Relion 615® series

Transformer protection and control RET615 ANSI Product guide

Power and productivity for a better world™

Contents

1. Description

The RET615 is a dedicated transformer protection and control relay for power transformers, unit and step-up transformers including power generator-transformer blocks in utility and industry power distribution systems. RET615 is a member of ABB's Relion® product family and a part of its 615 protection and control product series. The 615 series relays are characterized by their compactness and 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 between substation automation devices.

Unique RET615 ANSI features

- Six setting groups
- Drawout design
- Sensitive differential protection for turn-to-turn faults
- Restricted earth fault (REF) protection
- Overexcitation (V/Hz) protection
- High-speed (< 1 ms) outputs
- Arc flash detection (AFD)
- Thermal overload protection of transformer
- Ring-lug terminals for all inputs and outputs
- Large LCD screen with clearly visible font
- Environmentally friendly design with RoHS compliance

Application

The RET615 is the ultimate protection and control relay for two-winding power transformers and power generator-transformer blocks. It can be applied for protection and control of the most commonly used power transformer combinations of delta and wye (grounded or ungrounded) windings. Flexible order coding allows for choosing current-only or current-and-voltage configurations to best fit your transformer application needs.

Protection and control

The RET615 features three-phase, multi-slope transformer differential protection with an unrestrained stage and a restrained stage to provide fast and selective protection for phase-to-phase, winding interturn and bushing flash-over faults. Besides second harmonic restraint an advanced waveform-based blocking algorithm ensures stability at transformer energization and a fifth harmonic restraint function ensures good protection stability at moderate overexcitation of power transformers. Sensitive restricted earth-fault protection (REF) completes the overall differential protection to detect even single phase-to-ground faults close to the grounded neutral of the transformer.

When the low-impedance REF protection is used neither stabilizing resistors nor varistors are needed and as a further benefit the ratio of the grounded neutral CT can differ from those of the phase current transformers. Due to its unit protection character and absolute selectivity the REF protection does not need time grading with other protection schemes, and therefore high-speed fault clearance can be achieved.

RET615 also incorporates a thermal overload protection function, which supervises the thermal stress of the transformer windings to prevent accelerated aging of the insulations. Multiple stages of phase and ground overcurrents are provided for both transformer windings plus optional voltage metering and protection for one transformer winding. Ground-fault protection based on the measured or calculated residual overvoltage is also available. Finally, RET615 also offers circuit-breaker failure protection. Enhanced with an optional plug-in card, RET615 offers a fast three-channel arc-fault protection system for arc flash supervision of the switchgear compartments.

RET615 also integrates basic control functionality, which facilitates the control of one circuit breaker via the front panel HMI or by means of remote controls. To protect the relay from unauthorized access and to maintain the integrity of information, the device has been provided with a four-level, role-based user authentication system. The access control system applies to the front panel HMI, the web browser based HMI and the PCM600 Protection and Control Relay Manager.

2. Standard configurations

The RET615 relay main application is protection, control, metering and monitoring of two-winding power transformers and offers two standard configurations whose relay functions and features are based on the analog inputs ordered for each configuration. See Tables 1 and 2 for details.

One configuration comprises only current analog inputs useful in cost-effective two-winding power transformer protection, control and monitoring in industrial and utility applications. The second configuration includes the addition of voltage analog inputs for more comprehensive transformer protection and control applications. Both configurations include standard features of metering, monitoring and control plus sequence of event, fault and digital waveform recording. Advanced Ethernet communications is included standard with parallel support of DNP3.0 Level 2+*, Modbus and IEC61850 and SNTP over TCP/IP. Optional RS-232 and RS-485 serial communication ports are available 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	Current-based protection and control for a two-winding transformer and two breakers.
B	Current-based and voltage-based (LV- or HV-side) protection and control for a two-winding transformer and two breakers.
C	Current-based and voltage-based (LV- or HV-side) protection and control with RTDs for a two-winding transformer and two breakers.
D	Current-based and voltage-based (LV- and HV-side) protection and control for a two-winding transformer and two breakers.

Table 2. Functions and features

Included = •, Optional = O	ANSI function name	Functional application			
		A	B	C	D
Protection					
Phase percentage differential (two windings), restrained and unrestrained	87T, 87H	•	•	•	•
Phase overcurrents (Winding 1)	51P (1), 50P (1)	•	•	•	•
Phase overcurrents (Winding 2)	51P (2), 50P (2)	•	•	•	•
Directional phase overcurrent	67P		•	•	•
Neutral overcurrents (Winding 1)	51N (1), 50N (1)	•	•	•	•
Neutral overcurrents (Winding 2)	51N (2), 50N (2)	•	•	•	•
Ground overcurrents	51G, 50G	•	•	•	•
Directional neutral overcurrent	67N		•	•	•
Thermal overload (Winding 1)	49T (1)	•	•	•	•
Undercurrent (Winding 1)	37 (1)	•	•	•	•
Restricted earth fault (REF), low impedance (Winding 2)	REF (2)	•	•	•	•
Negative sequence overcurrent (Winding 1)	46 (1)	•	•	•	•
Negative sequence overcurrent (Winding 2)	46 (2)	•	•	•	•
Load sheds and restorations	81LSH		•	•	•
Underfrequencies, overfrequencies, rate-of-changes	81		•	•	•
Overexcitation	24		•	•	•
Resistive thermal devices (RTD)	38			•	
Phase undervoltage	27		•	•	•

Phase overvoltage	59		•	•	•
Phase sequence overvoltage	47		•	•	•
Ground overvoltage	59G		•	•	
Neutral overvoltage	59N		•	•	•
Circuit breaker failure1	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	o	o	o
Control					
Circuit breaker control[1)]	52 (1), 52(2)	•	•	•	•
Monitoring and supervision					
Trip circuit monitoring	TCM	•	•	•	•
Breaker condition monitoring[1)]	52CM (1), 52CM (2)	•	•	•	•
Fuse failure	60		•	•	•
Tap changer position	84T	•	•	•	•
Open CT secondary monitoring (Windings 1 & 2)	CTSRCTF	•	•	•	•
Measurement					
Three-phase currents (Winding 1)	IA, IB, IC (1)	•	•	•	•
Three-phase currents (Winding 2)	IA, IB, IC (2)	•	•	•	•
Sequence currents (Winding 1)	I1, I2, I0 (1)	•	•	•	•
Sequence currents (Winding 2)	I1, I2, I0 (2)	•	•	•	•
Ground current	IG	•	•	•	•
Demand values (Windings 1 & 2)		•	•	•	•
Maximum and minimum demand values (Windings 1 & 2)		•	•	•	•
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		•	•	•
Automation & Communications					
100Base-TX Ethernet (RJ-45)		o	o	o	o
100Base-FX Ethernet(LC)		o	o	o	o
100Base-TX Ethernet(RJ-45) + RS-485(1x4-wire or 2x2-wire) + IRIG-B		o	o	o	o
100Base-FX Ethernet(LC) + RS-485(1x4-wire or 2x2-wire) + IRIG-B		o	o	o	o
100Base-TX and -FX Ethernet (1 × LC, 2 × RJ-45) + serial glass fiber (ST)		o	o	o	o
100Base-TX Ethernet (3 × RJ-45) + serial glass fiber (ST)		o	o	o	o
Ethernet 100Base-TX (RJ-45) + configurable RS232/RS485 + [RS485 or serial glass fiber (ST) + IRIG-B][2)]		o	o	o	o
Records					
Sequence of events recorder	SER	•	•	•	•
Fault recorder	FLR	•	•	•	•
Digital fault (waveform) recorder	DFR	•	•	•	•

[1)] Applicable for two breakers
[2)] Not available with Arc Flash Detection (AFD) option

3. Protection functions

The RET615 relay features three-phase, multi-slope transformer differential protection with an instantaneous stage and a stabilized (biased) stage to provide fast and selective protection for phase-to-phase, winding interturn and bushing flash-over faults. Besides second harmonic restraint, an advanced waveform-based blocking algorithm ensures stability at transformer energization and a fifth harmonic restraint function ensures good protection stability at moderate overexcitation of power transformers. Sensitive low impedance restricted earth-fault (REF) protection completes the overall differential protection detecting ground faults nearest the grounded neutral point of the transformer. With the low-impedance REF protection, no external stabilizing resistors or varistors are needed and, for maximum flexibility, the grounded neutral CT is programmed independently of the phase CTs. Also, since the REF function does not require time-grading like other protection schemes, high-speed fault clearance can be achieved. The relay also incorporates a thermal overload protection function that supervises the thermal stress of the transformer windings that accelerate aging of the winding's insulation. Multiple stages of short-circuit, phase-overcurrent, negative-phase-sequence and ground fault back-up protection are available per winding. Ground fault protection based on the measured or calculated residual overvoltage is also available. Finally, the RET615 also includes circuit breaker failure protection, and, with optional hardware and software, features three light detection channels for arc fault protection of the circuit breaker, busbar and cable compartment of metal-enclosed indoor switchgear. The arc-fault protection sensor interface is available on the optional communication module. Fast tripping increases personal safety and limits material damage within the switchgear in an arc fault situation. Figures 1 through 6 show the protection functions available for the two standard configurations and their available analog inputs for each configuration. See section **24. Selection and ordering data** for details on the available analog inputs for each standard configuration.

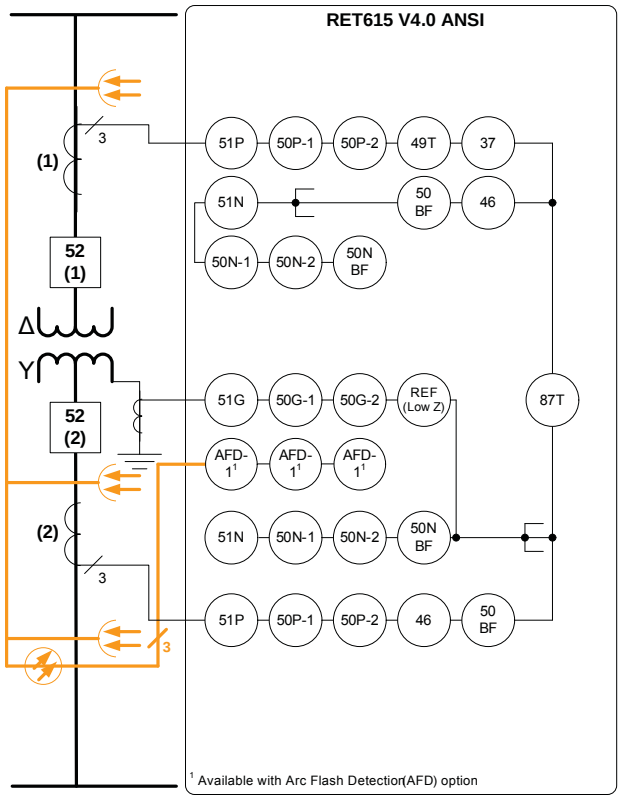

Figure 1. Protection functions overview for standard configuration A.

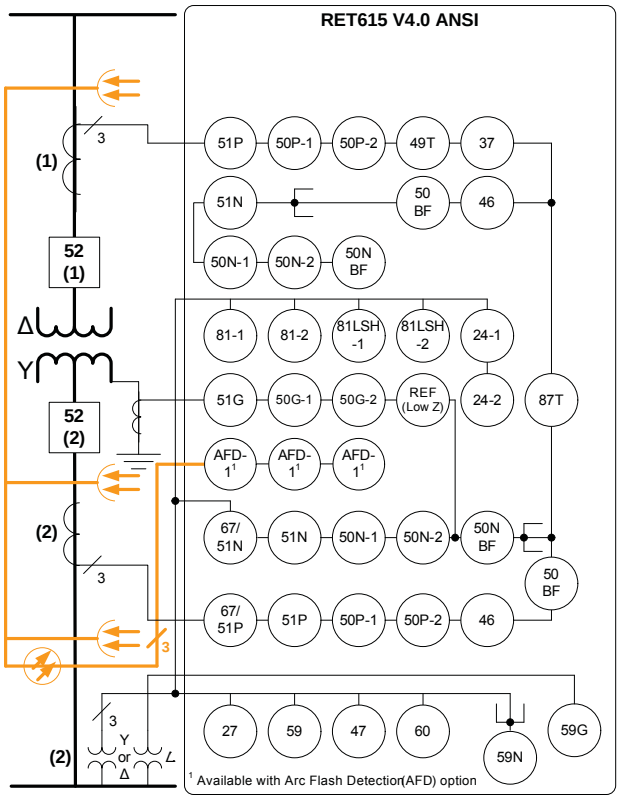

Figure 2. Protection functions overview for standard configuration B with analog inputs "BA".

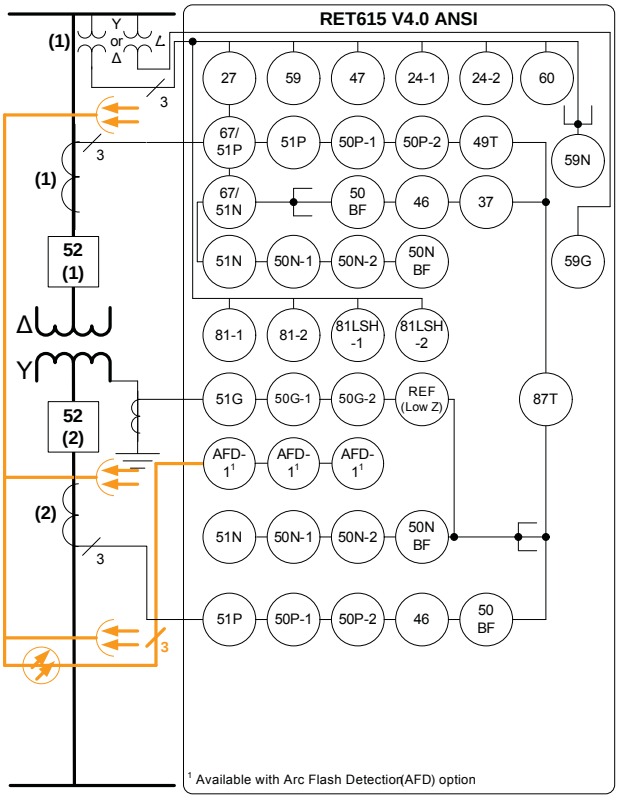

Figure 3. Protection functions overview for standard configuration B with analog inputs "BB".

