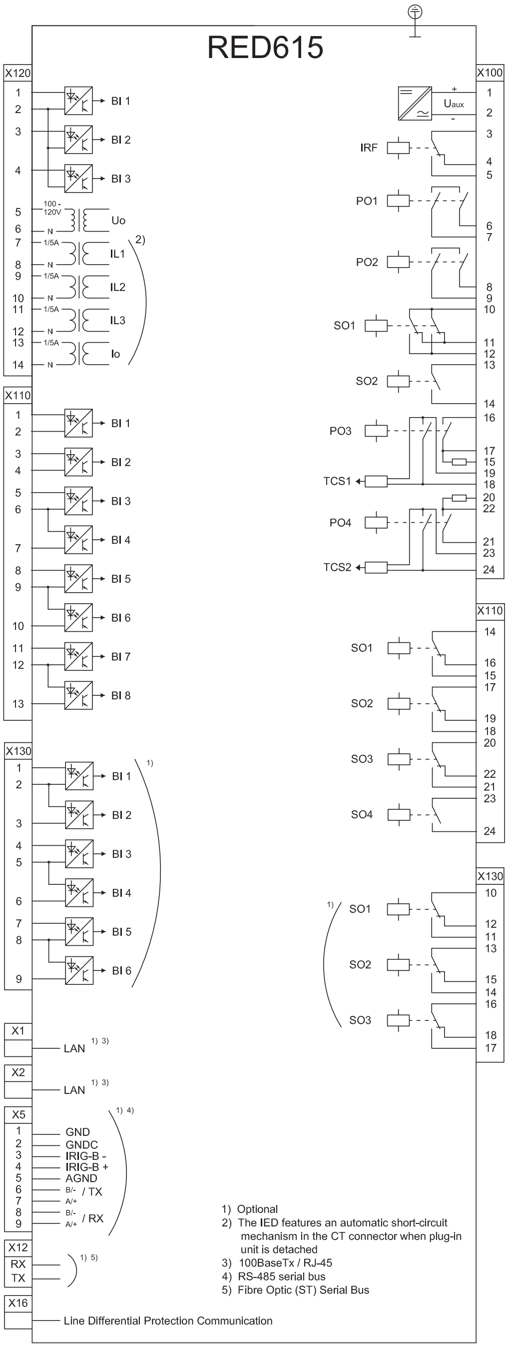


Figure 17. Terminal diagram for configuration B

26. References

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

You will find the latest relevant information on the RED615 protection IED on the product page.

