Relion® 620 series

Feeder protection and control
REF620 ANSI
Product guide

Power and productivity
for a better world™

Table of contents

1. Description 3
2. Standard configurations 4
3. Protection functions 11
4. Application 11
5. Supported ABB solutions 11
6. Control 13
7. Measurements 13
8. Digital fault recorder 13
9. Events recorder 13
10. Recorded data 13
11. Circuit-breaker condition monitoring 13
12. Trip-circuit monitoring 13
13. Self diagnostics 13
14. Fuse failure protection 13
15. Current circuit supervision 14
16. Load profile recording 14
17. Power quality 14
18. Single-line diagram (SLD) 14
19. Cable fault detection (CFD) 14
20. Access control 14
21. Inputs and outputs 14
22. Communications 16
23. Technical data 18
24. Display 44
25. Local HMI 44
26. Mounting methods 44
27. Accessories and ordering data 45
28. Tools 47
29. Terminal diagrams 48
30. Certificates 59
31. References 59
32. Functions, codes and symbols 59
33. Document revision history 61
34. Notes 62

1. Description

The REF620 is a dedicated feeder IED perfectly aligned for the protection, control, measurement and supervision of utility substations and industrial power systems.

REF620 is a member of ABB's Relion® family and a part of its 620 protection and control product series. The 620 series IEDs are characterized by flexibility and performance for demanding utility distribution and industrial applications. Engineered from the ground up, the 620 series has been designed to unleash the full potential of the IEC 61850 standard for communication and interoperability of substation automation devices.

Unique REF620 ANSI features

- Six setting groups
- Drawout design
- Underground, overhead cable fault detection (CFD)
- High-speed (< 1 ms) outputs
- High impedance (HIZ) fault detection
- Arc flash detection (AFD)
- Phase step distance protection
- Power quality
- Ring-lug terminals for all inputs and outputs
- Large, easy to read LCD screen
- Programmable push-buttons
- Environmentally friendly design with RoHS Compliance

The REF620 provides main protection for overhead lines, cable feeders, and busbar systems of distribution substations. It can be applied for protection and control of grounded and ungrounded distribution systems. It offers support for single breaker, one-and-half breaker and double breaker feeder configurations. Flexible order coding allows for choosing current-only or current-and-voltage configurations to best fit your distribution feeder application needs.

The REF620 is the most powerful, advanced and simplest feeder protection relay in its class, perfectly offering time and instantaneous overcurrent, negative sequence overcurrent, phase step distance, phase discontinuity, breaker failure, thermal overload, and voltage metering and protection. The relay also features high impedance fault (HIZ) and sensitive earth fault (SEF) protection for grounded and ungrounded distribution systems. Also, the relay incorporates a flexible three-phase multi-shot auto-reclose function for automatic feeder restoration in temporary faults on overhead lines.

Enhanced with safety options, the relay offers a three-channel arc-fault detection system for supervision of the switchgear. The REF620 also integrates basic control functionality, which facilitates the control of up to 2 circuit breakers via the relay's front panel human machine interface (HMI) or remote control system. To protect the relay from unauthorized access and to maintain the integrity of information, the relay has been provided with a four-level, role-based user authentication system, with individual passwords for the viewer, operator, engineer, and administrator levels. The access control system applies to the front panel HMI, embedded web browser based HMI, and the PCM600, Protection and Control IED Manager.

REF620 genuinely supports the new IEC 61850 standard for inter-device communication in substations. The relay also supports the industry standard DNP3 and Modbus® protocols. For accurate time stamping, REM620 supports synchronization over Ethernet using SNTP or over a separate bus using IRIG-B.

2. Standard configurations

The REF620 relay main application is feeder protection and control and offers three standard configurations whose relay functions and features are based on the needs of the application. See Tables 1 and 2 for details. Configuration A comprises protection scheme useful in enhanced utility and industrial feeder protection with single breaker . Configuration B includes functions and features for comprehensive feeder protection and control applications in with one-and-half breaker configuration . Configuration C includes functions and features for comprehensive feeder protection and control applications in with 2 breaker configuration.

Figures 1 through 3 show the protection functions available for the three standard confi gurations and available analog inputs within each configuration. See section **Selection and ordering data** for details on the available analog inputs for each standard configuration.

Figure 1. REF620 ANSI Functional Application A

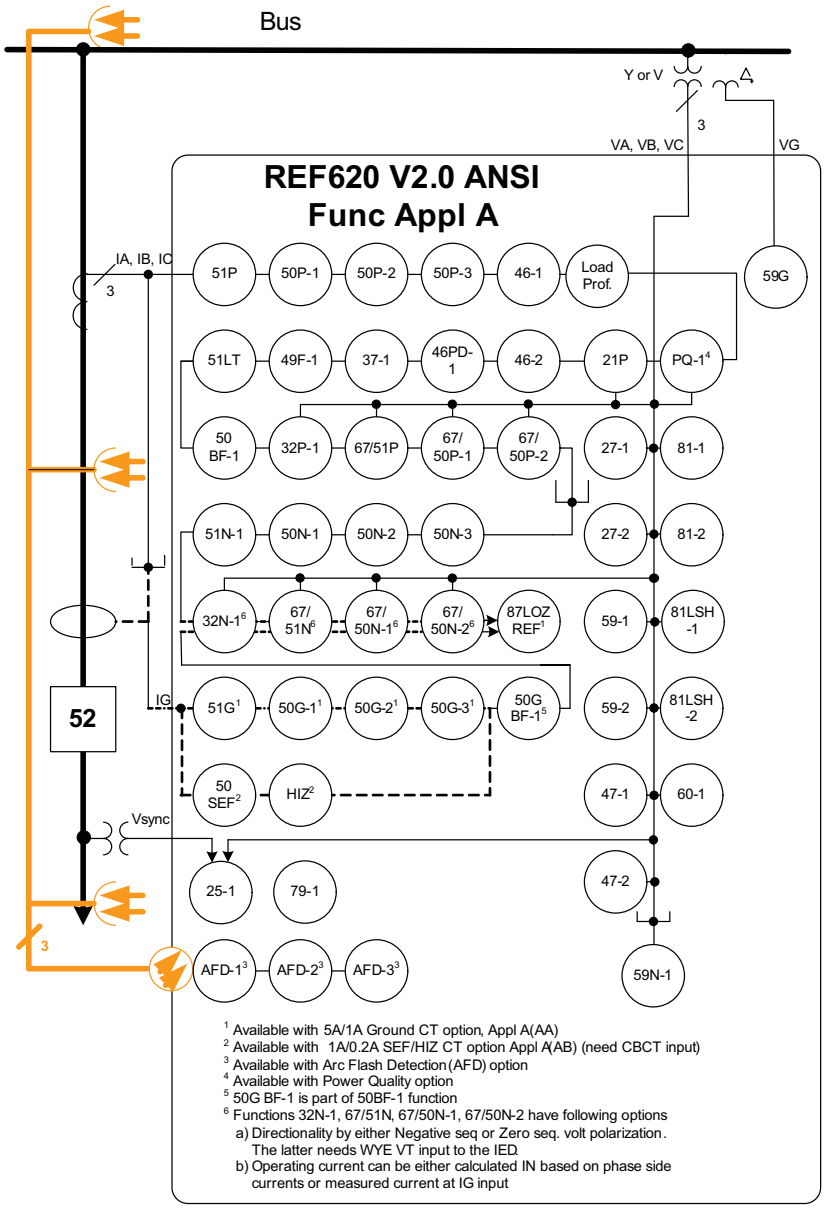


Figure 2. REF620 V4.0 ANSI Functional Applications B

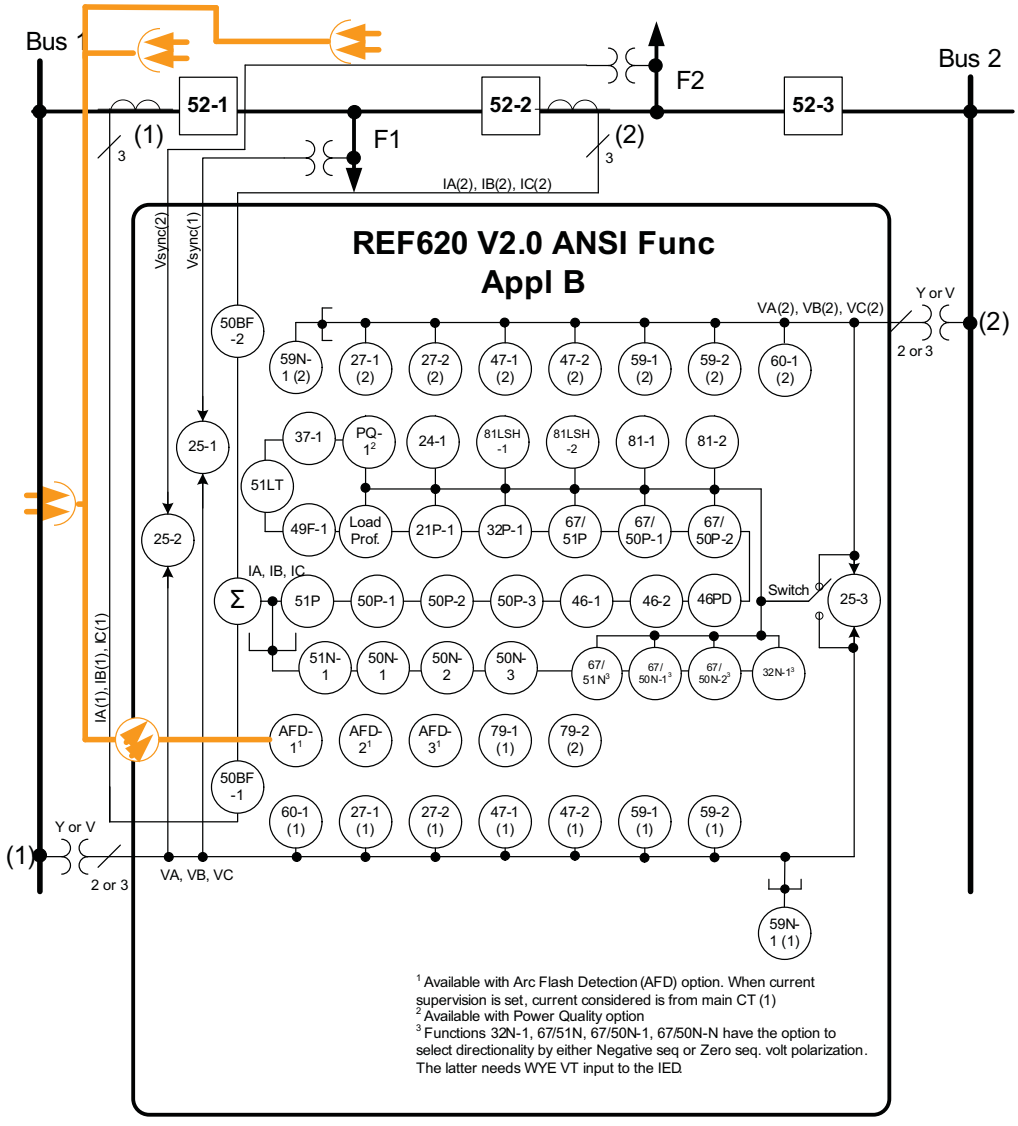
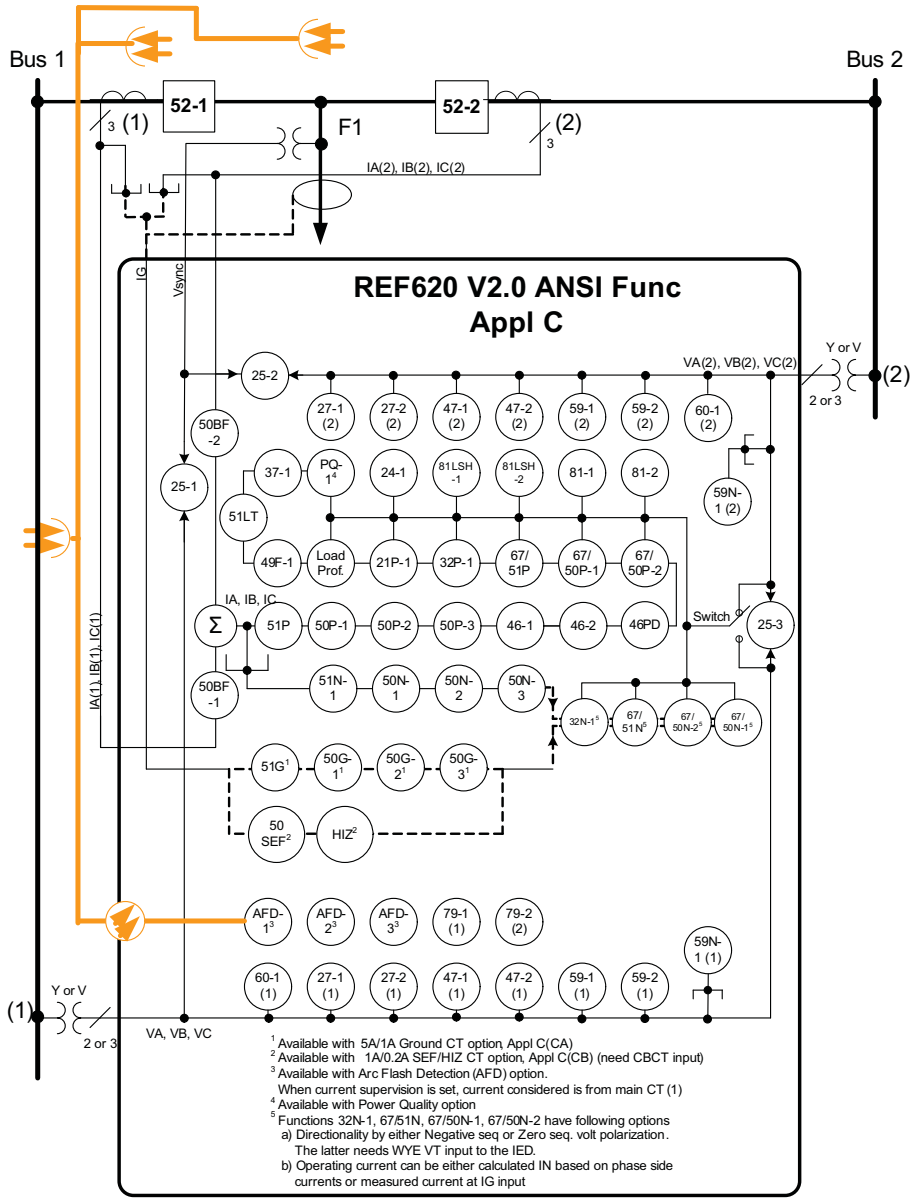