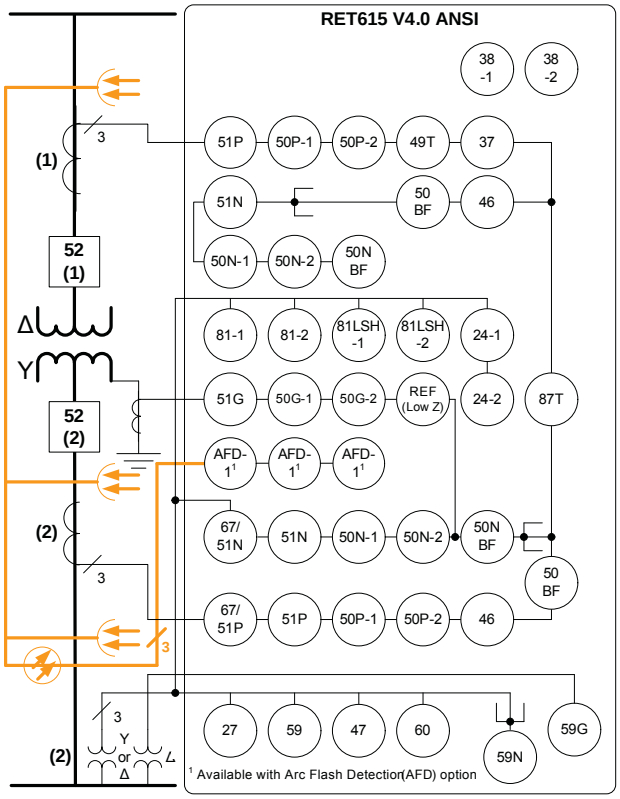

Figure 4. Protection functions overview for standard configuration C with analog inputs "CA".

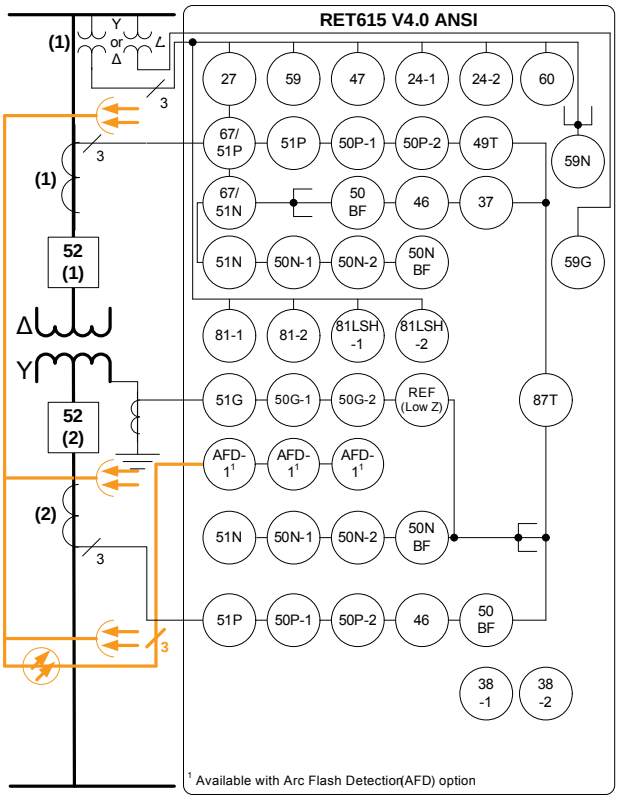

Figure 5. Protection functions overview for standard configuration C with analog inputs "CB".

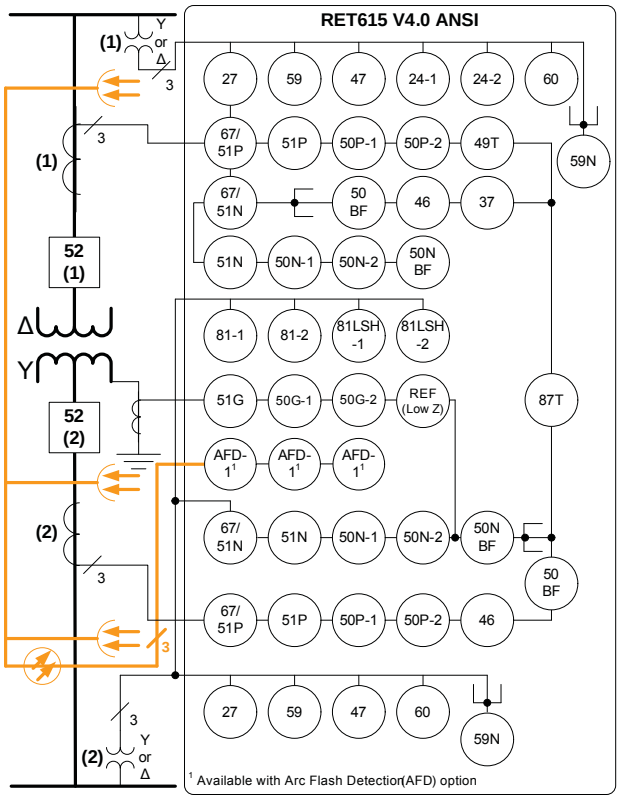

Figure 6. Protection functions overview for standard configuration D.

4. Application

The RET615 provides main protection for two-winding power transformers and power generator-transformer blocks. There are two standard configurations offering comprehensive protection functions for detection of faults within the transformer and within its zone of protection. Configuration A offers a current-only solution for cost-effective protection, control, measuring and recording of two-winding transformers with Ethernet communications. Configuration B includes voltage inputs for more comprehensive transformer protection and control with voltage protection against overexcitation and valuable power and energy metering measurements. The voltage inputs, and therefore, the voltage protection and measurements, are pre-configured to the winding-2 inputs of the RET615. In both configurations, the REF protective function is also pre-configured to the RET615 winding-2 inputs thus making it applicable only to a wye-grounded power transformer's low voltage winding configuration. Both relay standard configurations offer optional fiber Ethernet, serial and IRIG-B communications and arc flash detection sensors. Table 3 shows the programmable transformer winding configuration available for each winding and Figures 7-10 show typical two-winding power transformer winding configurations the RET615 will protect:

Table 3. Programmable power transformer winding configurations available per a) winding 1 and b) winding 2

a)

Winding 1 configuration type
"Y": WYE
"YN": WYE-GROUNDED
"D": DELTA
"Z": ZIG ZAG
"ZN": ZIG ZAG-GROUNDED

b)

Winding 2 configuration type
"y": wye
"yn": wye-grounded
"d": delta
"z": zig zag
"zn": zig zag-grounded

Table 4. Programmable transformer phase shift from winding 1 to winding 2

Clock number setting	Degrees phase shift (winding 1-2)
0	0°
1	30°
2	60°
4	120°
5	150°
6	180°
7	210°
8	240°
10	300°
11	330°

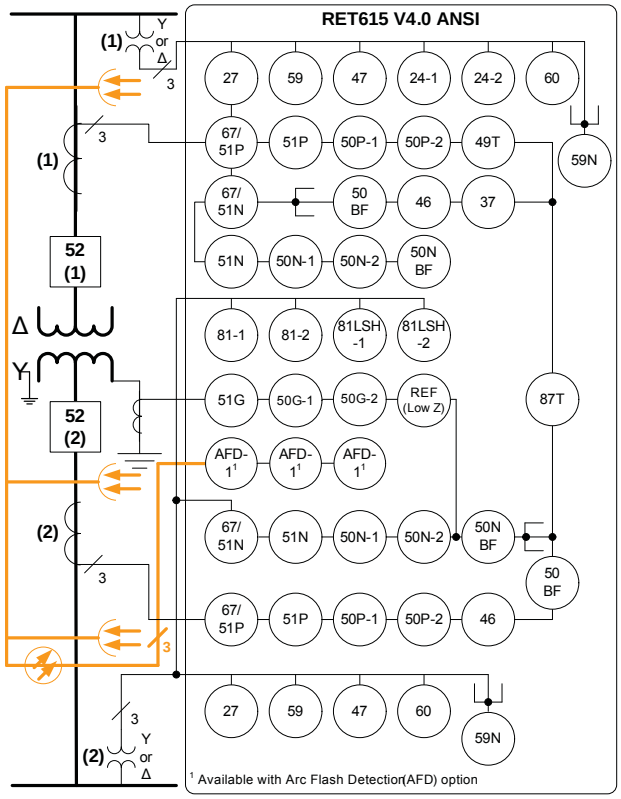

Figure 7. RET615 protection and control of a delta, wye-grounded power transformer.

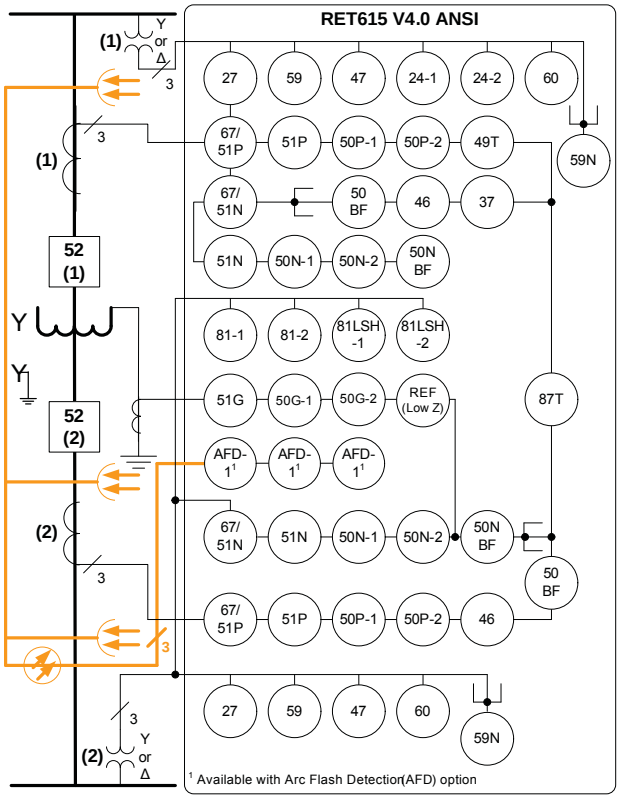

Figure 8. RET615 protection and control of a wye, wye-grounded power transformer or autotransformer.

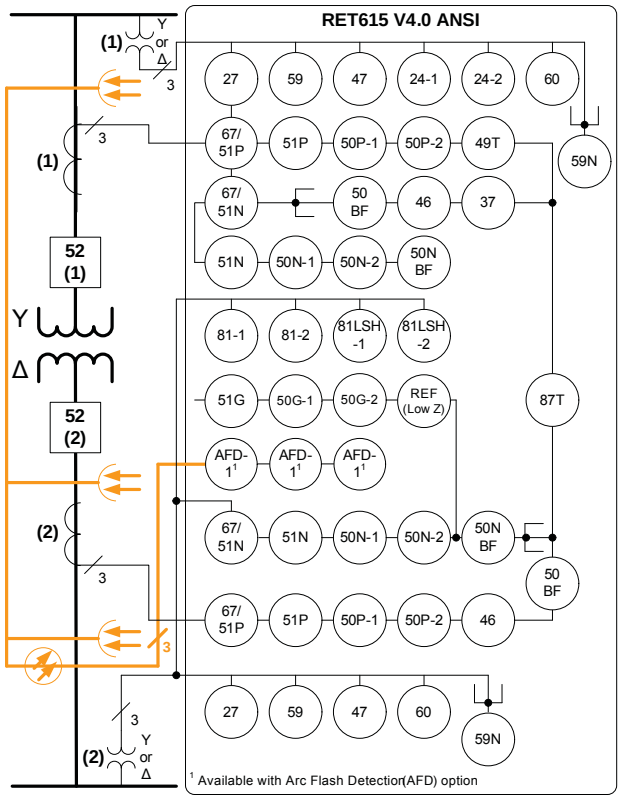

Figure 9. RET615 protection and control of a wye, delta power transformer.

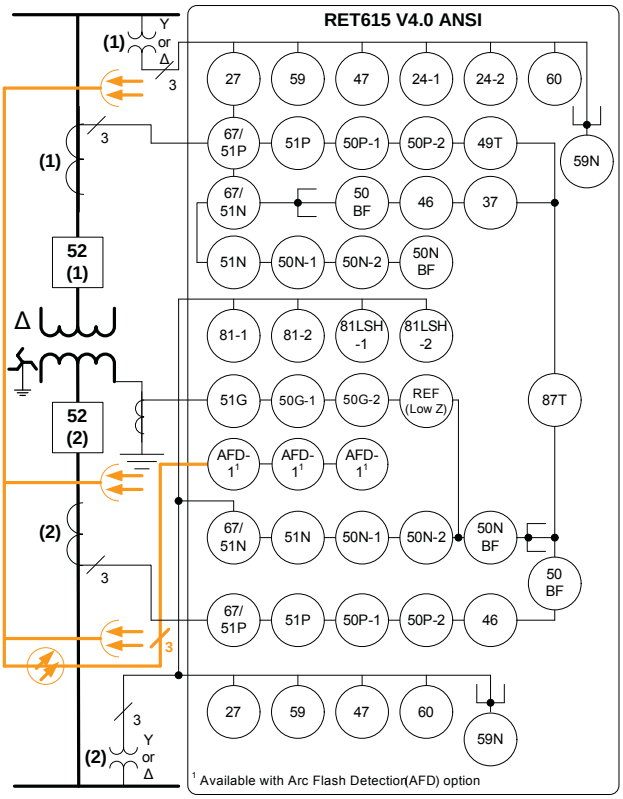

Figure 10. RET615 protection and control of a delta, zig zag-grounded power transformer.

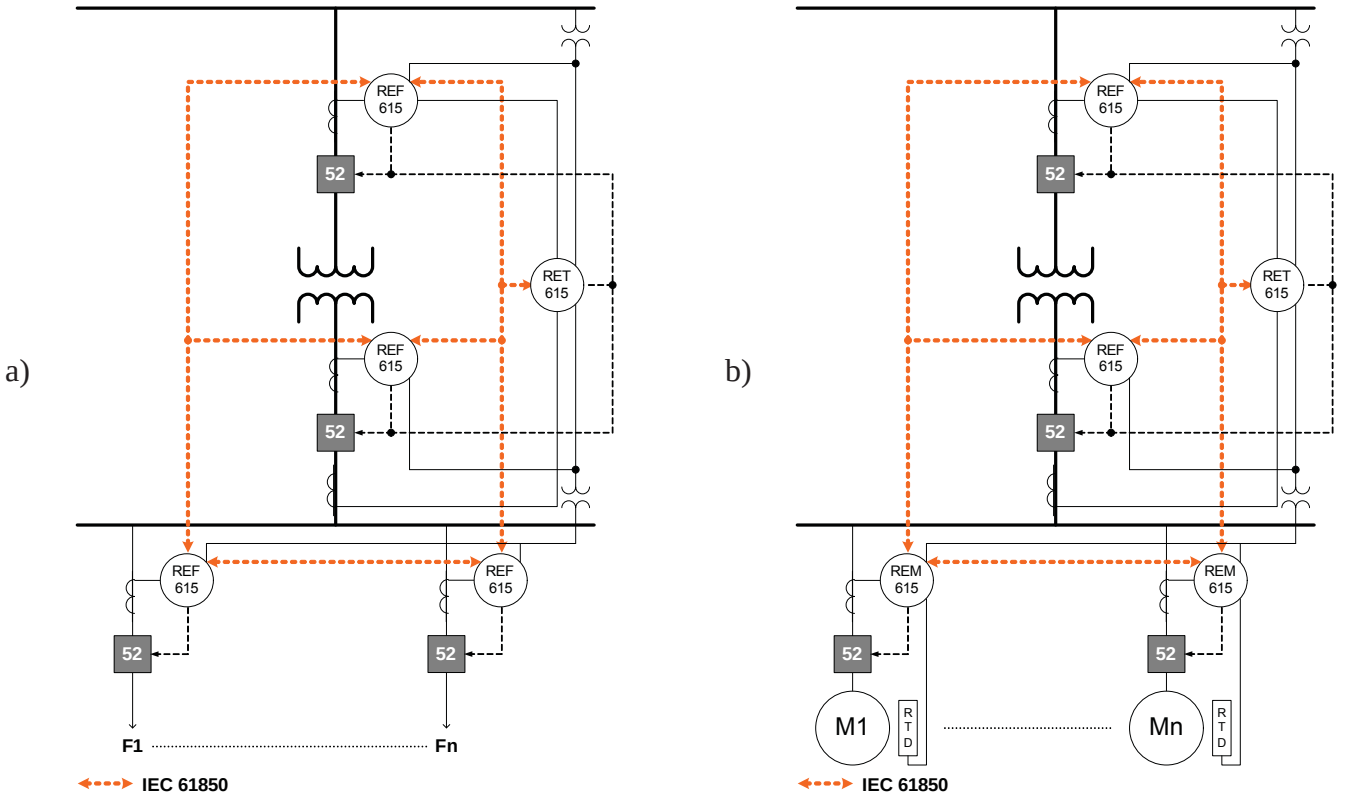

Figure 11. High-speed bus protection with the RET615 using IEC61850 in a) utility applications and b) industrial applications.