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

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

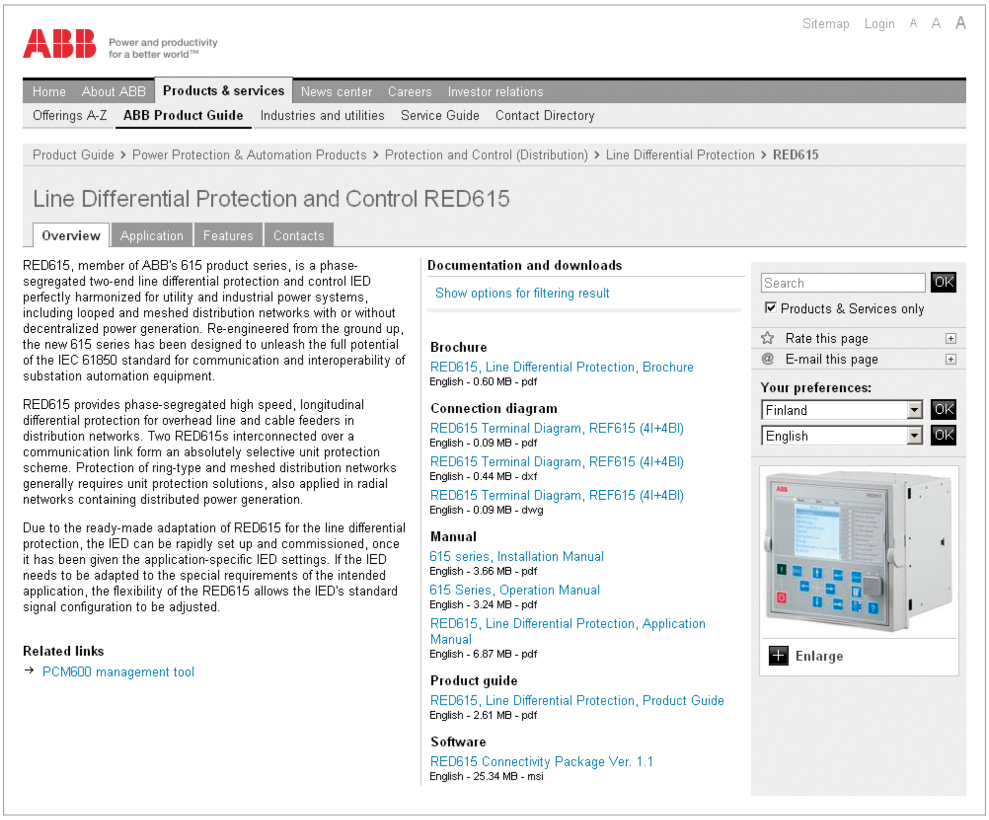


Figure 18. Product page

27. Functions, codes and symbols

Table 59. RED615 Functions, codes and symbols

Functionality	IEC 61850	IEC 60617	IEC-ANSI
Protection			
Three-phase non-directional overcurrent protection, low stage, instance 1	PHLPTOC1	3I> (1)	51P-1 (1)
Three-phase non-directional overcurrent protection, high stage, instance 1	PHHPTOC1	3I>> (1)	51P-2 (1)
Three-phase non-directional overcurrent protection, high stage, instance 2	PHHPTOC2	3I>> (2)	51P-2 (2)
Three-phase non-directional overcurrent protection, instantaneous stage, instance 1	PHIPTOC1	3I>>> (1)	50P/51P (1)
Non-directional earth-fault protection, low stage, instance 1	EFLPTOC1	I_0> (1)	51N-1 (1)
Non-directional earth-fault protection, low stage, instance 2	EFLPTOC2	I_0> (2)	51N-1 (2)
Non-directional earth-fault protection, high stage, instance 1	EFHPTOC1	I_0>> (1)	51N-2 (1)
Non-directional earth-fault protection, high stage, instance 2	EFHPTOC2	I_0>> (2)	51N-2 (2)
Non-directional earth-fault protection, instantaneous stage	EFIPTOC1	I_0>>>	50N/51N
Directional earth-fault protection, low stage, instance 1	DEFLPDEF1	I_0> → (1)	67N-1 (1)
Directional earth-fault protection, low stage, instance 2	DEFLPDEF2	I_0> → (2)	67N-1 (2)
Directional earth-fault protection, high stage	DEFHPDEF1	I_0>> →	67N-2
Transient / intermittent earth-fault protection	INTRPTEF1	I_0> → IEF	67NIEF
Non-directional (cross-country) earth fault protection, using calculated I_0	EFHPTOC1	I_0>>	51N-2
Negative-sequence overcurrent protection, instance 1	NSPTOC1	I_2> (1)	46 (1)

Table 59. RED615 Functions, codes and symbols, continued

Functionality	IEC 61850	IEC 60617	IEC-ANSI
Negative-sequence overcurrent protection, instance 2	NSPTOC2	I_2> (2)	46 (2)
Phase discontinuity protection	PDNSPTOC1	I_2/I_1>	46PD
Three-phase thermal protection for feeders, cables and distribution transformers	T1PTTR1	3Ith>F	49F
Binary signal transfer	BSTGGIO1	BST	BST
Line differential protection and related measurements, stabilized and instantaneous stages	LNPLDF1	3dI>L	87L
Circuit breaker failure protection	CCBRBRF1	3I>/I_0>BF	51BF/51NBF
Three-phase inrush detector	INRPHAR1	3I2f>	68
Master trip, instance 1	TRPPTRC1	Master Trip (1)	94/86 (1)
Master trip, instance 2	TRPPTRC2	Master Trip (2)	94/86 (2)
Control			
Circuit-breaker control	CBXCBR1	I ↔ O CB	I ↔ O CB
Disconnector position indication, instance 1	DCSXSWI1	I ↔ O DC (1)	I ↔ O DC (1)
Disconnector position indication, instance 2	DCSXSWI2	I ↔ O DC (2)	I ↔ O DC (2)
Disconnector position indication, instance 3	DCSXSWI3	I ↔ O DC (3)	I ↔ O DC (3)
Earthing switch indication	ESSXSWI1	I ↔ O ES	I ↔ O ES
Auto-reclosing	DARREC1	O → I	79
Condition Monitoring			
Circuit-breaker condition monitoring	SSCBR1	CBCM	CBCM
Trip circuit supervision, instance 1	TCSSCBR1	TCS (1)	TCM (1)
Trip circuit supervision, instance 2	TCSSCBR2	TCS (2)	TCM (2)
Current circuit supervision	CCRDIF1	MCS 3I	MCS 3I
Protection communication supervision	PCSRTPC1	PCS	PCS
Measurement			
Disturbance recorder	RDRE1	-	-

Table 59. RED615 Functions, codes and symbols, continued

Functionality	IEC 61850	IEC 60617	IEC-ANSI
Three-phase current measurement, instance 1	CMMXU1	3I	3I
Sequence current measurement	CSMSQI1	I_1, I_2, I_0	I_1, I_2, I_0
Residual current measurement, instance 1	RESCMMXU1	I_0	I_n
Residual voltage measurement	RESVMMXU1	U_0	V_n

28. Document revision history

Document revision/ date	Product version	History
A/03.10.2008	1.1	First release
B/03.07.2009	2.0	Content updated to correspond to the product version

Contact us

ABB Oy
Distribution Automation
P.O. Box 699
FI-65101 VAASA, Finland
Phone +358 10 22 11
Fax +358 10 22 41094

www.abb.com/substationautomation