Figure 3. REF620 V4.0 ANSI Functional Applications C



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

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

Table 1. Standard configurations (REF620)

	Functional application configuration
Advanced distribution feeder protection and control with single breaker	A
Advanced distribution feeder protection and control with breaker-and-a-half breakers	B
Advanced distribution feeder protection and control with two breakers or breaker-and-a-half breakers	C

Table 2. Supported functions (REF620)

Standard configuration functionality	Std config. A		Std config. B	Std config. C		ANSI/C37.2 - 2008
	AA	AB	BA	CA	CB	REF
Protection						
Three-phase non-directional overcurrent protection, low stage, instance 1	●	●	●	●	●	51P
Three-phase non-directional overcurrent protection, high stage, instance 1	●	●	●	●	●	50P-1
Three-phase non-directional overcurrent protection, high stage, instance 2	●	●	●	●	●	50P-2
Three-phase non-directional overcurrent protection, instantaneous stage, instance 1	●	●	●	●	●	50P-3
Three-phase non-directional long time overcurrent protection, low stage, instance 1	●	●	●	●	●	51LT
Three-phase directional overcurrent protection, low stage, instance 1	●	●	●	●	●	67/51P
Three-phase directional overcurrent protection, high stage, instance 1	●	●	●	●	●	67/50P-1
Three-phase directional overcurrent protection, high stage, instance 2	●	●	●	●	●	67/50P-2
Non-directional ground-fault protection, low stage, instance 1	●	-	-	●	-	51G
Non-directional ground-fault protection, low stage, instance 2	●	●	●	●	●	51N-1
Non-directional ground-fault protection, low stage, instance 4	-	●	-	-	●	50SEF
Non-directional ground-fault protection, high stage, instance 1	●	-	-	●	-	50G-1
Non-directional ground-fault protection, high stage, instance 2	●	-	-	●	-	50G-2
Non-directional ground-fault protection, high stage, instance 3	●	●	●	●	●	50N-1
Non-directional ground-fault protection, high stage, instance 4	●	●	●	●	●	50N-2
Non-directional ground-fault protection, instantaneous stage, instance 1	●	-	-	●	-	50G-3
Non-directional ground-fault protection, instantaneous stage, instance 2	●	●	●	●	●	50N-3
Directional ground-fault protection, low stage, instance 1	●[1,3]	●[1,3]	●[1,3]	●[1,3]	●[1,3]	67/51N
Directional ground-fault protection, high stage, instance 1	●[1,3]	●[1,3]	●[1,3]	●[1,3]	●[1,3]	67/50N-1
Directional ground-fault protection, high stage, instance 2	●[1,3]	●[1,3]	●[1,3]	●[1,3]	●[1,3]	67/50N-2
Three phase directional power protection, instance 1	●		●	●		32P-1
Ground directional power protection, instance 1	●[1,3]		●[1,3]	●[1,3]		32N-1
Phase Distance Protection, instance 1	●		●	●		21P
Negative-sequence overcurrent protection, instance 1	●		●	●		46-1
Negative-sequence overcurrent protection, instance 2	●		●	●		46-2
Phase discontinuity protection	●		●	●		46PD
Residual overvoltage protection, instance 1	●		●	-		59G
Residual overvoltage protection, instance 2	●[4]		●[4]	●[4]		59N-1(1)
Residual overvoltage protection, instance 3	-		-	●[4]		59N-1(2)
Three-phase undervoltage protection, instance 1	●		●	●		27-1(1)
Three-phase undervoltage protection, instance 2	●		●	●		27-2(1)
Three-phase undervoltage protection, instance 3	-		-	●		27-1(2)
Three-phase undervoltage protection, instance 4	-		-	●		27-2(2)
Three-phase overvoltage protection, instance 1	●		●	●		59-1(1)
Three-phase overvoltage protection, instance 2	●		●	●		59-2(1)
Three-phase overvoltage protection, instance 3	-		-	●		59-1(2)
Three-phase overvoltage protection, instance 4	-		-	●		59-2(2)
Negative-sequence overvoltage protection, instance 1	●		●	●		47-1(1)
Negative-sequence overvoltage protection, instance 2	●		●	●		47-2(1)
Negative-sequence overvoltage protection, instance 3	-		-	●		47-1(2)

Table 2. Supported functions (REF620)

Standard configuration functionality	Std config. A		Std config. B	Std config. C		ANSI/C37.2 - 2008
	AA	AB	BA	CA	CB	REF
Protection						
Negative-sequence overvoltage protection, instance 4	-		-		●	47-2(2)
Frequency protection, instance 1	●		●		●	81-1
Frequency protection, instance 2	●		●		●	81-2
Voltage per hertz protection, instance 1	●	●	●	●	●	24
Three-phase thermal protection for feeders, cables and distribution transformers, Instance 1	●		●	●	●	49F
Numerical stabilized low impedance restricted ground-fault protection	●	-	-	-	-	87LOZREF
Phase current sets summing function	-	-	●	●	●	CSUM
Three phase measurement switching	-	-	●	●	●	VSWI
Circuit breaker failure protection, instance 1	●	●	●	●	●	50BF-1
Circuit breaker failure protection, instance 2	-	-	●	●	●	50BF-2
Three-phase inrush detector, instance 1	●	●	●	●	●	INR
Master trip, instance 1	●	●	●	●	●	86/94-1
Master trip, instance 2	●	●	●	●	●	86/94-2
Arc protection, instance 1	●	●	●	●	●	AFD-1
Arc protection, instance 2	●	●	●	●	●	AFD-2
Arc protection, instance 3	●	●	●		●	AFD-3
High impedance fault detection	-	●	-	-	●	HIZ
Load shedding and restoration, instance 1	●	●	●	●	●	81LSH-1
Load shedding and restoration, instance 2	●	●	●	●	●	81LSH-2
Loss of phase, instance 1	●	●	●	●	●	37-1
Control						
Circuit-breaker control, instance 1	●	●	●	●	●	52-1
Circuit-breaker control, instance 2	-	-	●	●	●	52-2
Auto-reclosing, instance 1	●	●	●	●	●	79-1
Auto-reclosing, instance 2	-	-	●	●	●	79-2
Synchronism and energizing check, instance 1	●	●	●	●	●	25-1
Synchronism and energizing check, instance 2	-	-	●	●	●	25-2
Synchronism and energizing check, instance 3	-	-	●	●	●	25-3
Condition Monitoring						
Circuit-breaker condition monitoring, instance 1	●	●	●	●	●	52CM-1
Circuit-breaker condition monitoring, instance 2	-	-	●	●	●	52CM-2
Trip circuit supervision, instance 1	●	●	●	●	●	TCM-1
Trip circuit supervision, instance 2	●	●	●	●	●	TCM-2
Current circuit supervision	●	●	-	●	-	CCM
Fuse failure supervision, instance 1	●	●	●	●	●	60-1
Fuse failure supervision, instance 2	-	-	●	●	●	60-2
Cable fault detection	●	●	●	●	●	CFD
Measurement						
Three-phase current measurement, instance 1	●	●	●	●	●	IA, IB, IC
Sequence current measurement, instance 1	●	●	●	●	●	I1, I2, I0
Residual current measurement, instance 1	●	●	-	●	-	IG
Three-phase voltage measurement, instance 1	●	●	●	●	●	VA, VB, VC
Three-phase voltage measurement, instance 2	-	-	●	●	●	VA, VB, VC (2)
Residual voltage measurement, instance 1	●	●	-	-	-	VG
Sequence voltage measurement, instance 1	●	●	●	●	●	V1, V2, V0
Sequence voltage measurement, instance 2	-	-	●	●	●	V1, V2, V0 (2)
Single-phase power and energy measurement, instance 1	●	●	●	●	●	SP, SE-1
Three-phase power and energy measurement, instance 1	●	●	●	●	●	P, E-1
Load profile	●		●	●	●	LoadProf
Frequency measurement, instance 1	●	●	●	●	●	f

Table 2. Supported functions (REF620) (continued)