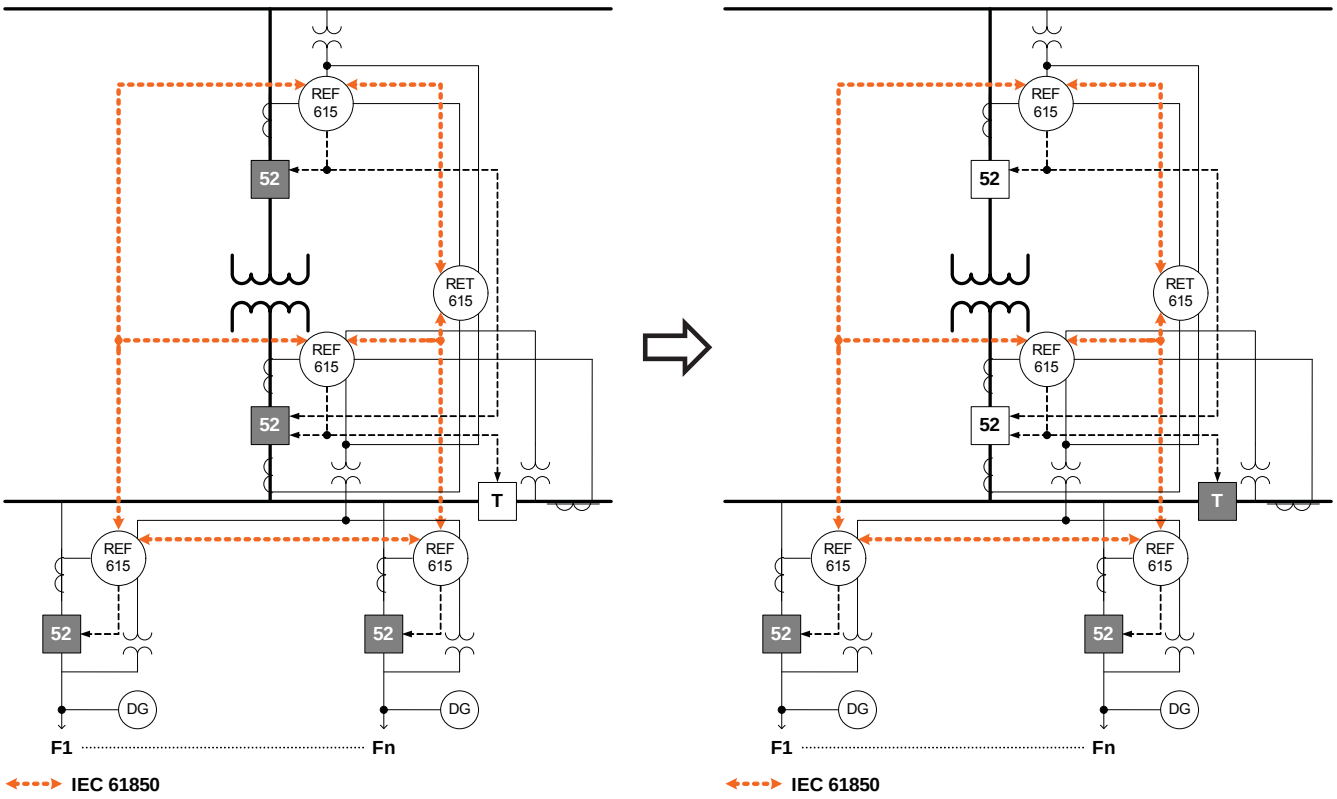

Figure 12. Open (cold) high-speed bus transfer with the RET615 and IEC 61850 GOOSE messaging.

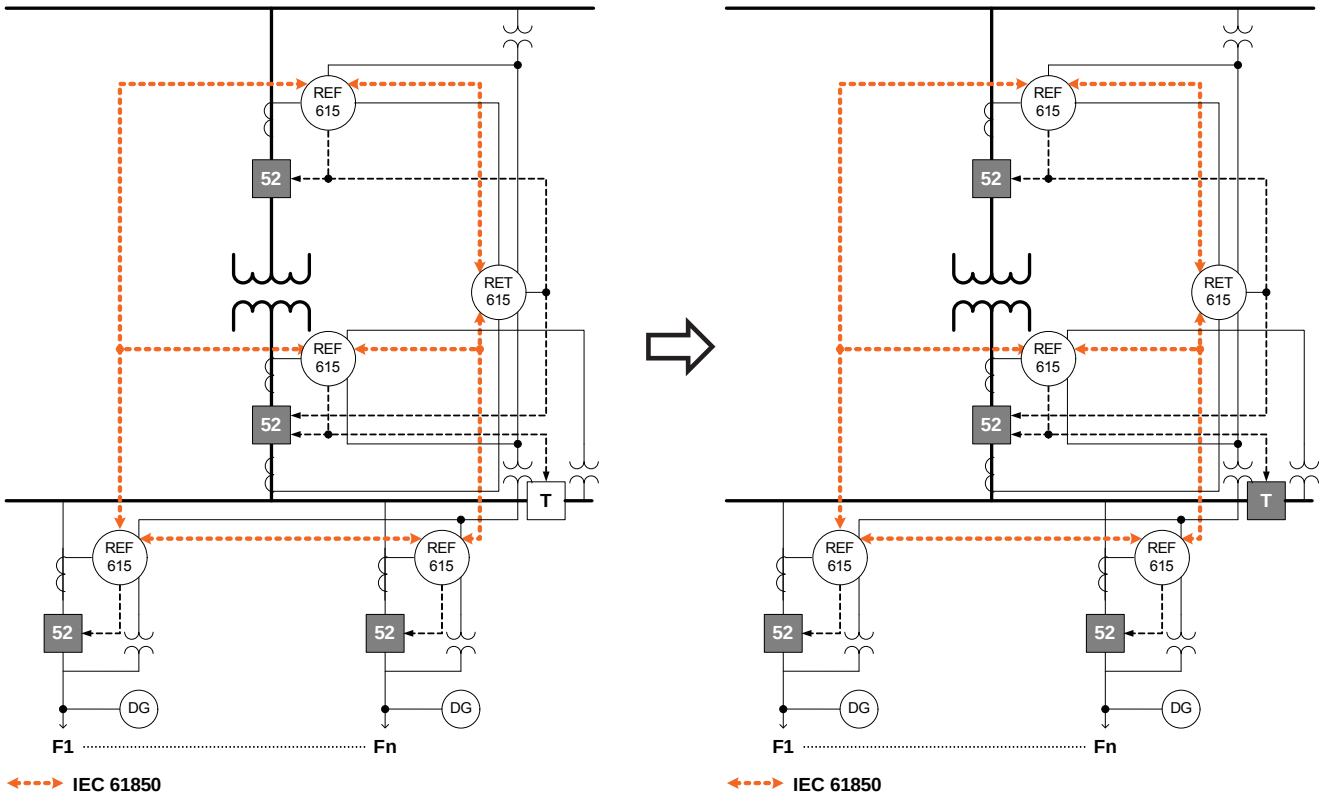

Figure 13. Closed (hot) high-speed bus transfer with the RET615 and IEC 61850 GOOSE messaging.

5. Supported ABB solutions

ABB's 615 series protection and control relays 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 relays are supplied with Connectivity Packages containing a compilation of software and relay-specific information including single-line diagram templates, a full relay data model including event and parameter lists. By utilizing the Connectivity Packages the relays can be readily configured via the PCM600 Protection and Control Relay Manager and integrated with the COM600 Station Automation device or the MicroSCADA Pro network control and management system.

The 615 series relays 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 relays 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 relays. 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 relays and network-level control and management systems such as MicroSCADA Pro and System 800xA.

Table 5. Supported ABB solutions

Product	Version
Station Automation COM600	3.4 or later
MicroSCADA Pro	9.3 or later

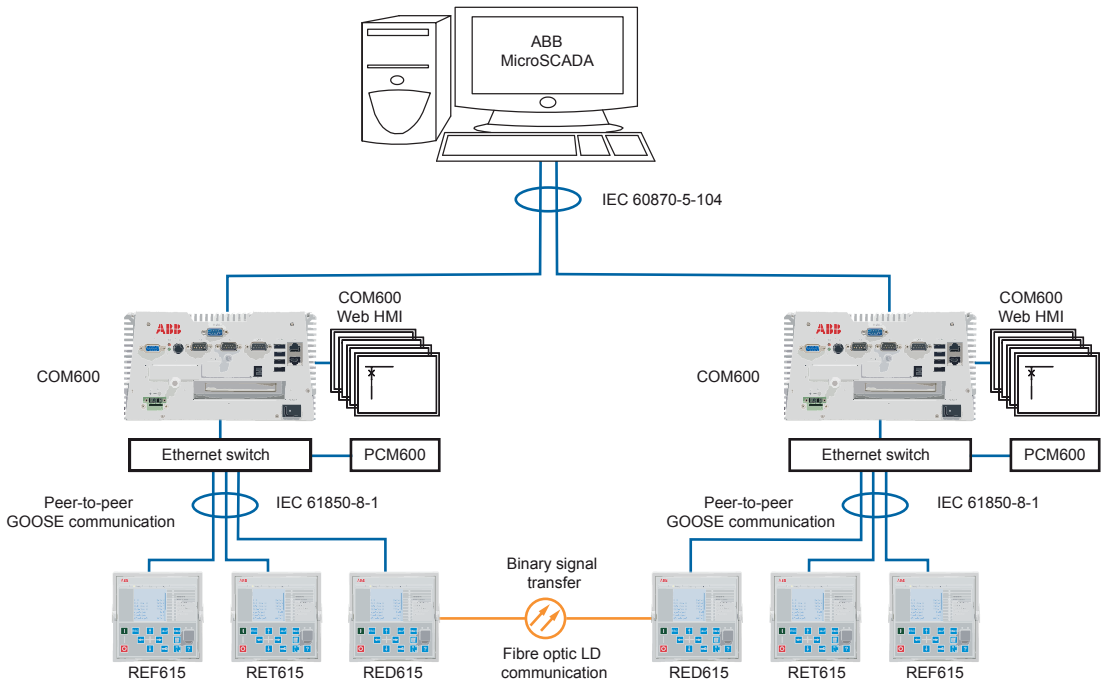

Figure 14. Utility distribution network example using 615 series relays, Station Automation COM600 and MicroSCADA Pro

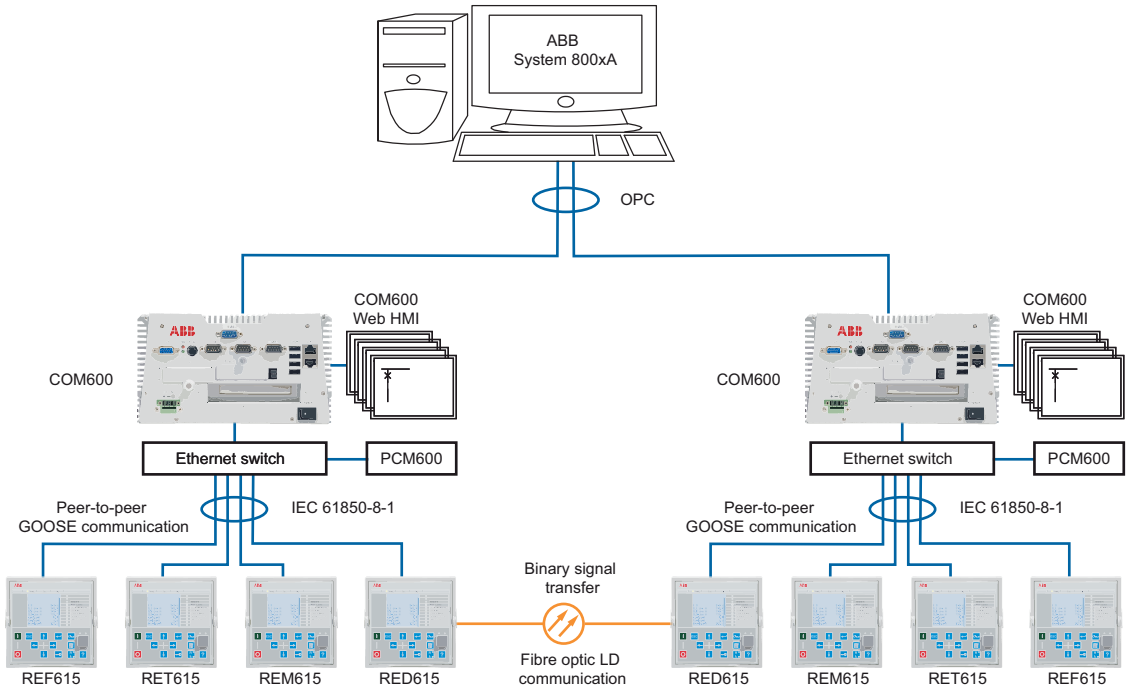

Figure 15. Industrial distribution network example using 615 series relays, Station Automation COM600 and System 800xA

6. Control

The relay offers status and control of two breakers with a set of push-buttons on the front panel local human machine interface (LHMI) for opening and closing a breaker. Interlocking schemes required by the application are configured with the signal matrix in PCM600.

7. Measurements

The RET615 continuously measures the winding-1 high-voltage (HV) side and winding-2 low-voltage (LV) sides' phase currents and calculated neutral currents of the protected transformer. Where an applicable ground neutral CT input is connected, measured ground current is available. With VT inputs options, 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.