Standard configuration functionality	Std config. A		Std config. B	Std config. C		ANSI/C37.2 - 2008
	AA	AB	BA	CA	CB	REF
Power quality						
Current total demand distortion, instance 1	●	●	●	●	●	PQI-1
Voltage total harmonic distortion, instance 1	●	●	●	●	●	PQVPH-1
Voltage total harmonic distortion, instance 2	-	-	●	●	●	PQVPH-2
Voltage variation, instance 1	●	●	●	●	●	PQSS-1
Voltage unbalance, instance 1	●	●	●	●	●	PQVUB-1
Voltage unbalance, instance 2	-	-	●	●	●	PQVUB-2
Other functions						
Minimum pulse timer (2 pcs), instance 1	●		●	●		TP-1
Minimum pulse timer (2 pcs), instance 2	●		●	●		TP-2
Minimum pulse timer (2 pcs), instance 3	●		●	●		TP-3
Minimum pulse timer (2 pcs), instance 4	●		●	●		TP-4
Minimum pulse timer (2 pcs, second resolution), instance 1	●		●	●		62CLD-1
Minimum pulse timer (2 pcs, second resolution), instance 2	●		●	●		62CLD-3
Minimum pulse timer (2 pcs, minute resolution), instance 1	●		●	●		62CLD-2
Minimum pulse timer (2 pcs, minute resolution), instance 2	●		●	●		62CLD-4
Pulse timer (8 pcs), instance 1	●		●	●		PT-1
Pulse timer (8 pcs), instance 2	●		●	●		PT-2
Time delay off (8 pcs), instance 1	●		●	●		TOF-1
Time delay off (8 pcs), instance 2	●	●	●	●	●	TOF-2
Time delay off (8 pcs), instance 3	●	●	●	●	●	TOF-3
Time delay off (8 pcs), instance 4	●	●	●	●	●	TOF-4
Time delay on (8 pcs), instance 1	●	●	●	●	●	TON-1
Time delay on (8 pcs), instance 2	●	●	●	●	●	TON-2
Time delay on (8 pcs), instance 3	●	●	●	●	●	TON-3
Time delay on (8 pcs), instance 4	●	●	●	●	●	TON-4
Set reset (8 pcs), instance 1	●	●	●	●	●	SR-1
Set reset (8 pcs), instance 2	●	●	●	●	●	SR-2
Set reset (8 pcs), instance 3	●	●	●	●	●	SR-3
Set reset (8 pcs), instance 4	●	●	●	●	●	SR-4
Move (8 pcs), instance 1	●	●	●	●	●	MV-1
Move (8 pcs), instance 2	●	●	●	●	●	MV-2
Move (8 pcs), instance 3	●	●	●	●	●	MV-3
Move (8 pcs), instance 4	●	●	●	●	●	MV-4
Move (8 pcs), instance 5	●	●	●	●	●	MV-5
Move (8 pcs), instance 6	●	●	●	●	●	MV-6
Move (8 pcs), instance 7	●	●	●	●	●	MV-7
Move (8 pcs), instance 8	●	●	●	●	●	MV-8
Generic control points, instance 1	●	●	●	●	●	CNTRL-1
Generic control points, instance 2	●	●	●	●	●	CNTRL-2
Generic control points, instance 3	●	●	●	●	●	CNTRL-3
Remote Generic control points, instance 1	●	●	●	●	●	RCNTRL-1
Local Generic control points, instance 1	●	●	●	●	●	LCNTRL-1
Generic Up-Down Counters, instance 1	●	●	●	●	●	CTR-1
Generic Up-Down Counters, instance 2	●	●	●	●	●	CTR-2
Generic Up-Down Counters, instance 3	●	●	●	●	●	CTR-3
Generic Up-Down Counters, instance 4	●	●	●	●	●	CTR-4
Generic Up-Down Counters, instance 5	●	●	●	●	●	CTR-5
Generic Up-Down Counters, instance 6	●	●	●	●	●	CTR-6
Generic Up-Down Counters, instance 7	●	●	●	●	●	CTR-7
Generic Up-Down Counters, instance 8	●	●	●	●	●	CTR-8
Generic Up-Down Counters, instance 9	●	●	●	●	●	CTR-9
Generic Up-Down Counters, instance 10	●	●	●	●	●	CTR-10

Table 2. Supported functions (REF620) (continued)

Standard configuration functionality	Std config. A		Std config. B	Std config. C		ANSI/C37.2 - 2008
	AA	AB	BA	CA	CB	REF
Other functions						
Generic Up-Down Counters, instance 11	●	●	●	●	●	CTR-11
Generic Up-Down Counters, instance 12	●	●	●	●	●	CTR-12
Programmable buttons(16 buttons), instance 1	●	●	●	●	●	FKEY1
Logging functions						
Disturbance recorder	●	●	●	●	●	DFR
Fault recorder	●	●	●	●	●	FR
Sequence event recorder	●	●	●	●	●	SER
Fault location	●	●	●	●	●	FLO

1) Io selectable by parameter, I2 as default
2) Calculated neutral current is always used
3) Vo calculated and negative sequence voltage selectable by parameter, V2 as default
4) Vo calculated is always used

3. Protection functions

Th is IED provides non-directional phase and ground overcurrent, phase step distance, thermal overload, phase unbalance and phase discontinuity protection with sensitive earth fault (SEF), high impedance fault detection (HIZ), directional phase, ground and neutral overcurrent and phase, ground (residual), positive sequence and negative sequence undervoltage and overvoltage protection. Also, the IED offers three-pole multishot autoreclose function for utility overhead distribution feeders. Enhanced with an arc fl ash detection (AFD), the relay also features three light detection channels for arc fault detection of the circuit breaker, busbar and cable compartment of metal-enclosed switchgear. The AFD sensor interface is available on the optional communication module. Fast tripping increases personal safety and limits material damage within the switchgear in an arc fault situation.

4. Application

The REF620 offers users maximum fexibility of application with three standard confgurations A, B and C. Each configuration allows users convenient ordering selections to perfectly match available analog inputs (AI) and binary inputs and outputs (I/O) required in their distribution feeder protection and control designs. All configurations include the customer programmable phase and ground CT and, where applicable, VT secondary nominal settings plus wide protection setting ranges that increase the REF620 flexibility of application and eliminate need for multiple different feeder relay order codes. Here are the descriptions of each of the three configurations available:

A: Advanced distribution feeder protection and control with single breaker
B: Advanced distribution feeder protection and control with breaker-and-a-half bus system
C Advanced distribution feeder protection and control with two breakers or breaker-and-a-half bus system

In addition to protection, control and metering, each configuration includes many features standard for comprehensive utility and industrial distribution feeder schemes including graphical user-programmable logic, digital fault (waveform), sequence of events (SOE) and fault recording, monitoring, load profile and advanced Ethernet communications supporting IEC61850-8 with GOOSE (peer-to-peer) messaging and DNP3 Level 2+ and Modbus protocols over TCP/IP. Valuable options include serial communications supporting DNP3 Level 2+ and Modbus protocols, Power Quality, Spanish or Portuguese menu/WebHMI language, and Arc Flash Detection safety feature. Costly bus diff erential protection and bus transfer control schemes due to dedicated CTs, I/O wiring and special communication cables are now affordable with the 620 series relays' standard Ethernet communications. Using peer-to-peer communications via IEC-61850's GOOSE messaging affords integration of high-speed monitoring and control applications.

5. Supported ABB solutions

ABB's 620 series protection and control IEDs together with the COM600 Station Automation device constitute a genuine IEC 61850 solution for reliable power distribution in utility and industrial power systems. To facilitate and streamline the system engineering ABB's IEDs are supplied with Connectivity Packages containing a compilation of software and IED-specific information including single-line diagram templates, a full IED data model including event and parameter lists. By utilizing the Connectivity Packages the IEDs can be readily configured via the PCM600 Protection and Control IED Manager and integrated with the COM600 Station Automation device or the MicroSCADA Pro network control and management system.

The 620 series IEDs offer native support for the IEC 61850 standard also including horizontal GOOSE messaging. Compared with traditional hard-wired inter-device signaling, peer-to-peer communication over a switched Ethernet LAN offers an advanced and versatile platform for power system protection. Fast software-based communication, continuous supervision of the integrity of the protection and communication system, and inherent flexibility for reconfiguration and upgrades are among the distinctive features of the protection system approach enabled by the full implementation of the IEC 61850 substation automation standard.

At the substation level COM600 utilizes the data content of the design level IEDs to offer enhanced substation level functionality. COM600 features a web-browser based HMI providing a customizable graphical display for visualizing single line mimic diagrams for switchgear design solutions. To enhance personnel safety, the web HMI also enables remote access to substation devices and processes. Furthermore, COM600 can be used as a local data warehouse for technical documentation of the substation and for network data collected by the IEDs. The collected network data facilitates extensive reporting and analyzing of network fault situations using the data historian and event handling features of COM600.

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

Figure 4. Utility distribution network example using 620 series IEDs, Station Automation COM600 and MicroSCADA Pro

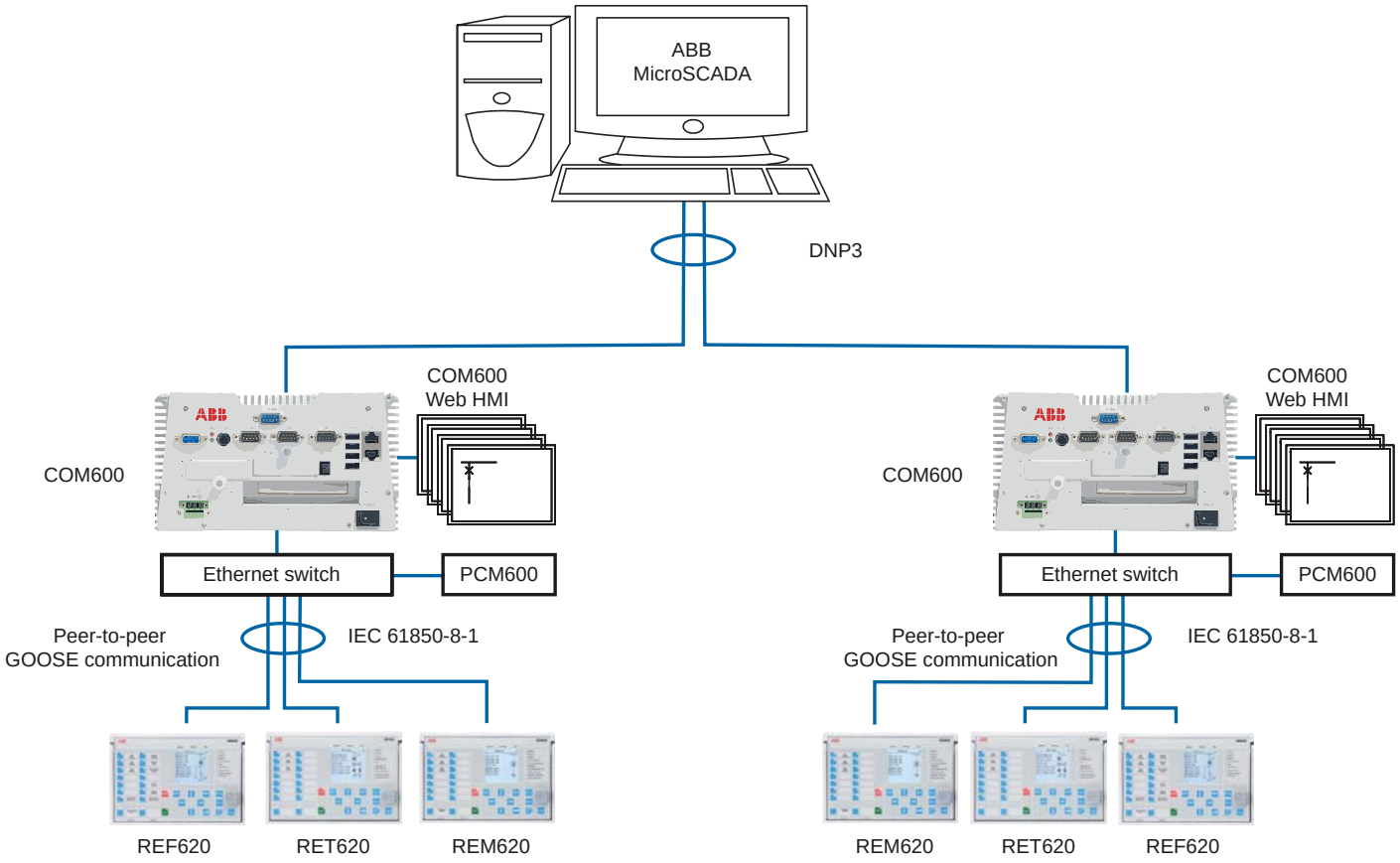
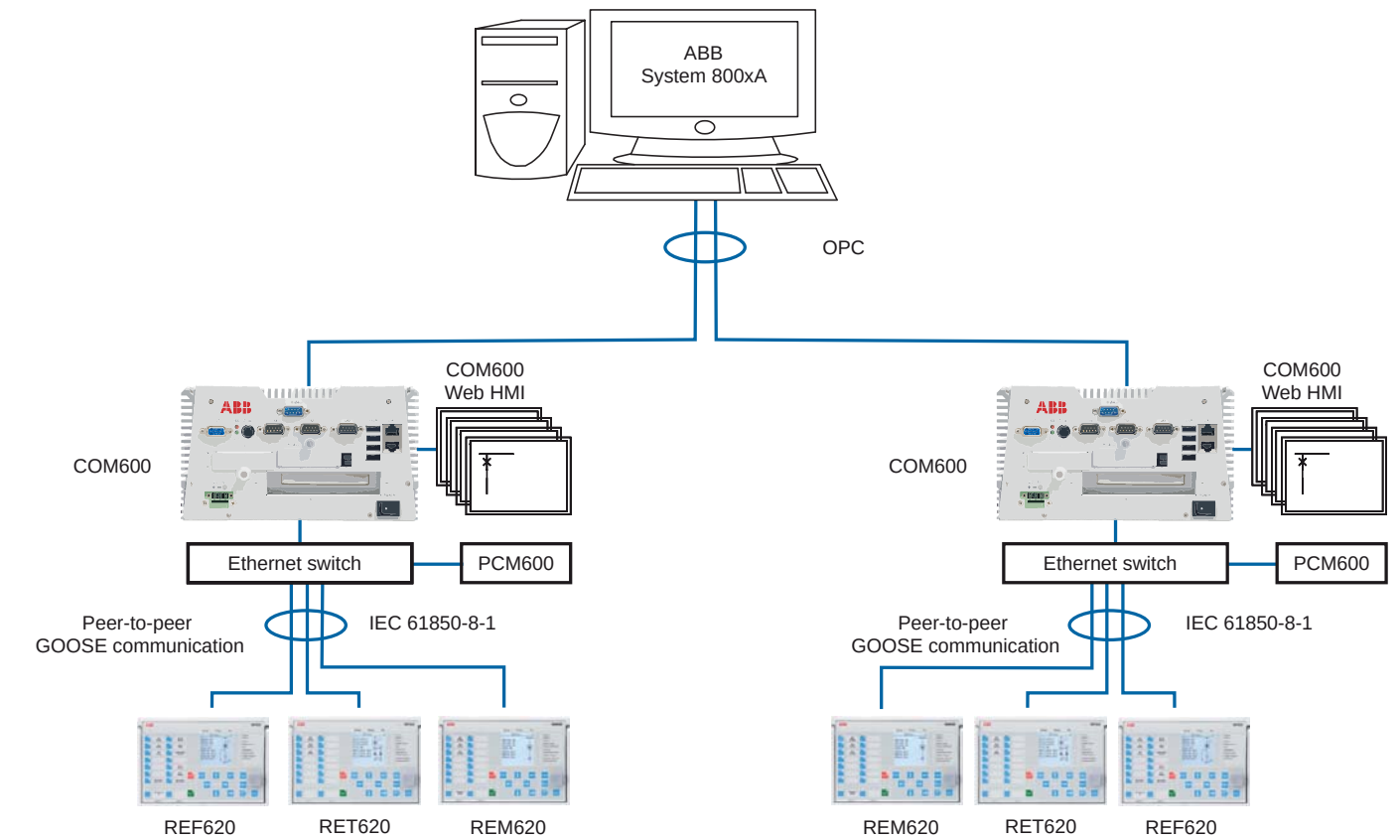


Figure 5. Industrial distribution network example using 620 series IEDs, Station Automation COM600 and System 800xA



6. Control

The relay offers status and control of one or two breakers, depending on the standard configuration selected, with a set of push-buttons on the front panel local human machine interface (LHMI) for opening and closing a breaker. Flexible remote breaker control of select-before-trip (SBO) or direct trip is also available with each of the supported DNP3.0 Level 2+, Modbus and IEC 61850 communication protocols. Interlocking schemes required by the application can be configured with the application configuration tool in PCM600.

7. Measurements

The relay continuously measures the phase currents and voltages, the sequence components and the residual current. If the relay includes the ground ct or broken delta vt option, it also measures the ground currrent IG or residual voltage VG, respectively.

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

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

8. Digital fault recorder

The relay is provided with a digital fault recorder (DFR) featuring up to 12 analog and 64 binary signal channels. The analog channels record either the waveform or the trend of the currents and voltages. 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

9. Events recorder

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

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

10. Recorded data

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

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

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

11. Circuit-breaker condition monitoring

For continuous knowledge of the operational availability of the REF620 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. There is a condition monitoring feature for each of the breakers supported.

12. 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. There is a trip-circuit monitoring feature for each of the breakers supported.

13. Self diagnostics

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

14. Fuse failure protection

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

15. Current circuit supervision

Depending on the chosen standard configuration, the IED includes current circuit supervision. 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. The current circuit supervision function calculates the sum of the phase currents from the protection cores and compares the sum with the measured single reference current from a core balance current transformer or from separate cores in the phase current transformers.

16. Load profile recording

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

17. Power quality

The ability to monitor and detect current and voltage Harmonics, voltage unbalance and short duration system disturbances with the REF620 is possible through the optional power quality (PQ) function. This function enables studying system quality conditions, documenting cases and implementing new procedures to improve reliability of service. The PQ functions include these features per the IEEE 1159 standard:

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

18. Single-line diagram (SLD)

The relay includes the ability for the user to design a unique single line diagram (SLD) view in the front panel LHMI LCD. An applicable default SLD view is provided for each standard confi guration. 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. Information can be split in two separate pages if needed. This reduces significantly time the substation personnel need to obtain this relevant information from smaller LCDs.

19. Cable fault detection (CFD)

The REF620 offers feeder cable fault detection (CFD) function that is able to real-time detect extremely short duration overhead and underground faults in feeders. This dedicated function is programmable to monitor and detect self-clearing and fuse-cleared faults. These short duration faults are typically undetectable by conventional protection where there is no operation of their substation breaker or feeder recloser. Where dispatchers gain knowledge of these events from customer calls, this real-time detection provides immediate indication to the dispatcher prior to the first customer call. Overall outage restoration times may be reduced having knowledge of such feeder event as soon as they happen improving a utility's reliability metrics.

20. Access control

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

21. Inputs and outputs

The availability of analog and binary inputs depends upon the standard configuration ordered. Standard and optional binary inputs and outputs (I/O) also depend upon the selected IED configuration. Table xx (see comment 16) details the analog and binary inputs available for each standard configuration. The phase-current inputs are user programmable for 5 A or 1 A ct secondary nominal rating. The ground ct option is programmable for 5/1 A nominal rating, the SEF/HIZ ct option has a fixed 0.2 A nominal rating. The sensitive earth fault ct option provides SEF protection and includes a separate, independent HIZ protective function for detecting downed conductors. The phase-current and ground current nominal rating of 5 A or 1 A are selected in the relay software. The nominal secondary voltage of the three-phase and ground VT inputs are user programmable. The binary input turn-on thresholds are programmable from 18…176 V DC by adjusting the relay's parameter settings.

Table 3. Available analog inputs per REF620 configuration

		# of analog inputs	
Functional application (order code character #4)	Analog inputs (order code characters #5 and #6)	CT	VT
A	AA	4[1]	5
A	AB	4[2]	5
B	BA	6	8
C	CA	7[1]	7
C	CB	7[2]	7

[1]Ground CT (Inom = 5/1A)
[2]SEF/HIZ CT (Inom = 0.2A)

Table 4. Available binary inputs and outputs per REF620 configuration

		# of binary inputs/binary outputs			
Functional application (order code character #4)	Binary inputs and outputs (order code characters #7 and #8)	Binary inputs	Signal outputs	Power outputs	High speed power outputs
A	AA	16	6	4	0
A	AB	24	10	4	0
A	AC	32	14	4	0
A	A1	16	2	4	3
A	A2	24	6	4	3
A	A3	32	10	4	3
B	BA	16	10	4	0
B	BB	24	14	4	0
B	B1	16	2	4	6
B	B2	16	6	4	3
B	B3	24	6	4	6
B	B4	24	10	4	3
C	CA	16	10	4	0
C	CB	24	14	4	0
C	C1	16	2	4	6
C	C2	16	6	4	3
C	C3	24	6	4	6
C	C4	24	10	4	3

22. Communications

The relay (IED) supports a range of communication protocols including IEC 61850, Modbus® and DNP3.0 Level 2. Operational information and controls are available through these protocols. Certain communication functionality, e.g., horizontal communication between relays, is only enabled by the IEC 61850 communication protocol.

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

The IED can send binary signals to other IEDs (so called horizontal communication) using the IEC 61850-8-1 GOOSE (Generic Object Oriented Substation Event) profile. Binary GOOSE messaging can, e.g., be employed for protection and interlocking-based protection schemes. The relay meets the GOOSE performance requirements for tripping applications in distribution substations, as defined by the IEC 61850 standard. Also, the IED supports the sending and receiving of analog values using GOOSE messaging. Analog GOOSE messaging enables fast transfer of analog measurement values over the network bus, thus facilitating, for example, sharing of RTD input values, such as surrounding temperature values, to other IED applications.

The IED offers an optional second Ethernet bus to enable the creation of a self-healing Ethernet ring topology. The IED communication module options include both galvanic and fiber-optic Ethernet combinations. The communication module including one fiber-optic LC port and two galvanic RJ-45 ports is used when the ring between the IEDs is built using CAT5 STP cables. The LC port can in this case be used for connecting the IED to communication ports outside the switchgear. The communication module including three RJ-45 ports is used when the whole substation network bus is based on CAT5 STP cabling.

The self-healing Ethernet ring solution enables a cost-effective communication ring solution controlled by a managed switch with rapid spanning tree protocol (RSTP) support to be created. The managed switch controls the consistency of the loop, routes the data and corrects the data flow in case of a communication disturbance. The IEDs in the ring topology act as unmanaged switches forwarding unrelated data traffic. The Ethernet ring solution supports the connection of up to 30 ABB 615 or 620 series relays. If more than 30 IEDs are to be connected, it is recommended that the network is split into several rings with no more than 30 IEDs per ring. The self-healing Ethernet ring solution avoids single point of failure concerns and improves the reliability of the communication. The solution can be applied for the Ethernet-based IEC 61850, Modbus and DNP3.0 Level 2 protocols.

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

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

DNP3.0 Level 2 supports both serial and TCP modes for connection to one master. Additionally, changing of the active setting group is supported.

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

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

Ethernet-based:
- SNTP (Simple Network Time Protocol) – primary and secondary SNTP servers supported

With special time synchronization wiring:
- IRIG-B (Inter-Range Instrumentation Group
  - Time Code Format B)

In addition, the IED supports time synchronization via the following serial communication protocols:
- Modbus
- DNP3.0 Level 2

Table 5. Supported station communication interfaces and protocols

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

23. Technical data

Table 6. Dimensions

Description	Value	
Width	Frame	10.32 inches (262.2 mm)
	Case	9.69 inches (246 mm)
Height	Frame	6.97 inches (177 mm), 4U
	Case	6.30 inches (160 mm)
Depth		7.91 inches (201 mm)
Weight	Complete IED	10.5 lbs (4.8 kg)
	Plug-in unit only	6.0 lbs (2.8 kg)

Table 7. 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
Vn variation	38...110% of V_n (38...264 V AC) 80...120% of V_n (38.4...300 V DC)	50...120% of Vn (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 8. 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	20 A	4 A
	• For 1 s	500 A	100 A
	Dynamic current withstand:		
	• Half-wave value	1250 A	250 A
	Input impedance	<20 mΩ	<100 mΩ
Voltage inputs	Rated voltage V_n	60...210 V AC (Parametrization)	
	Voltage withstand:		
	• Continuous	2 x V_n (240 V AC)	
	• For 10 s	3 x V_n (360 V AC)	
	Burden at rated voltage	<0.05 VA	

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

Table 9. Measuring range

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

Table 10. RTD/mA inputs

Description		Value	
RTD inputs	Supported RTD sensors	100 Ω platinum	TCR 0.00385 (DIN 43760)
		250 Ω platinum	TCR 0.00385
		100 Ω nickel	TCR 0.00618 (DIN 43760)
		120 Ω nickel	TCR 0.00618
		250 Ω nickel	TCR 0.00618
		10 Ω copper	TCR 0.00427
	Supported resistance range	0…2 kΩ	
	Maximum lead resistance (three-wire measurement	25 Ω per lead	
	Isolation	2 kV (inputs to protective ground)	
	Response time	<4 s	
	RTD/resistance sensing current	Maximum 0.33 mA rms	
	Operation accuracy	Resistance	Temperature
		± 2.0% or ±1 Ω	±1°C
			10 Ω copper: ±2°C
mA inputs	Supported current range	0…20 mA	
	Current input impedance	44 Ω ± 0.1%	
	Operation accuracy	±0.5% or ±0.01 mA	

Table 11. Binary inputs

Description	Value
Operating range	±20 % of the rated voltage
Rated voltage	24...250 V DC
Current drain	1.6...1.9 mA
Power consumption	31.0...570 mW
Threshold voltage	18...176 V DC
Reaction time	3 ms

Table 12. Signal outputs and IRF output

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

Table 13. Double-pole power output (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	20...250 V AC/DC
- Current drain through the monitoring circuit	~1.5 mA
- Minimum voltage over the TCM contact	20 V AC/DC (15...20 V)

Table 14. 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 15. Double pole signal outputs with higher make and carry capabilities (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 16. 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 17. Ethernet and serial interfaces

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

[1] Depending on the optional communication module.