In addition, the relay calculates the demand and minimum and maximum demand currents over a user-selectable pre-set time frame plus additional voltage, power, energy and power factor measurements with the VT inputs option. Calculated values are also obtained from the protection and condition monitoring functions of the RET615.

The values measured can be accessed locally via the user interface on the LHMI front panel display or remotely via its user tool interface PCM600. 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. With the VT option, phase and ground voltage waveforms would be available for inclusion in each digital recording.

9. Events recorder

The relay 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. In addition, the maximum demand phase currents with date and time stamp are separately stored as recorded data. 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.

11. Circuit-breaker condition monitoring

For continuous knowledge of the operational availability of the RET615 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. For all standard configurations, there is a condition monitoring feature for each of the two breakers supported.

12. Current circuit supervision

The RET615 includes a unique current circuit supervision feature to monitor the health of the two sets of three-phase CT circuits. Current circuit supervision is used for detecting an open in the current transformer secondary circuits. On detecting an opening circuit, the current circuit supervision function activates an alarm LED and blocks certain protection functions to avoid unintended operation.

13. Single-line diagram (SLD)

The relay includes the ability for the user to design a unique single line diagram (SLD) viewed 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.

14. Trip-circuit monitoring

The trip-circuit monitoring continuously supervises 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.

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.

15. 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.

16. Fuse failure protection

Depending on the chosen standard configuration, the RET615 includes fuse failure supervision functionality. The fuse failure supervision detects failures between the voltage measurement circuit and the RET615. 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.

17. Access control

To protect the RET615 from unauthorized access and to maintain information integrity, the RET615 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.

18. Inputs and outputs

In both standard configurations available, the RET615 is equipped with three-phase CT analog inputs per winding and a ground CT input for fundamental two-winding power transformer protection and control including restrained and high-set unrestrained phase differential, restricted earth fault (REF), transformer thermal overload and backup phase, neutral and ground overcurrent protection, plus control, current and demand current measurements and event, fault and waveform recording. Maximizing flexibility of application, each winding's phase CT and the ground CT secondary ratings are independently user programmable to 5 A or 1 A. The "B" configuration having the voltage inputs (VT) option allows for independent user programmable VT secondary rating for the three-phase and ground VT analog inputs and includes valuable phase and ground voltage protection functions useful in transformer overexcitation, LV bus voltage concerns and high-speed bus transfer schemes. Expanded metering of voltage, power, energy and power factor measurements are included with the VT inputs option.

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 the RET615 PCM600 software user tool. Relay analog input and binary input/output overview:

- Three phase-current CT inputs for winding-1
- Three phase-current CT inputs for winding-2
- Ground CT input
- Optional three-phase, and ground VT inputs
- Twelve binary inputs standard with VT inputs
- Three NO outputs
- One Form C output
- One Form C self-check alarm output
- Additional binary inputs and outputs optional
- High-speed outputs (1 ms operate time) optional

Table 6. Analog inputs overview

Standard configuration	Analog inputs	Analog inputs			
		CT[1)]	VT	RTD	mA
A	AA	7	0	0	0
B	BA	7	4	0	0
B	BB	7	4	0	0
C	CA	7	4	2	1
C	CB	7	4	2	1
D	DA	7	6	0	0

[1)] Ground CT (I_{nom} = 5/1 A)

Table 7. Binary inputs and outputs (I/O) overview

Standard configuration	Binary I/O	Binary inputs / binary outputs (type[1)])				
		BI	BO(PO)	BO(HSO)	BO(TO)	BO(SO)
A	A1	8	4	3	1	1
A	AA	8	4	0	1	5
A	A2	14	4	3	1	4
A	AB	14	4	0	1	8
B	B1	12	4	3	1	1
B	BA	12	4	0	1	5
C	C1	8	4	3	1	1
C	CA	8	4	0	1	5
D	D1	11	4	3	1	1
D	DA	11	4	0	1	5

[1)] PO: Power output (trip rated; high-current inductive break)
HSO: High-speed output (1 ms operate time; trip rated; high-current inductive break)
TO: Trip output (trip rated; low-current inductive break) on X100 named SO1
SO: Signal output (signal rated; low-current inductive break)

19. Communications

The relay 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 relay supports simultaneous event reporting to five different clients on the communication network bus.

The relay can send binary signals to other relays (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 relay 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 relay applications.

The relay offers an optional second Ethernet bus to enable the creation of a self-healing Ethernet ring topology. The relay 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 relays is built using CAT5 STP cables. The LC port can in this case be used for connecting the relay 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 relays 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 relays are to be connected, it is recommended that the network is split into several rings with no more than 30 relays 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 relay 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 relay 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 relay 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 relay 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 relay 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 relay supports time synchronization via the following serial communication protocols:
• Modbus
• DNP3.0 Level 2

Table 8. Supported station communication interfaces and protocols

Interfaces/Protocols	Ethernet		Serial	
	100BASE-TX (RJ-45)	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

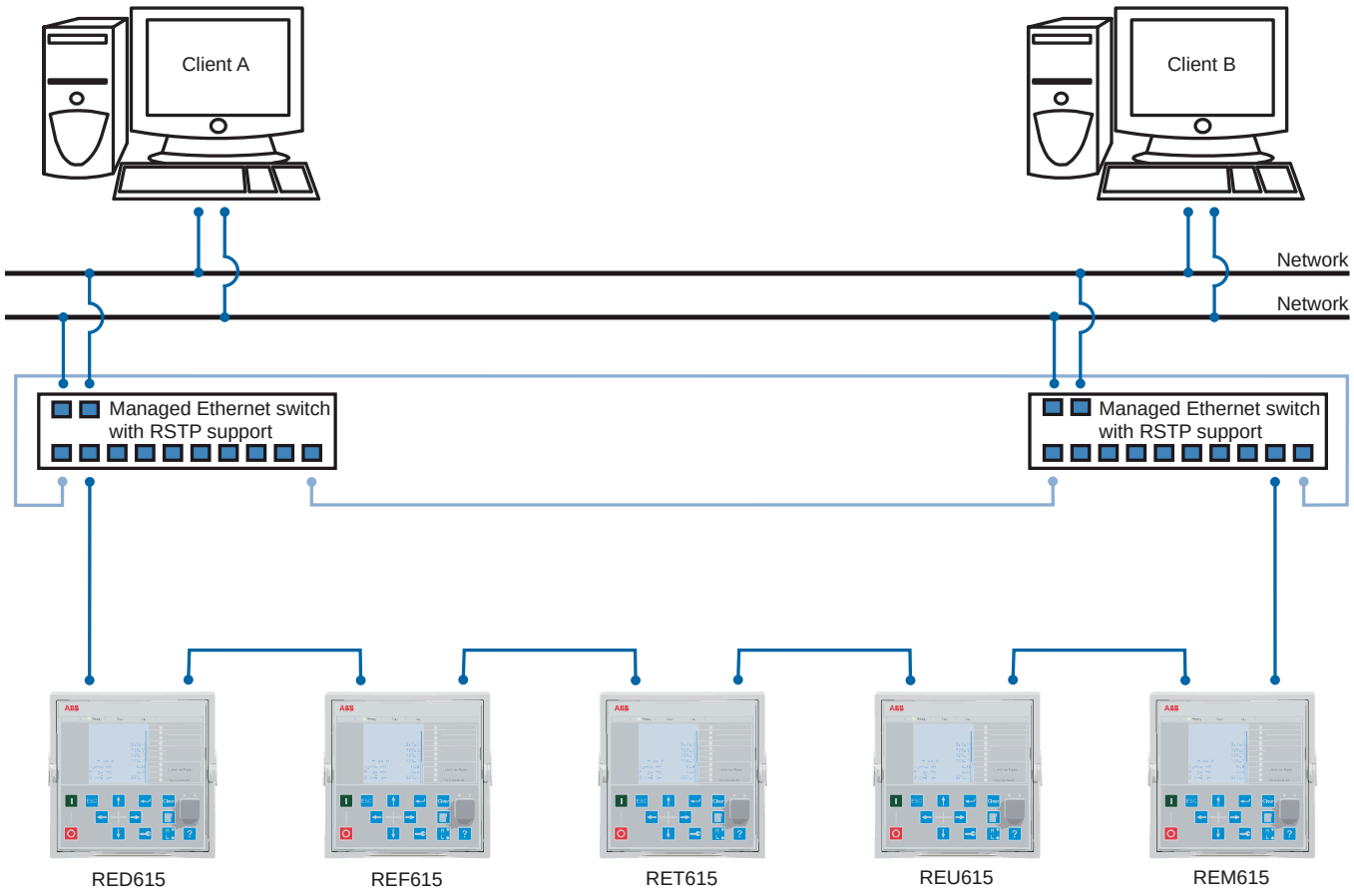

Figure 16. Communication ring application

20. Technical data

Table 9. Dimensions

Description	Value	
Width	frame case	7.08" (179.8 mm) 6.46" (164 mm)
Height	frame case	6.97" (177 mm), 4U 6.30" (160 mm)
Depth	case	7.64" (194 mm)
Weight	relay draw-out unit	7.72 lbs. (3.5 kg) 3.97 lbs. (1.8 kg)

Table 10. 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 < 12.0 W (nominal) / < 18.0 W (max), AC < 16.0 W (nominal) / < 21.0W (max)	DC < 12.0 W (nominal) / < 18.0 W (max)
Ripple in the DC auxiliary voltage	Max 15% of the DC value (at frequency of 100 Hz)	
Maximum interruption time in the auxiliary DC voltage without resetting the relay	50 ms at nominal voltage	50 ms at nominal voltage
Fuse type	T4A/250 V	

Table 11. Analog inputs

Description		Value	
Rated frequency		60/50 Hz ± 5 Hz	
Current inputs	Rated current, I_n	5/1 A[1)]	0.2 A[2)]
	Thermal withstand capability: • Continuously • For 1 s	 20 A 500 A	 4 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 • For 10 s	 2 × V_n (240 V AC) 3 × V_n (360 V AC)	
	Burden at rated voltage	<0.05 VA	

[1)] Phase and ground current inputs
[2)] Sensitive earth fault (SEF)/high impedance (HIZ) detection current input

Table 12. Measuring range

Description	Value
Measured currents on phases IA, IB and IC as multiples of the rated currents of the analog inputs	0...50 × I_n
Ground current as a multiple of the rated current of the analog input	0...50 × I_n

Table 13. 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 14. Signal outputs (SO) on X120 and X130 [Typical operation time: 5...8 ms]

Description	Value
Rated voltage	250 V AC/DC
Continuous 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 15. 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 16. Double-pole power output (PO) relays with TCM [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 (two contacts connected in series)	5 A/3 A/1 A
Minimum contact load	100 mA at 24 V AC/DC
Trip-circuit monitoring (TCM): • Control voltage range • Current drain through the monitoring circuit • Minimum voltage over the TCM contact	 20...250 V AC/DC ~1.5 mA 20 V AC/DC (15...20 V)

Table 17. Single-pole power output (PO) relays [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 18. Double-pole signal output (SO1) on X100 [Typical operation time: 8...11 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 19. High-speed output (HSO) devices [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 20. Ethernet 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	115200bits/s

[1] Depending on the optional communication module.

Table 21. Network Ethernet ports specifications

Connector	Fiber type[1]	Wavelength	Max. distance	Permitted path attenuation[2]
LC	MM 62.5/125 µm glass fiber core	1300 nm	2 km	<8 dB
ST	MM 62.5/125 µm glass fiber core	820-900 nm	1 km	<11 dB

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

Table 22. IRIG-B

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

[1] According to 200-04 IRIG standard

Table 23. Lens sensor and optical fiber for arc flash detection (AFD)

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...+212 °F (-40...100 °C)
Maximum service temperature range of the lens, max 1 h	+284 °F (+140 °C)
Minimum permissible bending radius of the connection fiber	3.94" (100 mm)

Table 24. Degree of protection of flush-mounted relay

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

Table 25. Environmental conditions

Description	Value
Continuous operating temperature range	-25...+55 °C
Short-term operating temperature range	-40...+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 HMI performance outside the continuous operating temperature range.
[2] For relays with an LC communications interface, the maximum operating temperature is +70 °C .

Table 24. Environmental tests

Description	Type test value	Reference
Dry heat test (humidity <50%)	• 96 h at +55 °C • 16 h at +85 °C [1] • 12 h at +85 °C [1]	IEC 60068-2-2 IEEE C37.90-2005
Dry cold test	• 96 h at -25 °C • 16 h at -40 °C • 12 h at -40 °C	IEC 60068-2-1 IEEE C37.90-2005
Damp heat test, cyclic	• 6 cycles (12 h + 12 h) at +25...+55 °C, humidity >93% • +25 °C, Rh = 95%, 96h	IEC 60068-2-30 IEEE C37.90-2005
Storage test	• 96 h at -40 °C • 96 h at +85 °C	IEC 60068-2-48 IEEE C37.90-2005

[1)] For relays with an LC communication interface the maximum operating temperature is +70 °C.