Table 18. Network Ethernet ports specifications

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

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

Table 19. IRIG-B

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

[1)] According to 200-04 IRIG -standard

Table 20. Lens sensor and optical fibre for arc protection

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

Table 21. Degree of protection of flush-mounted relay

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

Table 22. Environmental conditions

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

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

Table 23. Environmental tests

Description	Type test value	Reference
Dry heat test (humidity <50%)	• 96 h at +55ºC	IEC 60068-2-2
	• 16 h at +85ºC [1]	
	• 12h at +85 ºC [1] [2]	IEEE C37.90-2005
Dry cold test	• 96 h at -25ºC	IEC60068-2-1
	• 16 h at -40ºC	
	• 12h at -40ºC [1] [2]	IEEE C37.90-2005
Damp heat test, cyclic	• 6 cycles (12 h + 12 h) at +25°C…+55°C, humidity >93%	IEC 60068-2-30
	• +25°C, Rh = 95%, 96h	IEEE C37.90-2005
Storage test	• 96 h at -40ºC	IEC 60068-2-48
	• 96 h at +85ºC	IEEE C37.90-2005

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

Table 24. Electromagnetic compatibility tests

The EMC immunity test level meets the requirements listed below:

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

Table 24. Electromagnetic compatibility tests (continued)

The EMC immunity test level meets the requirements listed below:		
Description	**Type test value**	**Reference**
Voltage dips and short interruptions	30%/10 ms 60%/100 ms 60%/1000 ms >95%/5000 ms	According to IEC 61000-4-11
Power frequency immunity test: - Common mode - Differential mode	Binary inputs only 300 V rms 150 V rms	IEC 61000-4-16 IEC 60255-22-7, class A
Emission tests: - Conducted 0.15-0.50 MHz 0.5-30 MHz - Radiated 30-230 MHz 230-1000 MHz	 < 79 dB(µV) quasi peak < 66 dB(µV) average < 73 dB(µV) quasi peak < 60 dB(µV) average < 40 dB(µV/m) quasi peak, measured at 10 m distance < 47 dB(µV/m) quasi peak, measured at 10 m distance	EN 55011, class A IEC 60255-25

Table 25. Insulation tests

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

Table 26. Mechanical tests

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

Table 27. Product safety

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

Table 28. EMC Compliance

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

Table 29. RoHS compliance

Description
Complies with the RoHS directive 2002/95/EC

Protection functions

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

Characteristic		Value		
Pickup accuracy		Depending on the frequency of the current measured: f_n ±2Hz		
	51P	±1.5% of the set value or ±0.002 x I_n		
	50P-1, 50P-2 and 50P-3	±1.5% of set value or ±0.002 x I_n (at currents in the range of 0.1…10 x I_n) ±5.0% of the set value (at currents in the range of 10…40 x I_n)		
Pickup time [1) 2)]		Minimum	Typical	Maximum
	50P-3: I_{Fault} = 2 x set Pickup value	15 ms	16 ms	17 ms
	50P-3: I_{Fault} = 10 x set Pickup value	12 ms	13 ms	14 ms
	50P-1, 50P-2 and 51P: I_{Fault} = 2 x set Pickup value	23 ms	25 ms	28 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Retardation time		< 30 ms		
Trip time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Trip time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms [3)]		
Suppression of harmonics		RMS: No suppression DFT: -50dB at f = n x f_n, where n = 2, 3, 4, 5,… Peak-to-Peak: No suppression P-to-P+backup: No suppression		

[1)] Set Operate delay time = 0,02 s, Operate curve type = ANSI definite time, Measurement mode = default (depends on stage), current before fault = 0.0 x In, f_n = 50 Hz, fault current in one phase with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
[2)] Includes the delay of the signal output contact
[3)] Maximum Pickup value = 2.5 x I , Pickup value multiples in range of 1.5 to 20

Table 31. Three-phase non-directional overcurrent protection (50P, 51P) main settings

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

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

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

Characteristic		Value		
Pickup accuracy		Depending on the frequency of the current/voltage measured: fn ±2Hz		
	67/51P	Current: ±1.5% of the set value or ±0.002 x I_n Voltage: ±1.5% of the set value or ±0.002 x V_n Phase angle: ±2°		
	67/50P-1, 67/50P-2	Current: ±1.5% of set value or ±0.002 x I_n (at currents in the range of 0.1…10 x I_n) ±5.0% of set value (at currents in the range of 10…40 x I_n) Voltage: ±1.5% of the set value or ±0.002 x V_n Phase angle: ±2°		
Pickup time [1] [2]		Minimum	Typical	Maximum
	I_{Fault} = 2.0 x set Pickup value	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 x fn, where n = 2, 3, 4, 5,…		

1) Measurement mode and Pol quantity = default, current before fault = 0.0 x I_n, voltage before fault 1.0 x U_n, f_n = 50 Hz, fault current in one phase with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Maximum Pickup value = 2.5 x I_n, Pickup value multiples in range of 1.5 to 20

Table 33. Three-phase directional overcurrent protection (67/51P, 67/50P) main settings

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

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

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

Characteristic		Value		
Pickup accuracy		Depending on the frequency of the current measured: fn ±2Hz		
	51N, 51G, SEF	±1.5% of the set value or ±0.002 x I_n		
	50N-1, 50N-2, 50G-1, 50G-2 and 50N-3, 50G-3	±1.5% of set value or ±0.002 x I_n (at currents in the range of 0.1…10 x I_n) ±5.0% of the set value (at currents in the range of 10…40 x I_n)		
Pickup time 1) 2)		Minimum	Typical	Maximum
	50N-3, 50G-3: I_{Fault} = 2 x set Pickup value I_{Fault} = 10 x set Pickup value	 15 ms 12 ms	 16 ms 13 ms	 17 ms 14 ms
	50N-1, 50N-2, 50G-1, 50G-2 and 51N, 51G, SEF: I_{Fault} = 2 x set Pickup value	23 ms	25 ms	28 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Retardation time		< 30 ms		
Trip time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Trip time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms 3)		
Suppression of harmonics		RMS: No suppression DFT: -50dB at f = n x fn, where n = 2, 3, 4, 5,… Peak-to-Peak: No suppression		

[1] Measurement mode = default (depends on stage), current before fault = 0.0 x In, fn = 50 Hz, earth-fault current with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
[2] Includes the delay of the signal output contact
[3] Maximum Pickup value = 2.5 x In, Pickup value multiples in range of 1.5 to 20

Table 35. Non-directional ground fault protection (51N, 51G, 50N, 50G) main settings

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

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

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

Characteristic		Value		
Pickup accuracy		Depending on the frequency of the current measured: fn ±2Hz		
	67/51N	Current: ±1.5% of the set value or ±0.002 x I_n Voltage: ±1.5% of the set value or ±0.002 x V_n Phase angle: ±2°		
	67/50N-1, 67/50N-2	Current: ±2% of the set value or ±0.003 x In (at currents in the range of 0.1…10 x I_n) ±5.0% of the set value (at currents in the range of 10…40 x I_n) Voltage: ±1.5% of the set value or ±0.01 x V_n Phase angle: ±2°		
Pickup time [1] [2]		Minimum	Typical	Maximum
	67/50N-1, 67/50N-2: I_{Fault} = 2 x set Pickup value	42 ms	45 ms	49 ms
	67/51N-1: I_{Fault} = 2 x set Pickup value	62 ms	65 ms	69 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Retardation time		< 30 ms		
Trip time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Trip time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms 3)		
Suppression of harmonics		RMS: No suppression DFT: -50dB at f = n x fn, where n = 2, 3, 4, 5,… Peak-to-Peak: No suppression		

[1] Set Definite time delay = 0,06 s, Inverse-time (IDMT) and definite-time (DT) curves = ANSI definite time, Measurement mode = default (depends on stage), current before fault = 0.0 x I_n, f_n = 50 Hz, earth-fault current with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
[2] Includes the delay of the signal output contact
[3] Maximum Pickup value = 2.5 x I_n, Pickup value multiples in range of 1.5 to 20

Table 37. Directional ground fault protection (67/51N, 67/50N) main settings

Parameter	Function	Value (Range)	Step
Pickup value	67/51N	0.010...5.000 x In	0.005
	67/50N-1, 67/50N-2	0.10...40.00 x In	0.01
Directional mode	67/51N, 67N/ 50N-1 and 67/50N-2	1=Non-directional 2=Forward 3=Reverse	
Time multiplier	67/51N	0.05...15.00	0.05
	67/50N-1, 67/50N-2	0.05...15.00	0.05
Definite time delay	67/51N	60...200000 ms	10
	67/50N-1, 67/50N-2	60...200000 ms	10
Operating curve type 1)	67/51N	Definite or inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
	67/50N-1, 67/50N-2	Definite or inverse time Curve type: 1, 3, 5, 15, 17	
Operation mode	67/51N, 67/50N-1 and 67/50N-2	1=Phase angle 2=I0Sin 3=I0Cos 4=Phase angle 80 5=Phase angle 88	

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

Characteristic		Value		
Pickup accuracy	51LT	Depending on the frequency of the current measured: f_n ±2Hz ±1.5% of the set value or ±0.002 x I_n		
Pickup time 1) 2)	51LT: I_{Fault} = 2 x set Pickup value	Minimum	Typical	Maximum
		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 4)		
Suppression of harmonics		RMS: No suppression DFT: -50dB at f = n x f_n, where n = 2, 3, 4, 5,… Peak-to-Peak: No suppression P-to-P+backup: No suppression		

1) Set Operate delay time = 0.02 s, Operate curve type = ANSI definite time, Measurement mode = default (depends on element), current before fault = 0.0 x I_n, f_n = 60 Hz, fault current in one phase with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Includes the delay of the heavy-duty output contact
4) Maximum Pickup value = 2.5 x I_n, Pickup value multiples in range of 1.5 to 20

Table 39. Three-phase non-directional long time overcurrent protection (51LT) main settings

Parameter	Function	Value (Range)	Step
Pickup value	51LT	0.05 - 5.00 x In	0.01
Time multiplier	51LT	0.10...15.001	0.01
Definite time delay	51LT	0.020...200.001 s	0.001
Operating curve type	51LT	Definite or inverse-time curve type: 6, 7, 14, 15, 17	