Table 27. Electromagnetic compatibility tests

Description	Type test value	Reference
1 MHz burst disturbance test: • Common mode • Differential mode	 2.5 kV 2.5 kV	IEC 61000-4-18 IEC 60255-22-1, class III IEEE C37.90.1-2002
Electrostatic discharge test • Contact discharge • Air discharge	 8 kV 15 kV	IEC 61000-4-2 IEC 60255-22-2 IEEE C37.90.3-2001
Radio frequency interference tests:	10 V (emf) f = 150 kHz...80 MHz 10 V/m (rms) f=80...2700 MHz 10 V/m f=900 MHz 20 V/m (rms) f=80...1000 MHz	IEC 61000-4-6 IEC 60255-22-6, class III IEC 61000-4-3 IEC 60255-22-3, class III ENV 50204 IEC 60255-22-3, class III IEEE C37.90.2-2004
Fast transient disturbance tests: • All ports	 4 kV	IEC 61000-4-4 IEC 60255-22-4 IEEE C37.90.1-2002
Surge immunity test: • Communication • Other ports	 1 kV, line-to-earth 4 kV, line-to-earth 2 kV, line-to-line	IEC 61000-4-5 IEC 60255-22-5
Power frequency (50 Hz) magnetic field: • Continuous • 1-3 s	 300 A/m 1000 A/m	IEC 61000-4-8
Voltage dips and short interruptions	30%/10 ms 60%/100 ms 60%/1000 ms >95%/5000 ms	IEC 61000-4-11
Power frequency immunity test: • Common mode • Differential mode	Binary inputs only 300 V rms 150 V rms	IEC 61000-4-16 IEC 60255-22-7, class A
Emission tests: • Conducted 0.15...0.50 MHz 0.5...30 MHz • Radiated 30...230 MHz 230...1000 MHz	 < 79 dB(µV) quasi peak < 66 dB(µV) average < 73 dB(µV) quasi peak < 60 dB(µV) average < 40 dB(µV/m) quasi peak, measured at 10 m distance < 47 dB(µV/m) quasi peak, measured at 10 m distance	EN 55011, class A IEC60255-25

Table 29. Insulation tests

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

Table 30. Mechanical tests

Description	Reference	Requirement
Vibration tests (sinusoidal)	IEC 60068-2-6 (test Fc) IEC 60255-21-1	Class 2
Shock and bump test	EC-60068-2-27 (test Ea shock) IEC 60068-2-29 (test Eb bump) IEC 60255-21-2	Class 2
Seismic test	IEC 60255-21-3	Class 2
Mechanical durability	IEEE C37.90-2005 IEC 602556-6	• 200 withdrawals and insertions of the plug-in unit • 200 adjustments of relay setting controls

Table 31. Product safety

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

Table 32. EMC compliance

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

Table 33. RoHS compliance

Complies with the RoHS directive 2002/95/EC

Protection functions

Table 34. Three-phase non-directional overcurrent protection (51P, 50P)

Characteristic		Value		
Pickup accuracy	51P	Depending on the frequency of the current measured: f_n ±2Hz		
		±1.5% of the set value or ±0.002 × I_n		
	50P-1, 50P-2	±1.5% of set value or ±0.002 × I_n (at currents in the range of 0.1...10 × I_n) ±5.0% of set value (at currents in the range of 10...40 × I_n)		
Pickup time [1) 2)]		Minimum	Typical	Maximum
	51P, 50P-1, and 50P-2: I_{Fault} = 2 × 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 × f_n, where n = 2, 3, 4, 5,... Peak-to-Peak: No suppression P-to-P+backup: No suppression		

1) Set Trip delay time = 0.02 s, Operate curve type = IEC definite time, Measurement mode = default (depends on stage), current before fault = 0.0 × I_n, f_n = 50 Hz, fault current in one phase with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements

2) Includes the delay of the signal output contact

3) Maximum Pickup range = 2.5 × I_n, Pickup range multiples in range of 1.5 to 20

Table 35. Three-phase non-directional overcurrent protection (51P, 50P) main settings

Parameter	Function	Value (Range)	Step
Pickup range	51P	0.05...5.00 × I_n	0.01
	50P-1. 50P-2	0.10...40.00 × I_n	0.01
Time multiplier	51P	0.05...15.00	0.05
	50P-1. 50P-2	0.05...15.00	0.05
Definite time delay	51P	40...200000 ms	10
	50P-1. 50P-2	40...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	

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

Table 36. Three-phase directional overcurrent protection (67/51P)

Characteristic		Value		
Pickup accuracy		Depending on the frequency of the current/voltage measured: f_n ±2Hz		
		Current: ±1.5% of the set value or ±0.002 × I_n Voltage: ±1.5% of the set value or ±0.002 × V_n Phase angle: ±2°		
Pickup time [1) 2)]		Minimum	Typical	Maximum
	I_{Fault} = 2.0 × set Pickup value	38 ms	43 ms	46 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 × f_n, where n = 2, 3, 4, 5,...		

[1)] Measurement mode and Pol quantity = default, current before fault = 0.0 × I_n, voltage before fault 1.0 × V_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 range = 2.5 × I_n, Pickup range multiples in range of 1.5 to 20

Table 37. Three-phase directional overcurrent protection (67/51P) main settings

Parameter	Function	Value (Range)	Step
Pickup range	67/51P	0.05...5.00 × I_n	0.01
Time multiplier	67/51P	0.05...15.00	0.05
Definite time delay	67/51P	40...200000 ms	10
Directional mode	67/51P	1 = Non-directional 2 = Forward 3 = Reverse	
Characteristic angle	67/51P	-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	

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

Table 38. Non-directional neutral, ground fault protection (51N, 51G, 50N, 50G)

Characteristic		Value		
Pickup accuracy		Depending on the frequency of the current measured: f_n ±2Hz		
	51N, 51G	±1.5% of the set value or ±0.002 × I_n		
	50N, 50G	±1.5% of set value or ±0.002 × I_n (at currents in the range of 0.1...10 × I_n)		
Pickup time [1) 2)]		Minimum	Typical	Maximum
	51N, 51G, and 50N-1, 50N-2, 50G-1, 50G-2: I_{Fault} = 2 × 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 × 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 × 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 range = 2.5 × I_n, Pickup range multiples in range of 1.5 to 20

Table 39. Non-directional neutral, ground fault protection (51N, 51G, 50N, 50G) main settings

Parameter	Function	Value (Range)	Step
Pickup range	51N, 51G	0.05...5.00 × I_n	0.01
	50N-1, 50N-2, 50G-1, 50G-2	0.10...40.00 × I_n	0.01
Time multiplier	51N, 51G	0.05...15.00	0.05
	50N-1, 50N-2, 50G-1, 50G-2	0.05...15.00	0.05
Definite time delay	51N, 51G	40...200000 ms	10
	50N-1, 50N-2, 50G-1, 50G-2	40...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	

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

Table 40. Directional neutral fault protection (67/51N)

Characteristic		Value		
Pickup accuracy		Depending on the frequency of the current measured: f_n ±2Hz		
		Current: ±1.5% of the set value or ±0.002 × I_n Voltage: ±1.5% of the set value or ±0.002 × V_n Phase angle: ±2°		
Pickup time [1) 2)]		Minimum	Typical	Maximum
	67/51N: I_{Fault} = 2 × 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 × f_n, 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 = IEC definite time, Measurement mode = default (depends on stage), current before fault = 0.0 × 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 range = 2.5 × I_n, Pickup range multiples in range of 1.5 to 20

Table 41. Directional neutral fault protection (67/51N) main settings

Parameter	Function	Value (Range)	Step
Pickup range	67/51N	0.05...5.00 × I_n	0.01
Directional mode	67/51N	1=Non-directional 2=Forward 3=Reverse	
Time multiplier	67/51N	0.05...15.00	0.05
Definite time delay	67/51N	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	
Operation mode	67/51N	1=Phase angle 2=I_0Sin 3=I_0Cos 4=Phase angle 80 5=Phase angle 88	

Table 42. Three-phase overvoltage protection (59)

Characteristic		Value		
Pickup accuracy		Depending on the frequency of the voltage measured: f_n ±2Hz		
		±1.5% of the set value or ±0.002 × V_n		
Pickup time [1) 2)]		Minimum	Typical	Maximum
	V_{Fault} = 1.1 × set Pickup value	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 × f_n, where n = 2, 3, 4, 5,...		

[1)] Pickup range = 1.0 × V_n, Voltage before fault 0.9 × V_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 range = 1.20 × V_n, Pickup range multiples in range of 1.10 to 2.00

Table 43. Three-phase overvoltage protection (59) main settings

Parameter	Function	Value (Range)	Step
Pickup range	59	0.05...1.60 × V_n	0.01
Time multiplier	59	0.05...15.00	0.05
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 44. Three-phase undervoltage protection (27)

Characteristic		Value		
Pickup accuracy		Depending on the frequency of the voltage measured: f_n ±2Hz		
		±1.5% of the set value or ±0.002 × V_n		
Pickup time [1) 2)]		Minimum	Typical	Maximum
	V_{Fault} = 0.9 × set Pickup value	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 × f_n, where n = 2, 3, 4, 5,...		

[1)] Pickup range = 1.0 × V_n, Voltage before fault 1.1 × V_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 range = 0.50, Pickup range multiples in range of 0.90 to 0.20

Table 45. Three-phase undervoltage protection (27) main settings

Parameter	Function	Value (Range)	Step
Pickup range	27	0.05...1.20 × V_n	0.01
Time multiplier	27	0.05...15.00	0.05
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 46. Negative sequence overvoltage protection (47)

Characteristic		Value		
Pickup accuracy		Depending on the frequency of the voltage measured: f_n ±2Hz		
		±1.5% of the set value or ±0.002 × V_n		
Pickup time [1) 2)]		Minimum	Typical	Maximum
	V_{fault} = 1.1 × set Pickup value	33 ms	35 ms	38 ms
	V_{fault} = 2.0 × 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 × f_n, where n = 2, 3, 4, 5,...		

[1)] Negative sequence voltage before fault 0.0 × V_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 47. Negative sequence overvoltage protection (47) main settings

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

Table 48. 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 × V_n		
Pickup time [1) 2)]		Minimum	Typical	Maximum
	V_{fault} = 1.1 × 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 × f_n, where n = 2, 3, 4, 5,...		

1) Residual voltage before fault 0.0 × V_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 49. Ground overvoltage protection (59G) main settings

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

Table 50. Negative sequence overcurrent protection (46)

Characteristic		Value		
Pickup accuracy		Depending on the frequency of the current measured: f_n = ±2Hz		
		±1.5% of the set value or ±0.002 × I_n		
Pickup time [1) 2)]		Minimum	Typical	Maximum
	I_{Fault} = 2 × set Pickup value	22 ms	25 ms	27 ms
	I_{Fault} = 10 × 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 × 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 Pickup range = 2.5 × I_n, Pickup range multiples in range of 1.5 to 20

Table 51. Negative sequence overcurrent protection (46) main settings

Parameter	Function	Value (Range)	Step
Pickup range	46	0.01...5.00 × I_n	0.01
Time multiplier	46	0.05...15.00	0.05
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 52. Thermal overload protection, two time constants (49T)

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

[1)] Overload current > 1.2 × Operate level temperature

Table 53. Thermal overload for protection, two time constants (49T) main settings

Parameter	Function	Value (Range)	Step
Temperature rise	**49T**	0.0...200.0 °C	0.1
Max temperature	**49T**	0.0...200.0 °C	0.1
Operate temperature	**49T**	80.0...120.0 %	0.1
Weighting factor p	**49T**	0.00...1.00	0.01
Short time constant	**49T**	6...60000 s	1
Current reference	**49T**	0.05...4.00 × I_n	0.01
Operation	**49T**	Off On	-

Table 54. Stabilized differential protection of two winding transformers (87T)

Characteristic		Value		
Pickup accuracy		Depending on the frequency of the voltage measured: f_n ±2Hz		
		±3.0% of the set value or ±0.002 × I_n		
Trip time [1) 2)]		Minimum	Typical	Maximum
	Low stage	34 ms	40 ms	44 ms
	High stage	21 ms	22 ms	24 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Suppression of harmonics		DFT: -50dB at f = n × f_n, where n = 2, 3, 4, 5,...		

[1)] Current before fault = 0.0, f_n = 50 Hz, results based on statistical distribution of 1000 measurements
[2)] Includes the delay of the output contact. When differential current = 2 × set operate value and f_n = 50 Hz.

Table 55. Stabilized differential protection of two winding transformers (87T) main settings

Parameter	Function	Value (Range)	Step
Restraint mode	87T	2.h & 5.h & wav	-
High operate value	87T	500...3000 %	10
Low operate value	87T	5...50 %	1
Slope section 2	87T	10...50 %	1
End section 2	87T	100...500 %	1
Pickup value 2.H	87T	7...20 %	1
Pickup value 5.H	87T	10...50 %	1
Operation	87T	Off On	-
Winding 1 type	87T	Y YN D Z ZN	-
Winding 2 type	87T	Y YN D Z ZN	-
Zro A elimination	87T	Not eliminated Winding 1 Winding 2 Winding 1 and 2	-

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

Characteristic	Value
Pickup accuracy	At the frequency f=f_n
	Current measurement: ±1.5% of the set value or ±0.002 × I_n 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 57. Three-phase inrush current detection (INR) main settings

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

Table 58. Circuit breaker failure protection (50BF, 50NBF)

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

Table 59. Circuit breaker failure protection (50BF, 50NBF) main settings

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

Table 60. Arc protection (AFD)

Characteristic		Value		
Pickup accuracy		±3% of the set value or ±0.01 × I_n		
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 range = 1.0 × I_n, current before fault = 2.0 × set Phase Pickup range, fn = 50Hz, fault with nominal frequency, results based on statistical distribution 200 measurements

[2)] Includes the delay of the heavy-duty output contact

Table 61. Arc protection (AFD) main settings

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

Table 62. 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 63. 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 × I_n		
Pickup time [1) 2)]		Minimum	Typical	Maximum
	I_{Fault} = 2.0 × 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 × f_n, where n = 2, 3, 4, 5,...		

[1)] Pickup range = 1.0 × V_n, Voltage before fault 0.9 × V_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

Table 64. 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 range 2.H	REF	10...50 %	1
Minimum trip time	REF	40...300000 ms	1
Operation	REF	Off On	

Table 65. 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 × 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 66. Single-phase undercurrent protection (37) main settings

Parameter	Function	Value (Range)	Step
Pickup value	37	0.01...1.00 × I_n	0.01
Current block value	37	0.01...0.50 × I_n	0.01
Definite time delay	37	400...600000 ms	10
Operation	37	Off On	

Table 67. Overexcitation protection (24)

Characteristic	Value
Pickup accuracy	±3.0% of the set value
Pickup time[1), 2)]	Frequency change: Typical 200 ms Voltage change: Typical < 40 ms
Reset time	< 50 ms
Reset ratio	Typical 0.96
Retardation time	< 35 ms
Pickup time accuracy in definite-time mode	±1.0% of the set value or ±20 ms
Pickup 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 68. 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 69. Frequency protection (81)

Characteristic		Value
Pickup 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 70. Frequency protection (81) main settings

Parameter	Function	Values (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 × F_n	0.001
Pickup value 81U	81	0.800...1.100 × F_n	0.001
Pickup value df/dt	81	-0.200...0.200 × F_n/s	0.005
Trip time 81O/81U	81	80...200000 ms	10
Trip time df/dt	81	120...200000 ms	10

Table 71. 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)
Pickup 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 72. Load shed and restoration (81LSH) main settings

Parameter	Function	Values (range)	Step
Load shed mode	81LSH	81U 81U and df/dt 81U or df/dt	-
Restore mode	81LSH	Disabled Auto Manual	-
Pickup value 81U	81LSH	0.800...1.200 × F_n	0.001
Pickup value df/dt	81LSH	-0.200...-0.005 × F_n/ds	0.005
Trip time 81U	81LSH	80...200000 ms	10
Trip time df/dt	81LSH	120...200000 ms	10
Restore pickup val	81LSH	0.800...1.200 × F_n	0.001
Restore delay time	81LSH	80...200000 ms	10

Table 73. Multipurpose analog protection (MAP)

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

Table 74. Multipurpose analog protection (MAP) main settings

Parameter	Function	Value (Range)	Step
Pickup value	MAP	-10000.0...10000.0	0.1
Trip delay time	MAP	0...200000 ms	100
Operation mode	MAP	Over Under	-

Measurement functions

Table 75. Three-phase current measurements (IA, IB, IC)

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

Table 76. Current sequence components (I1, I2, I0)

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

Table 77. 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 × V_n)
	Voltage: ±0.5% or ±0.002 × V_n Phase angle: ±2.5°
Suppression of harmonics	DFT: -50dB at f = n × f_n, where n = 2, 3, 4, 5,... RMS: No suppression

Table 78. 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 × V_n
	±1.0% or ±0.002 × V_n
Suppression of harmonics	DFT: -50dB at f = n × f_n, where n = 2, 3, 4, 5,...

Table 79. Ground current measurement (IG)

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

Table 80. Ground voltage measurement (VG)

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

Table 81. Frequency measurement (f)

Characteristic	Value
Measurement accuracy	±10 mHz (in measurement range 35...75 Hz)

Table 82. Three-phase and single-phase power and energy (P, SP, E, SE)

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

Supervision functions

Table 83. Fuse failure supervision (60)

Characteristic	Value	
Trip time [1)]	NPS function: V_{Fault} = 1.1 × set Neg Seq voltage Lev V_{Fault} = 5.0 × set Neg Seq voltage Lev	 < 33 ms < 18 ms
	Delta function: ΔV = 1.1 × set Voltage change rate ΔV = 2.0 × set Voltage change rate	 <30 ms <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

21. 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.

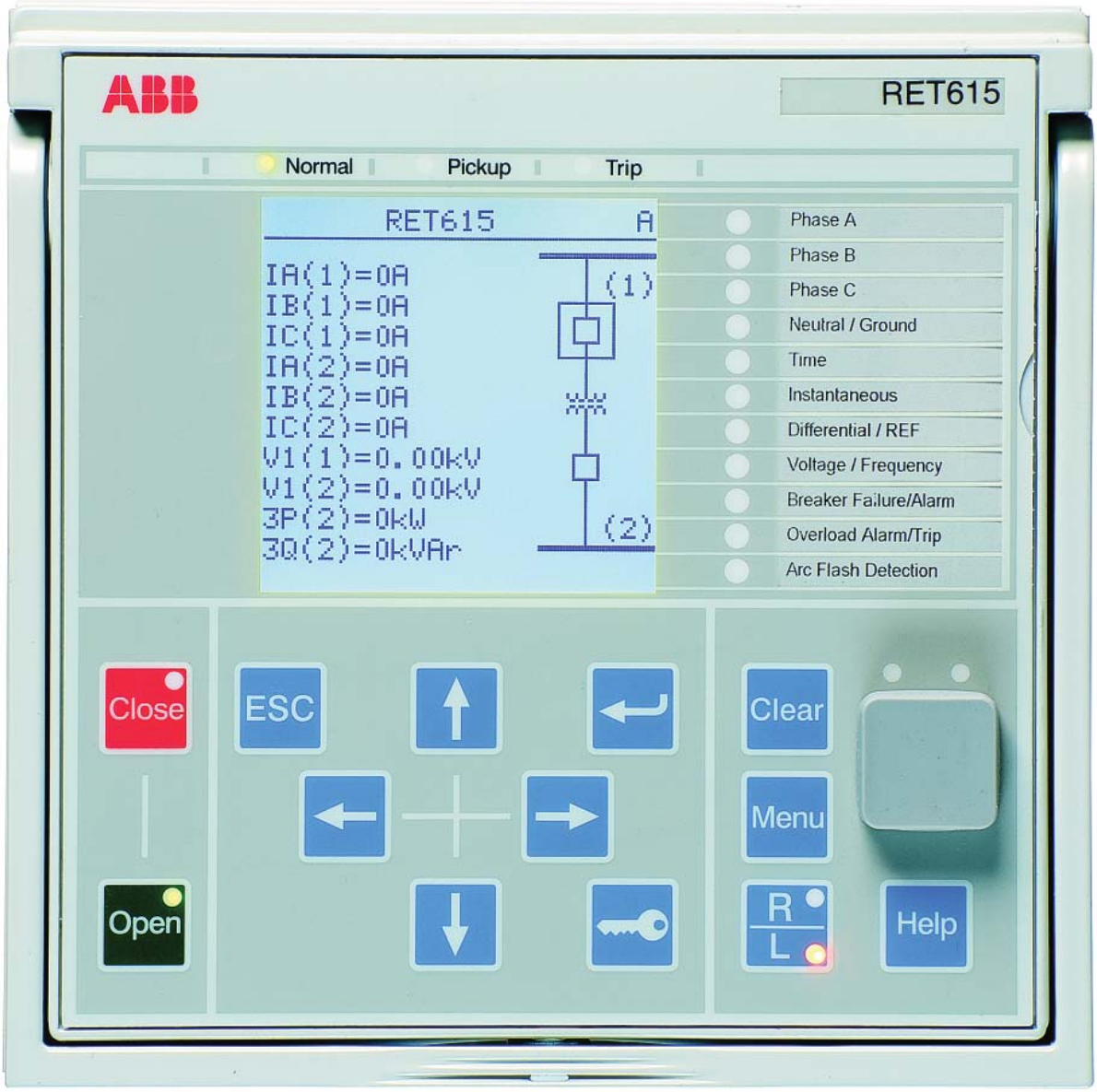

Figure 17. Large display standard

Table 84. Large display

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

22. Mounting methods

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

Further, the relays can be mounted in any standard 19" instrument cabinet by means of 19" mounting panels available with cut-outs for one or two relays.

For the routine testing purposes, the relay cases can be equipped with Flexitest (FT) test switches, type FT-1 or FT-19R, which can be mounted side by side or below the relay 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 Flexitest (FT) test switches to a 19" rack

Panel cut-out for flush mounting:

- Height: 6.36" ± 0.04" (161.5±1 mm)
- Width: 6.52" ± 0.04" (165.5±1 mm)

23. Relay case and drawout unit

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

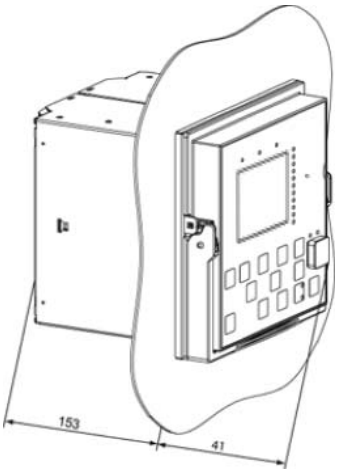

Figure 18. Flush mounting

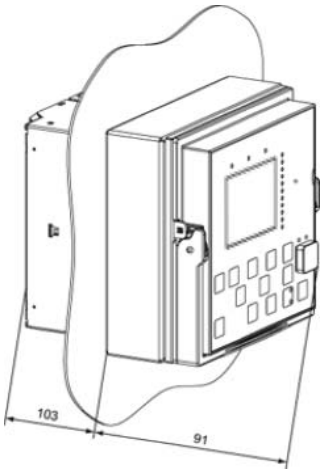

Figure 19. Semi-flush mounting

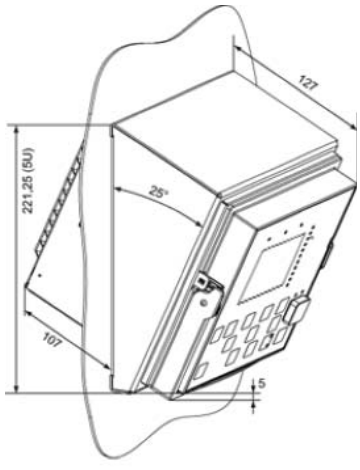

Figure 20. Semi-flush with a 25º tilt

24. Selection and ordering data

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 below to generate the order number when ordering complete protection relays.

RET615 ANSI Order Codes

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Notes
	Ex: HATDDADANBE1BNN1XE	H	A	T	D	D	A	D	A	N	B	E	1	B	N	N	1	X	E	
Digit	**Description**																			
1) Product Series	H: 615 (Tiger including case)	H																		
2) Standard	A: ANSI		A																	
3) Main Application	T: Transformer protection and control			T																
4) Functional Application	A: Differential and overcurrent protection for two-winding transformers				A															
	B: Differential, overexcitation, overcurrent, voltage (winding 1 or 2) and frequency protection and power system metering for two-winding transformers				B															
	C: Differential, overexcitation overcurrent, voltage (winding 1 or 2), frequency and RTD protection and power system metering for two-winding transformers				C															
	D: Differential, overexcitation, overcurrent, voltage (windings 1 and 2) and frequency protection and power system metering for two-winding transformers				D															
5-6) Analog Inputs	A: 6 CT + Ground CT					A	A													
	B: 6 CT + Ground CT + 5 VT(Winding 2)					B	A													
	B: 6 CT + Ground CT + 5 VT (Winding 1)					B	B													
	C: 6 CT + Ground CT + 5 VT(Winding 2) + 2 RTD					C	A													
	C: 6 CT + Ground CT + 5 VT(Winding 1) + 2 RTD					C	B													
	D: 6 CT + Ground CT + 6 VT (Windings 1 & 2)					D	A													
7-8) Binary I/O	A: 8 BI + 6 BO + 3 HSO							A	1											
	A: 8 BI + 10 BO							A	A											
	A: 14 BI + 9 BO + 3 HSO							A	2											
	A: 14 BI + 13 BO							A	B											
	B: 12 BI + 6 BO + 3 HSO							B	1											
	B: 12 BI + 10 BO							B	A											
	C: 8 BI + 6 BO + 3 HSO							C	1											
	C: 8 BI + 10 BO							C	A											
	D: 11 BI + 6 BO + 3 HSO							D	1											
	D: 11 BI + 10 BO							D	A											
9-10) Communication Ports [1]	One port: Ethernet 100FX (LC)									N	A									1
	One port: Ethernet 10/100BaseT (RJ45)									N	B									1
	Two/three ports: [Ethernet 100 FX (LC) + RS-485 (1x4-wire or 2x2-wire) + IRIG-B]									A	A									1
	Two/three ports: [Ethernet 10/100BaseT (RJ45) + RS-485 (1x4-wire or 2x2-wire) + IRIG-B]									A	B									1
	Four ports: [Ethernet 100FX (LC) + 2 * Ethernet 10/100BaseT (RJ45) + serial glass fiber (ST)]									A	K									1
	Four ports: [Ethernet 3 * 10/100BaseT (RJ45) + serial glass fiber (ST)]									A	L									1
	Three ports: Ethernet 10/100BaseT (RJ45) + configurable RS232/RS485 + [RS485 or serial glass fiber (ST) + IRIG-B]									3	3									1

Table continues on next page

RET615 ANSI Order Codes (continued)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Notes
	Ex: HATDDADANBE1BNN1XE	H	A	T	D	D	A	D	A	N	B	E	1	B	N	N	1	X	E	
Digit	**Description**																			
Includes Arc Flash Detection	One port: [Ethernet 100FX (LC) + Arc Flash Detection]									N	F									1
	One port: [Ethernet 10/100BaseT (RJ45) + Arc Flash Detection]									N	G									1
	Two/three ports: [Ethernet 100 FX (LC) + RS-485 (1x4-wire or 2x2-wire) + IRIG-B + Arc Flash Detection]									F	F									1
	Two/three ports: [Ethernet 10/100BaseT (RJ45) + RS-485 (1x4-wire or 2x2-wire) + IRIG-B + Arc Flash Detection]									F	G									1
	Four ports: [Ethernet 100FX (LC) + 2 * Ethernet 10/100BaseT (RJ45) + serial glass fiber (ST) + Arc Flash Detection]									F	K									1
	Four ports: [Ethernet 3 * 10/100BaseT (RJ45) + serial glass fiber (ST) + Arc Flash Detection]									F	L									1
11) Protocols	IEC61850 + DNP3.0 Level 2 + Modbus											E								
12) Language	English												1							
	English + Spanish												5							
	English + Portuguese												8							
13) Front Panel	Large LCD (standard)													B						
14) Option 1	None														N					
15) Option 2	None															N				
16) Power Supply	Nominal: 48-250 V DC; 100-240 V AC 50/60 Hz																1			
	Nominal: 24-48 V DC																2			
17) Reserved	Reserved																	X		
18) Version	Version 4.0																		E	

Notes: 1) 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.

Example code: HATBBABAFFE1BNN1XE

Your ordering code:

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

25. Accessories and ordering data

Table 85. Accessories and ordering data.

Item	Order Number
Tools	
PCM600 V2.0 user tool	PCM600-20
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	
Semi-flush mounting kit	1MRS050696
Wall mounting kit	1MRS050697
Inclined semi-flush mounting kit	1MRS050831
19” rack mounting kit with cutout for one relay, ANSI 61	604539-K1
19” rack mounting kit with cutout for one relay, ANSI 70	604539-K3
19” rack mounting kit with cutout for two relays , ANSI 61	604540-K1
19” rack mounting kit with cutout for two relays , ANSI 70	604540-K3
Retrofit adapter plates	
TPU2000 Horizontal - ANSI 61 (medium gray)	604529-K1
TPU2000 Horizontal - ANSI 70 (light gray)	604529-K3
TPU2000 Vertical - ANSI 61 medium gray)	604529-K2
TPU2000 Vertical - ANSI 70 (light gray)	604529-K4
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

26. 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 relay signal configuration using the signal matrix tool, 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 86. Tools

Configuration, setting and SA system tools	Version
PCM600	2.3 or later
Web-browser based user interface	IE 7.0 or later
RET615 Connectivity Package	4.0 or later
COM600 substation product	V3.4 or later
MicroSCADA Pro Substation Automation system	9.3 or later

Table 87. Supported functions

Function	WebHMI	PCM600
Relay signal configuration (signal matrix tool)	-	•
IEC 61850 communication configuration, GOOSE (communication configuration tool)	-	•
Modbus® communication configuration (communication management tool)	-	-[1)]
DNP3.0 Level 2+ communication configuration (communication management tool)	-	•
IEC 60870-5-103 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	•	•
Single-line diagram	• (view)	• (edit)

• = Supported

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

27. Terminal diagrams

Terminal diagrams for the RET615 appear on the following pages.