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

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

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

Table 41. Three-phase overvoltage protection (59) main settings

Parameter	Function	Value (Range)	Step
Pickup value	59	0.05…1.60 x V_n	0.01
Time multiplier	59	0.05…15.00	0.05
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 42. 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 x V_n		
Pickup time [1) 2)]	V_{Fault} = 0.9 x set Pickup value	Minimum	Typical	Maximum
		62 ms	66 ms	69 ms
Reset time		< 40 ms		
Reset ratio		Depends on the set Relative hysteresis		
Retardation time		< 35 ms		
Trip time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Trip time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms [3)]		
Suppression of harmonics		DFT: -50dB at f = n x f_n, where n = 2, 3, 4, 5,…		

[1)] Pickup value = 1.0 x U_n, Voltage before fault 1.1 x U_n, f_n = 50 Hz, undervoltage in one phase-to-phase with nominal frequence injected from random phase angle, results based on statistical distribution of 1000 measurements
[2)] Includes the delay of the signal output contact
[3)] Minimum Pickup value = 0.50, Pickup value multiples in range of 0.90 to 0.20

Table 43. Three-phase undervoltage protection (27) main settings

Parameter	Function	Value (Range)	Step
Pickup value	27	0.05…1.20 x V_n	0.01
Time multiplier	27	0.05…15.00	0.05
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 44. Positive sequence undervoltage protection (27PS)

Characteristic		Value		
Pickup accuracy		Depending on the frequency of the voltage measured: f_n ±2Hz		
		±1.5% of the set value or ±0.002 x V_n		
Pickup time [1) 2)]	V_{Fault} = 0.99 x set Pickup value	Minimum	Typical	Maximum
		52 ms	55 ms	57 ms
	V_{Fault} = 0.9 x set Pickup value	44 ms	46 ms	49 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		
Suppression of harmonics		DFT: -50dB at f = n x f_n, where n = 2, 3, 4, 5,…		

[1)] Pickup value = 1.0 x U_n, Positive sequence voltage before fault 1.1 x U_n, f_n = 50 Hz, positive sequence undervoltage 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 45. Positive sequence undervoltage protection (27PS) main settings

Parameter	Function	Value (Range)	Step
Pickup value	27PS	0.010...1.200 x V_n	0.001
Definite time delay	27PS	40...120000 ms	10
Voltage block value	27PS	0.01...1.0 x V_n	0.01

Table 46. Negative sequence overvoltage protection (47)

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

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

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

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

Table 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 x V_n		
Pickup time [1) 2)]		Minimum	Typical	Maximum
	V_{Fault} = 1.1 x set Pickup value	55 ms	57 ms	60 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Retardation time		< 35 ms		
Trip time accuracy in definite time mode		±1.0% of the set value or ±20 ms		
Suppression of harmonics		DFT: -50dB at f = n x f_n, where n = 2, 3, 4, 5,…		

[1)] Residual voltage before fault 0.0 x U_n, f_n = 50 Hz, residual voltage with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
[2)] Includes the delay of the signal output contact

Table 49. Ground overvoltage protection (59G) main settings

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

Table 50. Negative sequence overcurrent protection (46)

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

[1)] Negative sequence current before fault = 0.0, f_n = 50 Hz, results based on statistical distribution of 1000 measurements
[2)] Includes the delay of the signal output contact
[3)] Maximum Pickup value = 2.5 x I_n, Pickup value multiples in range of 1.5 to 20

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

Parameter	Function	Value (Range)	Step
Pickup value	46	0.01...5.00 x I_n	0.01
Time multiplier	46	0.05...15.00	0.05
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. Phase discontinuity protection (46PD)

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

Table 53. Phase discontinuity protection (46PD) main settings

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

Table 54. Circuit breaker failure protection (50BF, 50NBF, 50GBF)

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

Table 55. Circuit breaker failure protection (50BF, 50NBF, 50GBF) main settings

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

Table 56. Three-phase thermal overload (49F)

Characteristic	Value
Pickup Accuracy	Depending on the frequency of the current measured: fn ±2Hz Current measurement: ±0.5% or ±0.002 x I_n (at currents in the range of 0.01…4.00 x I_n)
Trip time accuracy	±2.0% or ±0.50 s

Table 57. Three-phase thermal overload (49F) main settings

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

Table 58. Three-phase inrush current detection (INR)

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

Table. 58. Three-phase inrush current detection (INR) main settings

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

Table 59. Arc protection (AFD)

Characteristic		Value		
Pickup Accuracy		±3% of the set value or ±0.01 x In		
Trip time		Minimum	Typical	Maximum
	Operation mode = "Light+current" [1) 2)]	9 ms	12 ms	15 ms
	Operation mode = "Light only" [2)]	9 ms	10 ms	12 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		

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

Table 60. Arc protection (AFD) main settings

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

Table 61. 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 62. Restricted earth fault, low impedance (REF)

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

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

Table 63. Restricted earth fault, low impedance (REF) main settings

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

Table 64. Single-phase undercurrent protection (37)

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

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

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

Table 66. Autoreclose (79)

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

Table 67. Autoreclose (79) main settings

Parameter	Function	Value (Range)	Step
Reset time	79	0.10...1800.000 s	0.001
Reclose attempts	79	0...7	1
Reclose time	79	0.000...300.00 s	0.001
Enable/disable protection	79	Programmable per reclose attempt	

Table 68. 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
Trip time accuracy in definite-time mode	± 1.0% of the set value or + 20 ms
Trip time accuracy in inverse-time mode	± 5.0% of the theoretical value or + 50 ms

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

Table 69. 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 70. 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 71. Frequency protection (81) main settings

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

Table 72. Thermal overload protection, two time constants (T2PTTR)

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

Table 73. Load shed and restoration (81LSH)

Characteristic		Value
Pickup accuracy	81U	±10 mHz
	df/dt	±100 mHz/s (in range |df/ dt| < 5 Hz/s) ± 2.0% of the set value (in range 5 Hz/s < |df/dt| < 15 Hz/s)
Start time	81U	< 80 ms
	df/dt	< 120 ms
Reset time		< 150 ms
Trip time accuracy		±1.0% of the set value or ±30 ms

Table 74. Load shed and restoration (81LSH) main settings

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

Table 75. Synchronism check (25)

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

Table 76. Synchronism check (25) main settings

Parameter	Function	Value (Range)	Description
Live dead mode	25	-1=Off 1=Both Dead 2=Live L, Dead B 3=Dead L, Live B 4=Dead Bus, L Any 5=Dead L, Bus Any 6=One Live, Dead 7=Not Both Live	Energizing check mode
Difference voltage	25	0.01...0.50 xUn	Maximum voltage difference limit
Difference frequency	25	0.001...0.100 xFn	Maximum frequency difference limit
Difference angle	25	5...90 deg	Maximum angle difference limit
Synchrocheck mode	25	1=Off 2=Synchronous 3=Asynchronous	Synchrocheck operation mode
Control mode	25	1=Continuous 2=Command	Selection of the synchrocheck command or continuous control mode
Dead line value	25	0.1...0.8 xUn	Voltage low limit line for energizing check
Live line value	25	0.2...1.0 xUn	Voltage high limit line for energizing check
Close pulse	25	200...60000 ms	Breaker closing pulse duration
Max energizing V	25	0.50...1.15 xUn	Maximum voltage for energizing
Phase shift	25	-180...180 deg	Correction of phase difference between measured V_BUS and V_LINE
Minimum Syn time	25	0...60000 ms	Minimum time to accept synchronizing
Maximum Syn time	25	100...6000000 ms	Maximum time to accept synchronizing
Energizing time	25	100...60000 ms	Time delay for energizing check
Closing time of CB	25	40...250 ms	Closing time of the breaker

Table 77: Phase step distance protection (21P)

Characteristic	Value
Pickup accuracy	Depending of the frequency of the current measured: fn ±2Hz
	Current: ± 1.5 % of the set value or ± 0.002 x In
	Voltage: ±1.5% of the set value or ± 0.002 × Un
	Impedance: ±2.0% of the set value or ± 0.1 ohm
	Phase angle: ±2°
Pickup time 1)2)	Typical 23 ms
Reset time	< 40 ms
Reset ratio	Typical 0.96
Trip time accuracy in definite time mode	±1.0% of the set value or ±20 ms
Suppression of harmonics	DFT: -50dB at f = n x fn, where n = 2, 3, 4, 5,…

Table 78: Phase step distance protection (21P) main settings

Parameter	Function	Values (Range)	Step
Mho polarization method for zones	21P	Pos. seq. volt. Cross pol	
Voltage memory time	21P	0...3000 ms	10
Phase current pickup value, PSL	21P	0.10...10.00 x In	0.01
Enable Load Discrimination, PSL	21P	False True	
Voltage limit for enabling load discrimination, PSL	21P	x Un	0.1
Resistive reach for load discrimination, PSL	21P	0.10...1000.00 ohm	0.01
Load discrimination angle, PSL	21P	5.0...45.0 deg	0.1
Operation Disable/Enable, Zone 1	21P	Enable Disable	
Directional mode, zone Z1	21P	Forward Reverse	
Positive sequence zone reach, Zone Z1	21P	0.10...1000.00 ohm	0.01
Positive sequence line angle, Zone Z1	21P	10.0...90.0 deg	0.1
Time delay to trip of PP/3P-loops, Zone Z1	21P	30...200000 ms	10
Enable optional phase sequence supervision for PP/3P-loops, Zone Z1	21P	False True	
Minimum Pos. seq. current for 3P-loop, Zone 1	21P	0.10...10.00 x In	0.01
Minimum Neg. seq. current for PP-loop, Zone 1	21P	0.10...10.00 x In	0.01
	21P		

Measurement functions

Table 79. Three-phase current measurements (IA, IB, IC)

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

Table 80. Current sequence components (I1, I2, I0)

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

Table 81. Three-phase voltage measurements (VA, VB, VC)

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

Table 82. Voltage sequence components (V1, V2, V0)

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

Table 83. Ground current measurement (IG)

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

Table 84. Ground voltage measurement (VG)

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

Table 85. Three-phase and single-phase power and energy (P, SP, E, SE)

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

Table 86. Frequency measurement (f)

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

Table 87. Power quality sag (dip), swell, interruption measurements (PQSS)

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

Table 88: Voltage unbalance (PQVUB)

Characteristic	Value
Operation accuracy	± 1.5 % of the set value or ± 0.002 x In
Reset ratio	Typical 0.96

Table 89: Voltage unbalance (PQVUB) main settings

Parameter	Values (Range)	Step
Set the operation mode for voltage unbalance calculation	"Neg Seq Zero Seq Neg to Pos Seq Zero to Pos Seq Ph vectors Comp"	
Voltage unbalance pickup value	1...100 %	1
Specifies the observation period triggering mode	"Single Periodic Continuous"	
The percent to which percentile value PCT_UNB_VAL is calculated	1...100 %	1
Observation period for unbalance calculation	"1 Hour 12 Hours 1 Day 7 Days User defined"	
User defined observation period for statistic calculation	1...168 hours	1
Calendar time for observation period start given as YYYYMMDDhh	2008010100...2076010100	1

Supervision functions

Table 90. Current circuit supervision (CCM)

Characteristic	Value
Trip time [1]	< 30 ms

[1] Including the delay of the output contact

Table 91. Current circuit supervision (CCM) main settings

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

Table 92. Fuse failure supervision (60)

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

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

24. Display

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

The large display offers increased front-panel usability with less menu scrolling and improved information overview than with smaller LCD screens. The large display is well-suited for all relay installations providing an easy viewing interface.Use the photo of REF620 here.

Fig. 3. Large display standard

25. Local HMI

The IED'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. In addition, the large display includes a user configurable single line diagram (SLD) with position indication for the associated primary equipment. The standard configuration of the IED displays, apart from the primary equipment position, the related measuring values. Thus all necessary measurement can be viewed without scrolling through the IED menu. The SLD view can also be accessed using the web-browser based user interface. The default SLD can be modified according to user requirements using the graphical display editor in PCM600.

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

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

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

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

26. Mounting methods

By means of appropriate mounting accessories the standard relay case for the 620 series relays can be flush mounted, semi-fl ush mounted or wall mounted. Further, the relays can be mounted in any standard 19" instrument cabinet by means of 19" mounting panels available with cut-out for one relay. 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-fl ush 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:

- Width: 9.76" (248 ± 1 mm)
- Height: 6.38" (162 ± 1 mm)

27. Accessories 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.

		1	2	3	4			5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Ex: NAFCCBCBNBE1BAN1XF	N	A	F	C			C	B	C	B	N	B	E	1	B	A	N	1	X	F
Digit	**Description**																				
1) Product Series	620 series (Includes case)																				
2) Standard	ANSI																				
3) Main Appl	Feeder protection and control																				
4) Configuration	A: Advanced distribution feeder protection and control with single breaker				A																
	B: Advanced distribution feeder protection and control with one-and-a-half breakers					B															
	C: Advanced distribution feeder protection and control with two or one-and-a-half breakers						C														
5-6) Analog Inputs	3 CT + Ground CT + 5 VT + Reclosing							A	A												
	3 CT + SEF/HIZ CT + 5 VT + Reclosing							A	B												
	6 CT + 8 VT + Reclosing							B	A												
	6 CT + Ground CT + 7 VT + Reclosing							C	A												
	6 CT + SEF/HIZ CT + 7 VT + Reclosing							C	B												
7-8) Binary I/O	16 BI + 6 BO + 3 HSO									A	1										
	16 BI + 10 BO									A	A										
	24 BI + 10 BO + 3 HSO									A	2										
	24 BI + 14 BO									A	B										
	32 BI + 14 BO + 3 HSO									A	3										
	32 BI + 18 BO									A	C										
	16 BI + 6 BO + 6 HSO									B	1										
	16 BI + 10 BO + 3 HSO									B	2										
	16 BI + 14 BO									B	A										
	24 BI + 10 BO + 6 HSO									B	3										
	24 BI + 14 BO + 3 HSO									B	4										
	24 BI + 18 BO									B	B										
	16 BI + 6 BO + 6 HSO									C	1										
	16 BI + 10 BO + 3 HSO									C	2										
	16 BI + 14 BO									C	A										
	24 BI + 10 BO + 6 HSO									C	3										
	24 BI + 14 BO + 3 HSO									C	4										
	24 BI + 18 BO									C	B										
9-10) Communication Ports[1)]	One port: Ethernet 100FX (LC)											N	A								
	One port: Ethernet 10/100BaseT (RJ45)											N	B								
	Two/three ports: [Ethernet 100 FX (LC) + RS-485 (1x4-wire or 2x2-wire)] + IRIG-B											A	A								
	Two/three ports: [Ethernet 10/100BaseT (RJ45) + RS-485 (1x4-wire or 2x2-wire)] + IRIG-B											A	B								
	Four ports: [Ethernet 100FX (LC) + 2 * Ethernet 10/100BaseT (RJ45) + serial glass fiber (ST)]											A	K								
	Four ports: [Ethernet 3 * 10/100BaseT (RJ45) + serial glass fiber (ST)]											A	L								
	Three ports: Ethernet 10/100BaseT (RJ45) + configurable RS232/RS485 + [RS485 or serial glass fiber (ST)] + IRIG-B											3	3								

		1	2	3	4			5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Ex: NAFCCBCBNBE1BAN1XF	N	A	F	C			C	B	C	B	N	B	E	1	B	A	N	1	X	F
Digit	**Description**																				
Includes Arc Flash Detection	One port: Ethernet 100FX (LC) + Arc Flash Detection											N	F								
	One port: Ethernet 10/100BaseT (RJ45) + Arc Flash Detection											N	G								
	Two/three ports: [Ethernet 100 FX (LC) + RS-485 (1x4-wire or 2x2-wire)] + IRIG-B + Arc Flash Detection											F	F								
	Two/three ports: [Ethernet 10/100BaseT (RJ45) + RS-485 (1x4-wire or 2x2-wire)] + IRIG-B + Arc Flash Detection											F	G								
	Four ports: [Ethernet 100FX (LC) + 2 * Ethernet 10/100BaseT (RJ45) + serial glass fiber (ST)] + Arc Flash Detection											F	K								
	Four ports: [Ethernet 3 * 10/100BaseT (RJ45) + serial glass fiber (ST)] + Arc Flash Detection											F	L								
11) Protocols	IEC61850 + DNP3.0 L2 + Modbus													E							
12) Language	English														1						
	English + Spanish														5						
	English + Portuguese														8						
13) Front Panel	Large LCD (standard)															B					
14) Option 1	Power quality																A				
	None																N				
15) Option 2	None																	N			
16) Power Supply	48-250 Vdc; 100-240 Vac																		1		
	24-60 Vdc																		2		
17) SW Version	SW Version 2.0																			X	
18) HW Version	HW																				F

* Note: All communication options with RS-485 include IRIG-B connections.
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.
2) Version is “F” as product is based on M9.1

Table 93. Accessories and ordering data.

Item	Order Number
Tools	
PCM600 user tool	PCM600-24
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	2RCA030573A0001
Wall mounting kit	2RCA030894A0001
19” mounting panel kit	2RCA031135A0001
Protection cover kit	2RCA030963A0001
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

28. Tools

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

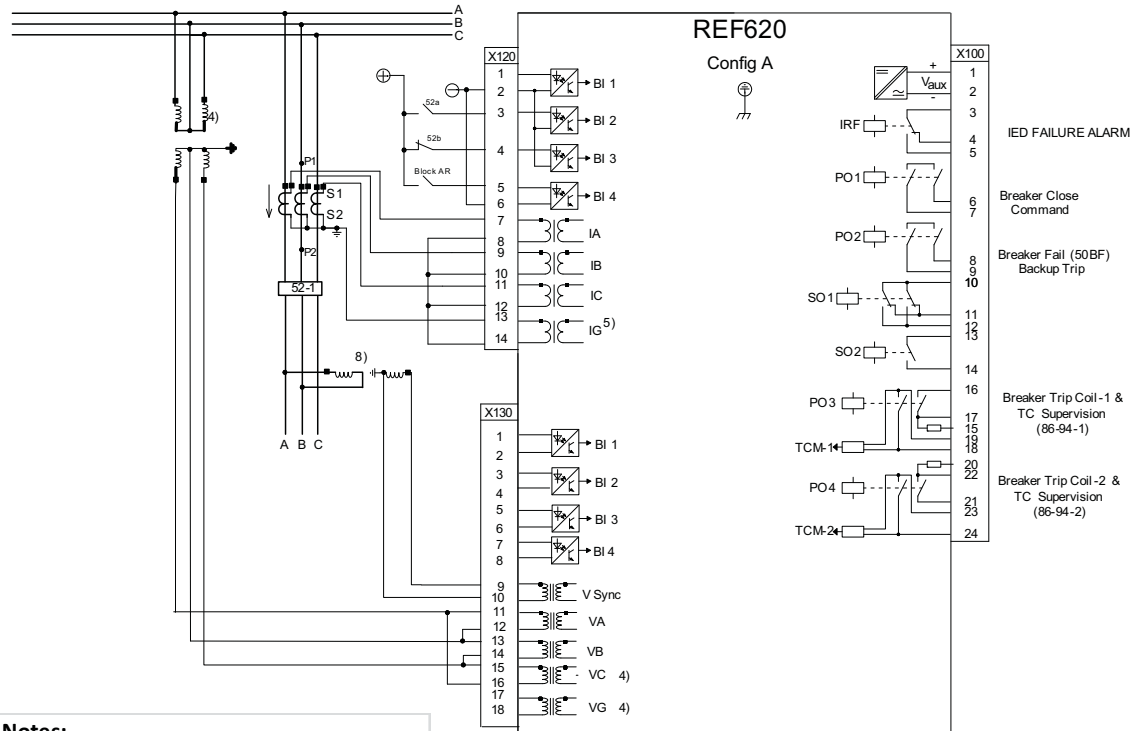
PCM600 offers extensive relay configuration functions such as application configuration, signal matrix, communication management, graphical display editor, and IEC 61850 communication configuration including horizontal relay-to-relay communication, GOOSE.

When the web-browser based user interface is used, the relay can be accessed either locally or remotely using a web browser (IE 6.0 or later). For security reasons, the web-browser based user interface is disabled by default. The interface can be enabled with the PCM600 tool or from the front panel user interface. The functionality of the interface can be limited to read-only access by means of PCM600.

Table 94. Tools

Tools	
Configuration, setting and SA system tools	Version
PCM600	2.4.1 or later
Web-browser based user interface	IE 7.0 or later
REF620 Connectivity Package	2.0 ANSI or later
COM600 substation product	V3.5 or later
MicroSCADA Pro Substation Automation system	9.3 or later

Figure 4. REF620 connection diagram configuration A



Notes:

1) Order Selectable, Optional

2) 100BaseFX / LC or 100BaseTX / RJ45

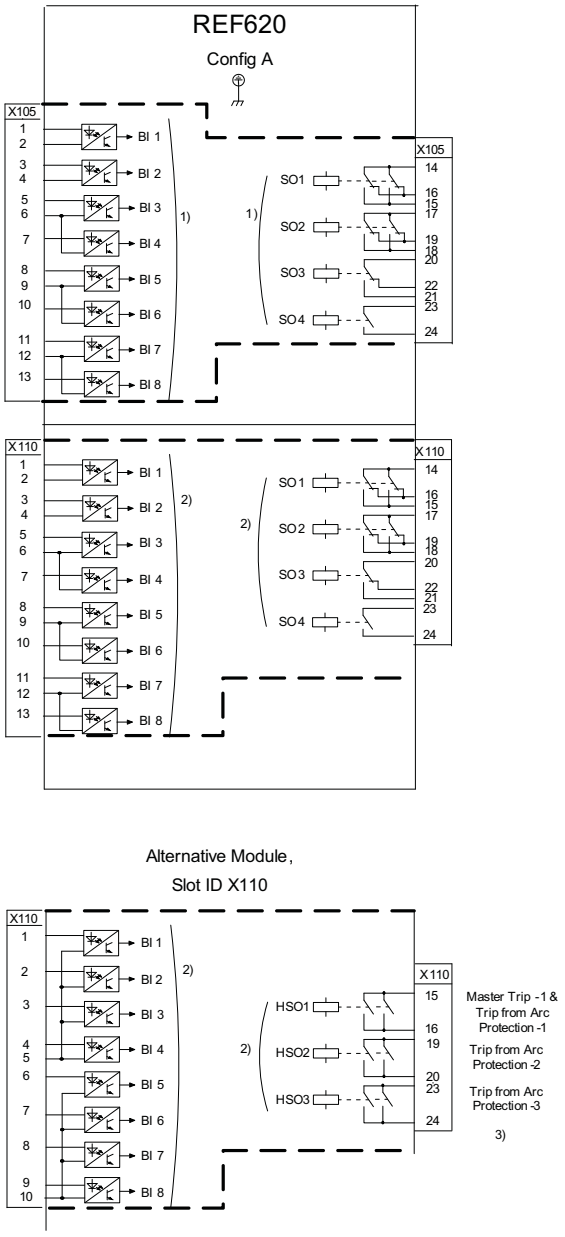
3) Refer next sheets for details of Binary Input and Output cards (BIO)

4) Connections shown are applicable with Open Delta (V) (Ph-Ph) connected VTs. Connections and configurations with WYE (along with Broken delta) VT connections are suggested in other parts of the application manual

5) IG Input is order selectable, either 5/1A or 1/0.2AWhen IG is ordered with sensitive current input (1/0.2A), current source is from CBCT