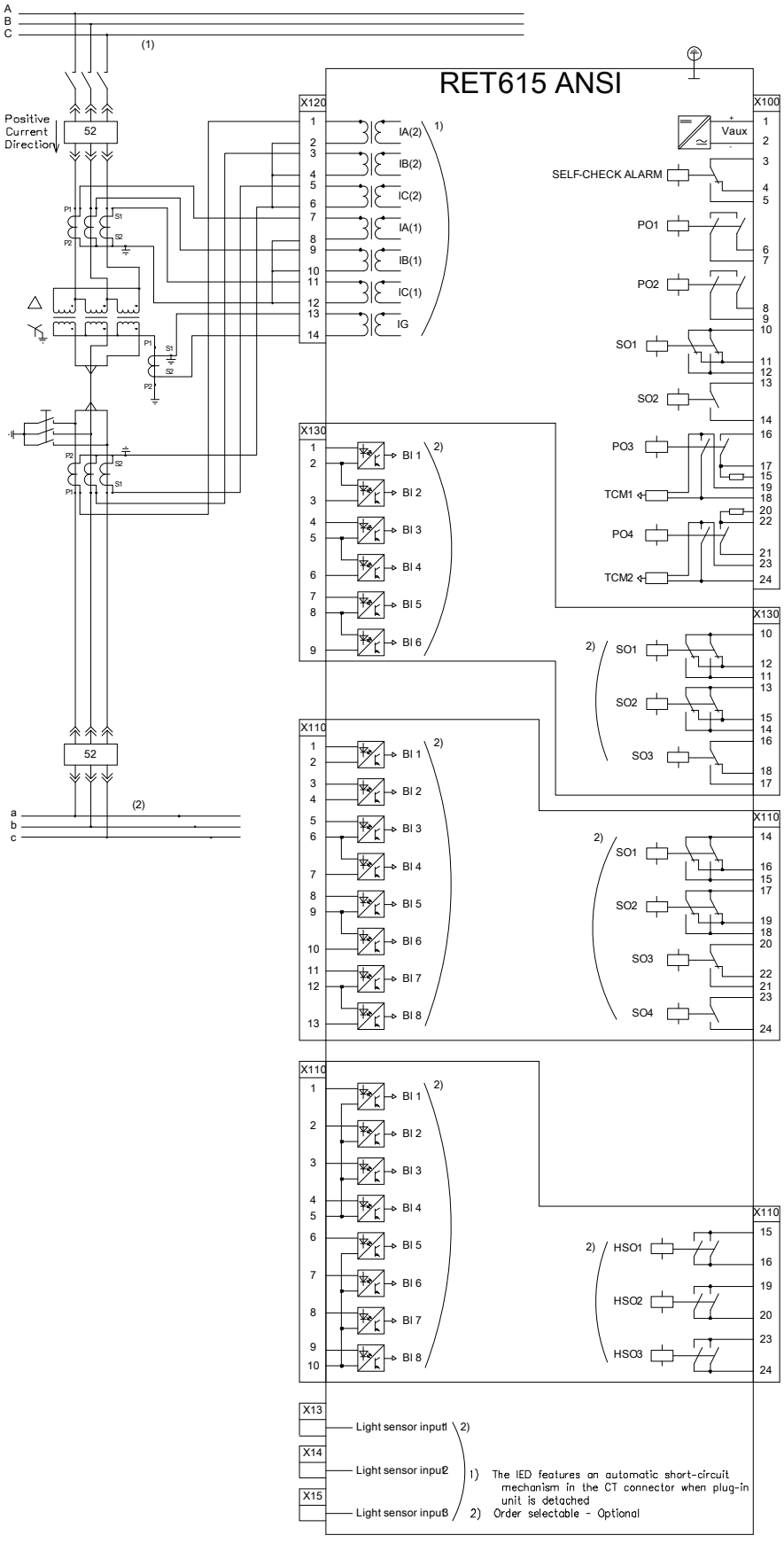

Figure 21. Terminal diagram for RET615 standard configuration A with options.

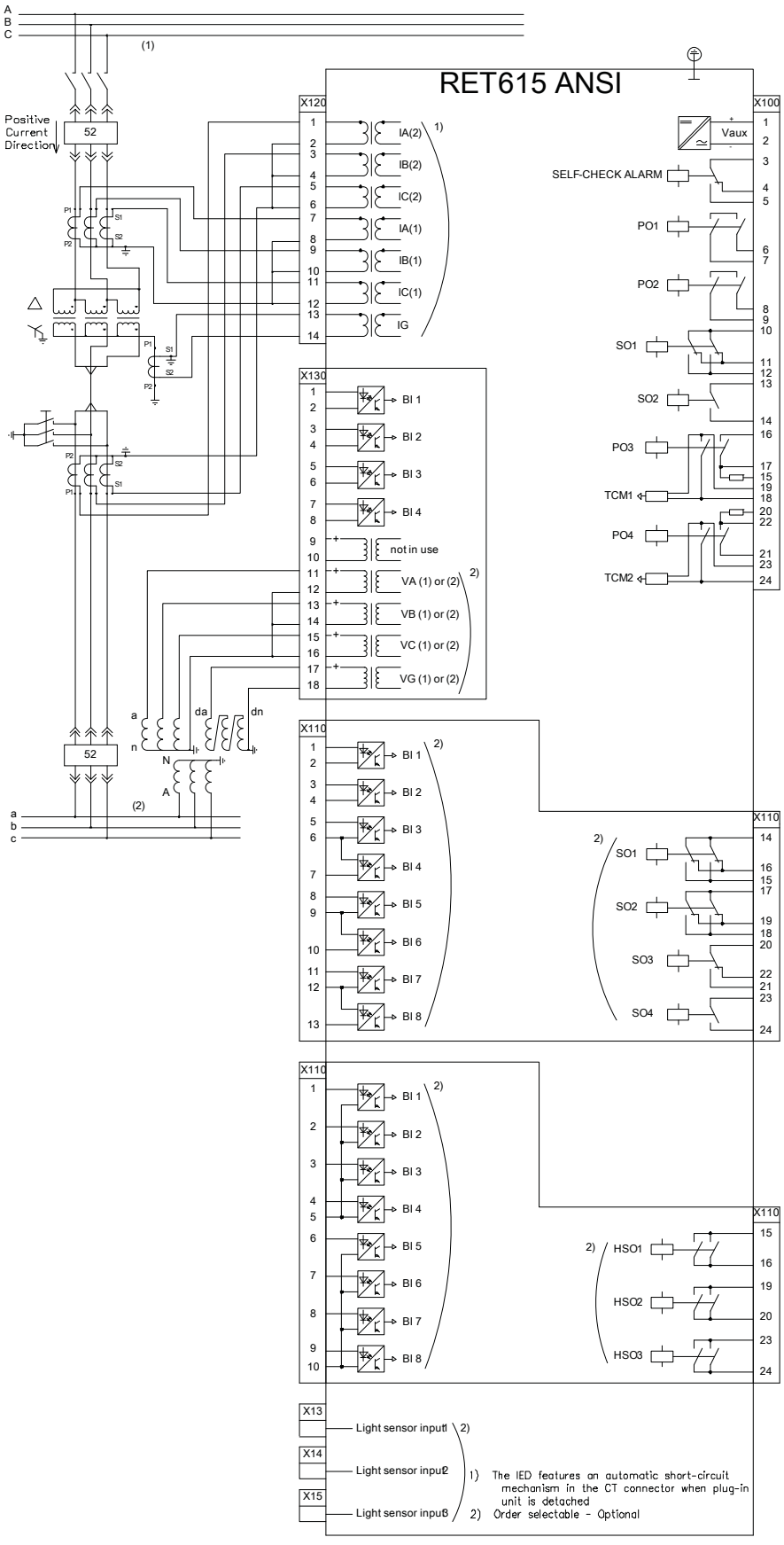

Figure 22. Terminal diagram for RET615 standard configuration B with options.

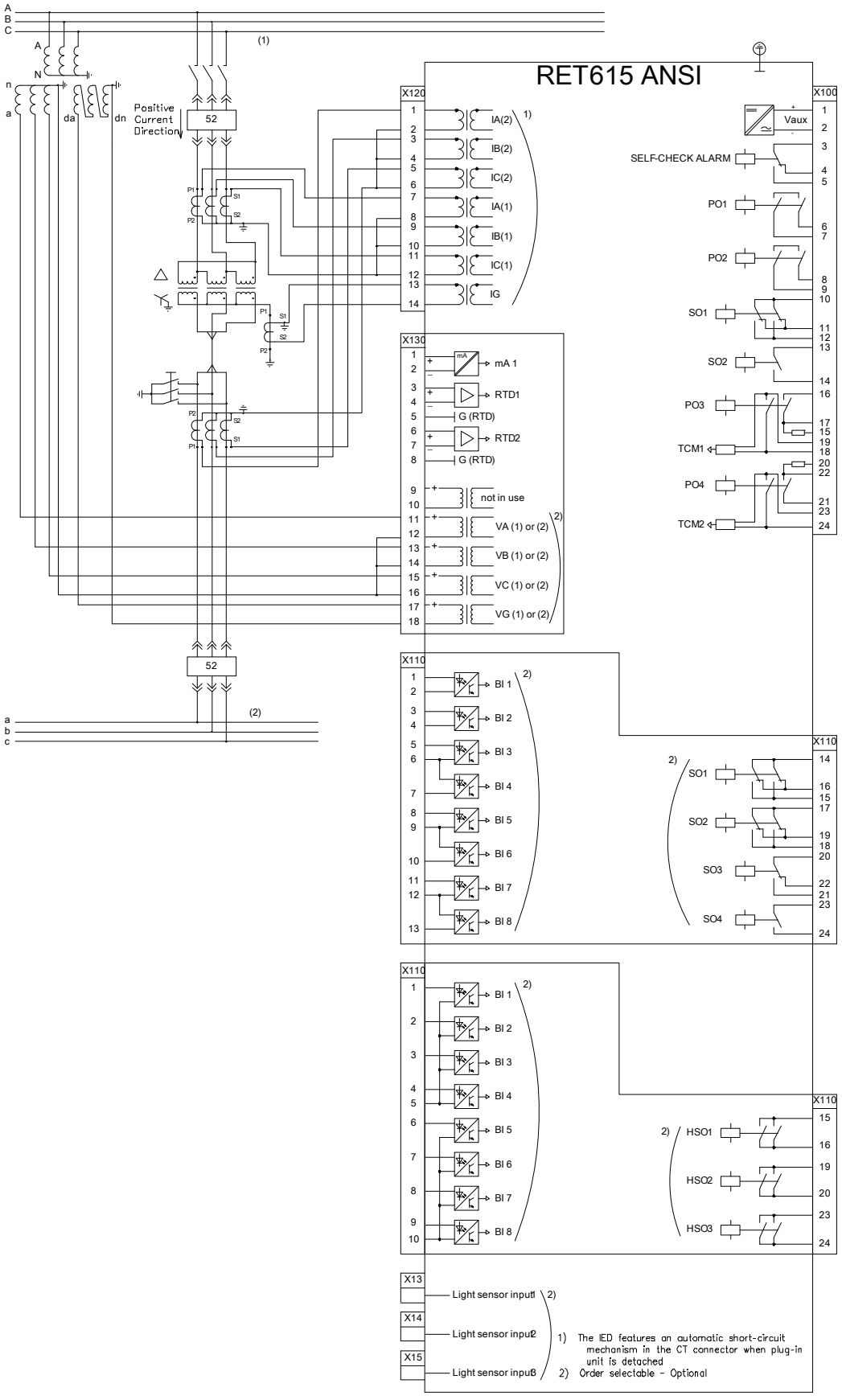

Figure 23. Terminal diagram for RET615 standard configuration C with options.

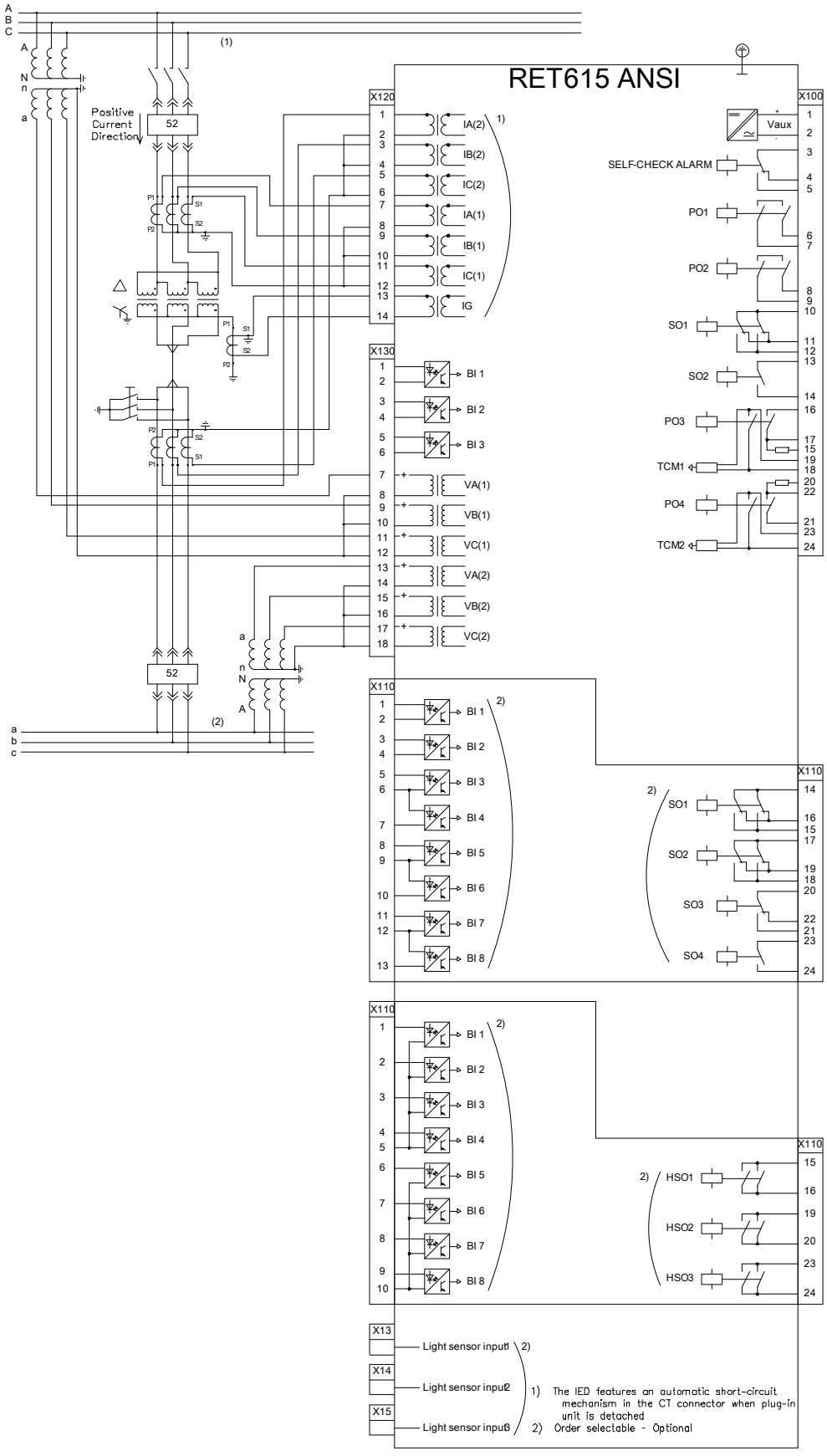

Figure 24. Terminal diagram for RET615 standard configuration D with options.

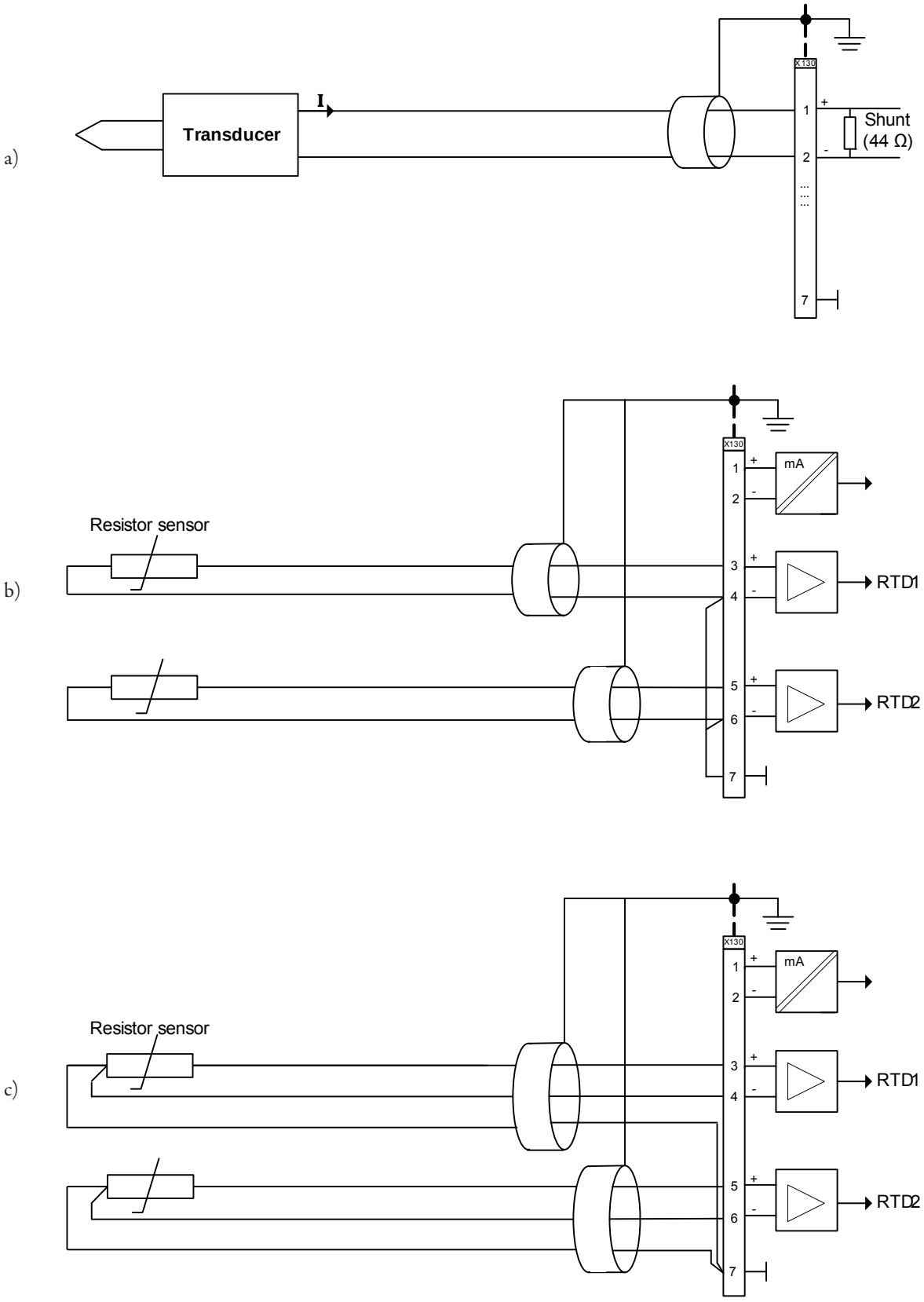

Figure 25. Typical connections of RET615 standard configuration D for a) mA input, b) 2-wire RTD inputs and c) 3-wire RTD inputs.

28. Certificates

KEMA has issued an IEC 61850 Certificate Level A1 for RET615. Certificate number: 30710144-Consulting 08-0115

The RET615 is a UL Listed product, UL File/Sec. E103204/2/2.

29. References

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.

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

You will find the latest relevant information on the RET615 protection relay on the product page.

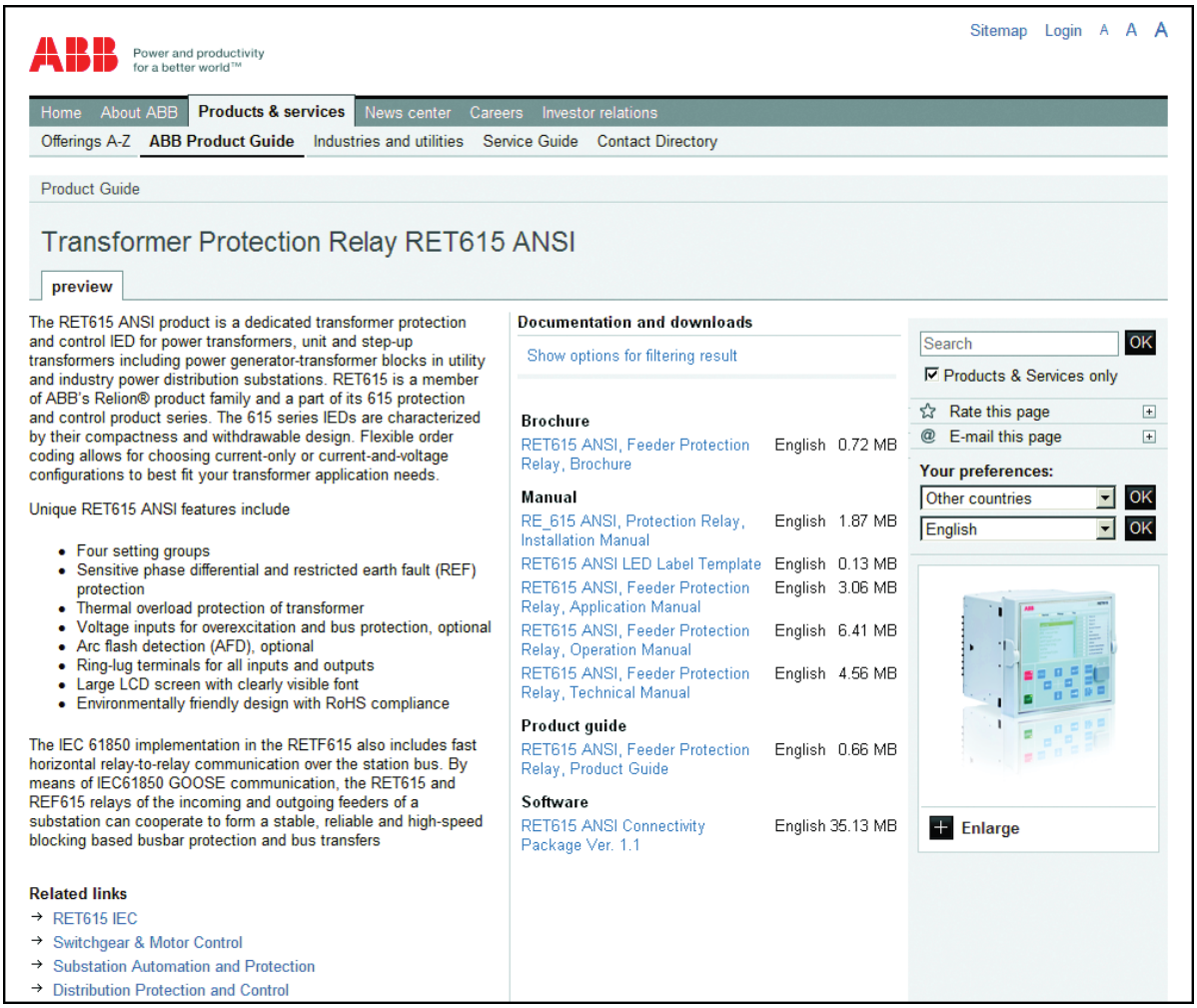

Figure 26. Product page

30. Functions, codes and symbols

Table 88. RET615 Functions, codes and symbols

Function	IEC 61850	RET615
Protection		
Three-phase non-directional overcurrent protection, low stage, instance 1	PHLPTOC1	51P (1)
Three-phase non-directional overcurrent protection, low stage, instance 2	PHLPTOC2	51P (2)
Three-phase non-directional overcurrent protection, high stage, instance 1	PHHPTOC1	50P-1 (1)
Three-phase non-directional overcurrent protection, high stage, instance 2	PHHPTOC2	50P-1 (2)
Three-phase non-directional overcurrent protection, high stage, instance 3	PHHPTOC3	50P-2 (1)
Three-phase non-directional overcurrent protection, high stage, instance 4	PHHPTOC4	50P-2 (2)
Three-phase directional overcurrent protection, low stage, instance 1	DPHLPDOC1	67/51P (2)
Three-phase directional overcurrent protection, low stage, instance 2	DPHLPDOC2	67/51P (1)
Non-directional earth-fault protection, low stage, instance 1	EFLPTOC1	51G
Non-directional earth-fault protection, low stage, instance 2	EFLPTOC2	51N (1)
Non-directional earth-fault protection, low stage, instance 3	EFLPTOC3	51N (2)
Non-directional earth-fault protection, high stage, instance 1	EFHPTOC1	50G-1
Non-directional earth-fault protection, high stage, instance 2	EFHPTOC2	50G-2
Non-directional earth-fault protection, high stage, instance 3	EFHPTOC3	50N-1 (1)
Non-directional earth-fault protection, high stage, instance 4	EFHPTOC4	50N-1 (2)
Non-directional earth-fault protection, high stage, instance 5	EFHPTOC5	50N-2 (1)
Non-directional earth-fault protection, high stage, instance 6	EFHPTOC6	50N-2 (2)
Directional earth-fault protection, low stage, instance 1	DEFLPDEF1	67/51N (2)
Directional earth-fault protection, low stage, instance 2	DEFLPDEF2	67/51N (1)
Negative-sequence overcurrent protection, instance 1	NSPTOC1	46 (1)
Negative-sequence overcurrent protection, instance 2	NSPTOC2	46 (2)
Residual overvoltage protection, instance 1	ROVPTOV1	59G (2)
Residual overvoltage protection, instance 2	ROVPTOV2	59N (2)
Residual overvoltage protection, instance 3	ROVPTOV3	59N (1)
Residual overvoltage protection, instance 4	ROVPTOV4	59G (1)
Three-phase undervoltage protection, instance 1	PHPTUV1	27 (2)
Three-phase undervoltage protection, instance 2	PHPTUV2	27 (1)
Three-phase overvoltage protection, instance 1	PHPTOV1	59 (2)
Three-phase overvoltage protection, instance 2	PHPTOV2	59 (1)
Negative-sequence overvoltage protection, instance 1	NSPTOV1	47 (2)
Negative-sequence overvoltage protection, instance 2	NSPTOV2	47 (1)

Table continues on next page

Table 88. RET615 Functions, codes and symbols (continued)

Function	IEC 61850	RET615
Frequency protection, instance 1	FRPFRQ1	81-1 (2)
Frequency protection, instance 2	FRPFRQ2	81-2 (2)
Frequency protection, instance 3	FRPFRQ3	81-1 (1)
Frequency protection, instance 4	FRPFRQ4	81-2 (1)
Voltage per hertz protection, instance 1	OEPVPH1	24-1 (2)
Voltage per hertz protection, instance 2	OEPVPH2	24-2 (2)
Voltage per hertz protection, instance 3	OEPVPH3	24-1 (1)
Voltage per hertz protection, instance 4	OEPVPH4	24-2 (1)
Three-phase thermal overload protection for power transformers, two time constants	T2PTTR1	49T (1)
Stabilized and instantaneous differential protection for 2W–transformers	TR2PTDF1	87T
Numerical stabilized low impedance restricted earth-fault protection	LREFPNDF1	87LOZREF (2)
Circuit breaker failure protection, instance 1	CCBRBRF1	50BF (1)
Circuit breaker failure protection, instance 2	CCBRBRF2	50BF (2)
Master trip, instance 1	TRPPTRC1	86/94-1
Master trip, instance 2	TRPPTRC2	86/94-2
Arc protection, instance 1	ARCSARC1	AFD-1 (2)
Arc protection, instance 2	ARCSARC2	AFD-2 (2)
Arc protection, instance 3	ARCSARC3	AFD-3 (2)
Multi-purpose protection, instance 1 2)	MAPGAPC1	MAP (1)
Multi-purpose protection, instance 2 2)	MAPGAPC2	MAP (2)
Multi-purpose protection, instance 3 2)	MAPGAPC3	MAP (3)
Load shedding and restoration, instance 1	LSHDPFRQ1	81LSH-1 (2)
Load shedding and restoration, instance 2	LSHDPFRQ2	81LSH-2 (2)
Load shedding and restoration, instance 3	LSHDPFRQ3	81LSH-1 (1)
Load shedding and restoration, instance 4	LSHDPFRQ4	81LSH-2 (1)
Loss of phase, instance 1	PHPTUC1	37 (1)
Control		
Circuit-breaker control, instance 1	CBXCBR1	52 (1)
Circuit-breaker control, instance 2	CBXCBR2	52 (2)
Tap changer position indication	TPOSSLTC1	84T
Condition monitoring		
Circuit-breaker condition monitoring, instance 1	SSCBR1	52CM (1)
Circuit-breaker condition monitoring, instance 2	SSCBR2	52CM (2)
Trip circuit supervision, instance 1	TCSSCBR1	TCM-1
Trip circuit supervision, instance 2	TCSSCBR2	TCM-2
Advanced current circuit supervision for transformers	CTSRCTF1	MCS 3I, I2

Table continues on next page

Table 88. RET615 Functions, codes and symbols (continued)

Function	IEC 61850	RET615
Fuse failure supervision, intance 1	SEQRFUF1	60 (1)
Fuse failure supervision, intance 2	SEQRFUF2	60 (2)
Measurement		
Three-phase current measurement, instance 1	CMMXU1	IA, IB, IC (1)
Three-phase current measurement, instance 2	CMMXU2	IA, IB, IC (2)
Sequence current measurement, instance 1	CSMSQI1	I1, I2, I0 (1)
Sequence current measurement, instance 2	CSMSQI2	I1, I2, I0 (2)
Residual current measurement, instance 1	RESCMMXU1	IG
Three-phase voltage measurement, instance 1	VMMXU1	VA, VB, VC (1)
Three-phase voltage measurement, instance 2	VMMXU2	VA, VB, VC (2)
Residual voltage measurement, instance 1	RESVMMXU1	VG
Residual voltage measurement, instance 2	RESVMMXU2	VG
Sequence voltage measurement, instance 1	VSMSQI1	V1, V2, V0 (1)
Sequence voltage measurement, instance 2	VSMSQI2	V1, V2, V0 (2)
Single-phase power and energy measurement, instance 1	SPEMMXU1	SP, SE (1)
Single-phase power and energy measurement, instance 2	SPEMMXU2	SP, SE (2)
Three-phase power and energy measurement, instance 1	PEMMXU1	P, E (1)
Three-phase power and energy measurement, instance 2	PEMMXU2	P, E (2)
2 RTD +1 mA	XARGGIO130	
Frequency measurement, instance 1	FMMXU1	f
Frequency measurement, instance 2	FMMXU2	f
Logging functions		
Disturbance recorder	RDRE1	DFR
Fault recorder	FLMSTA1	FR
Sequence event recorder	SER	SER

31. Document revision history

Table 89. Document revision history

A/ March 01, 2010	V2.0	Initial product version release
B/ April 15, 2011	V4.0	Product version 4.0 release

32. Notes

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