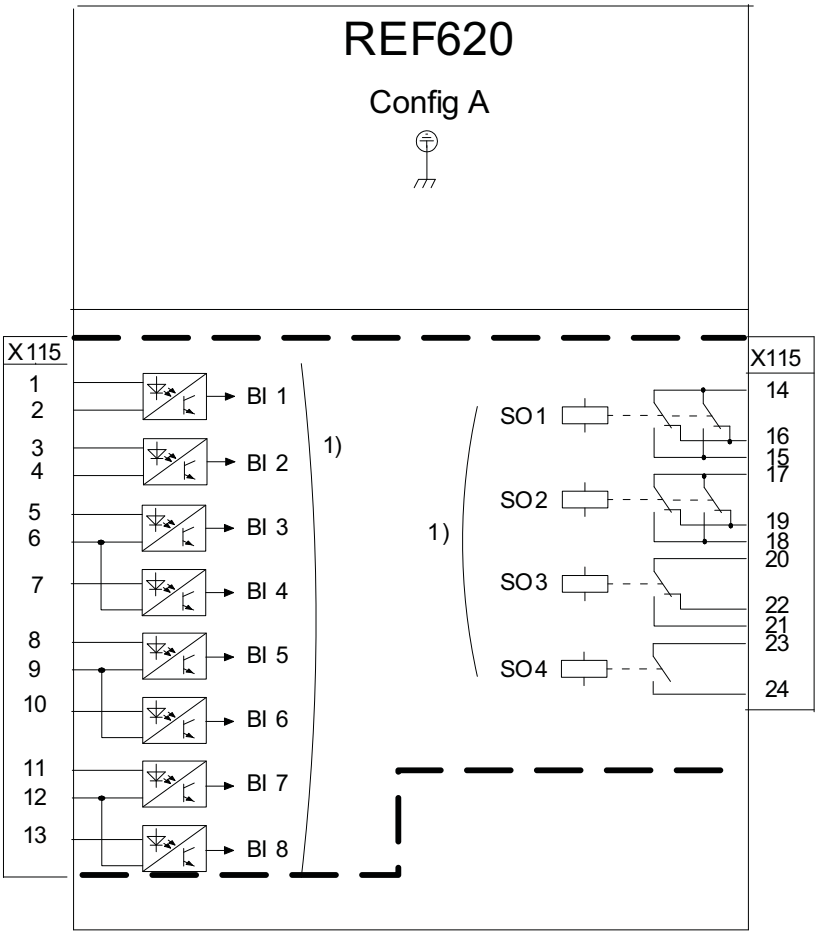
6) Synchronizing input is shown as Ph-Ph voltage input (Set as Delta in analog input channel configuration). Alternatively VA (Phase-Neutral) voltage input is possible, to be suitably configured in the IED

Figure 5. REF620 connection diagram configuration A



1) Order Selectable, Optional
2) Order Selectable, Optional alternatives
3) Default outputs configured with High Speed Outputs when Arc protection option is chosen

Figure 6. REF620 connection diagram config A



Notes:

1) Order Selectable, Optional

Figure 7. REF620 connection diagram configuration A

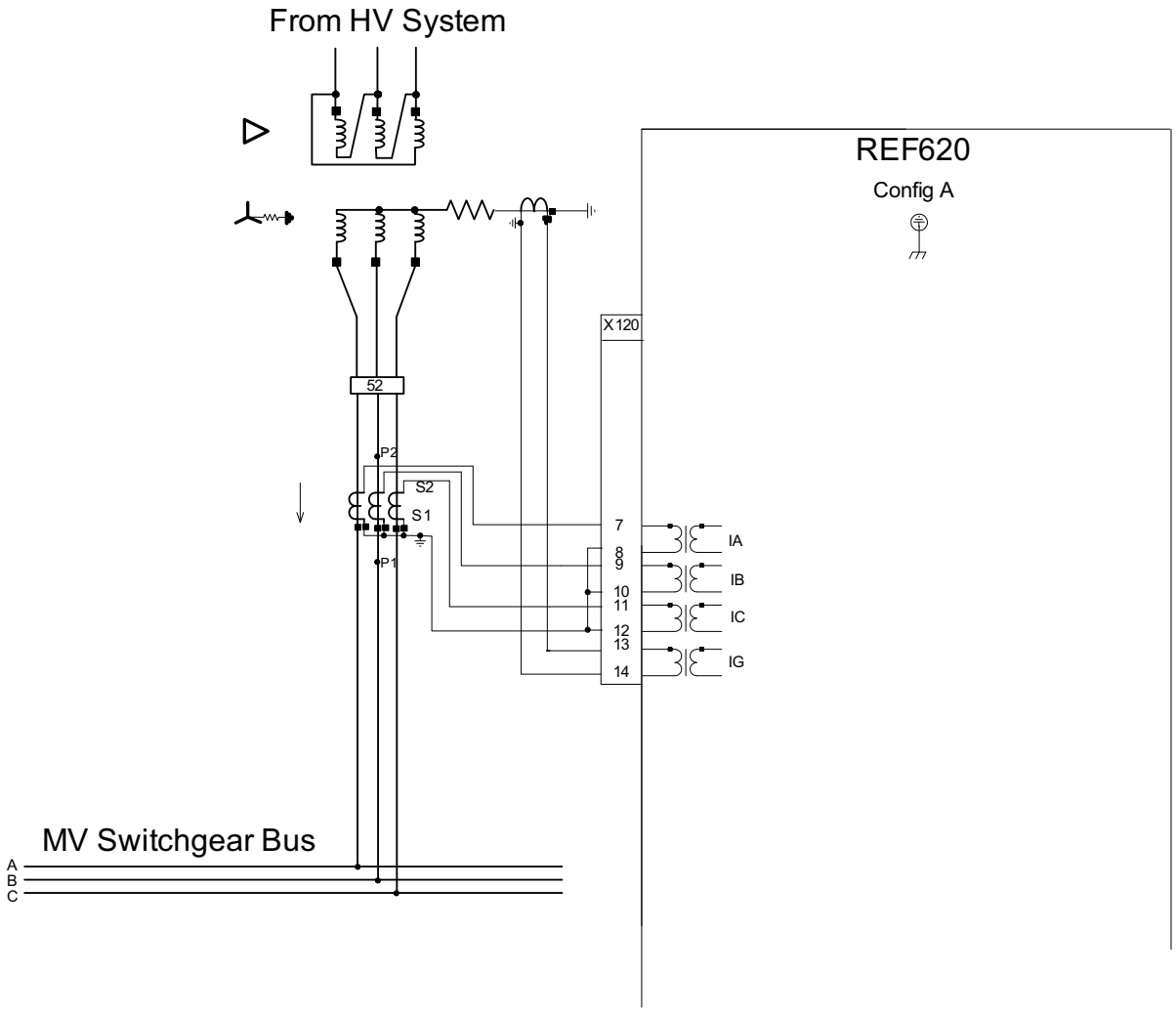
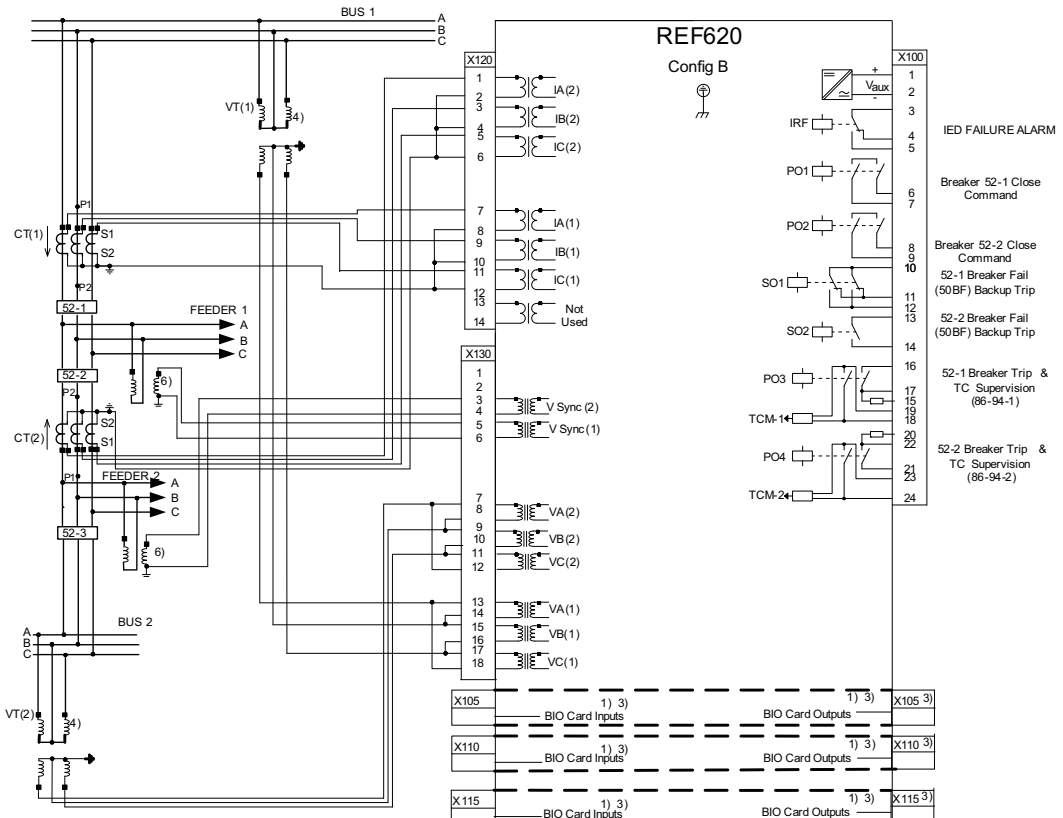


Figure 8. REF620 connection diagram config B



Notes:

1) Order Selectable, Optional

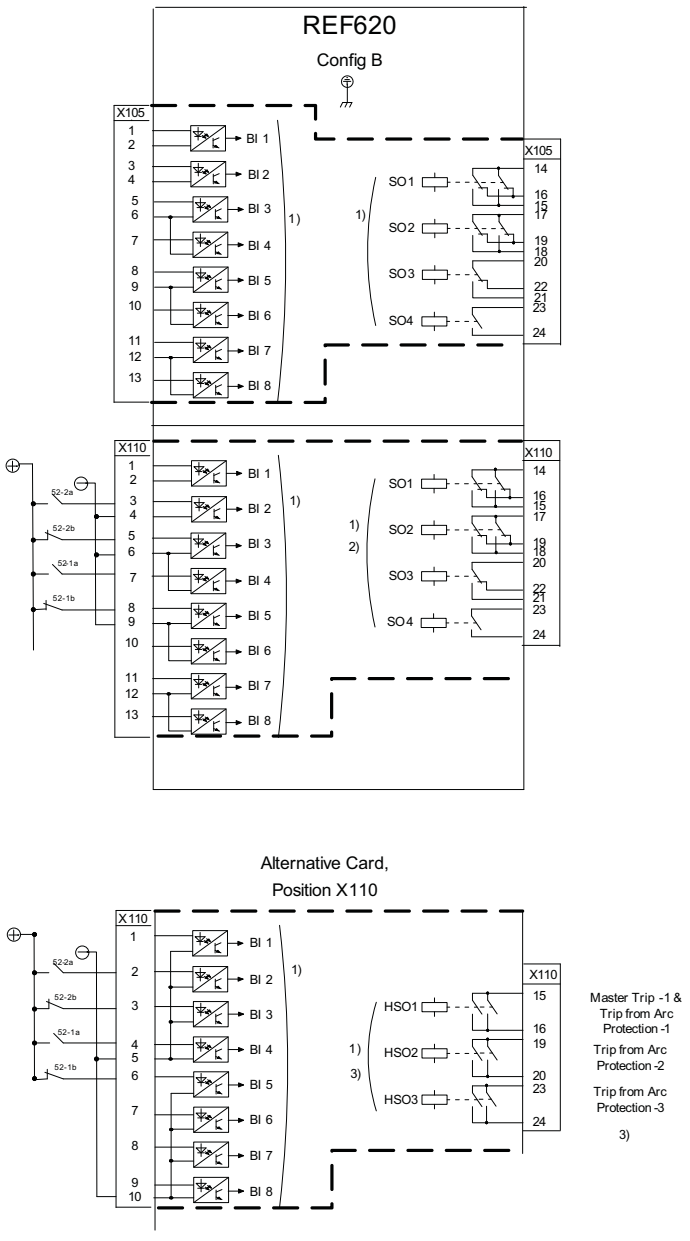
2) 100BaseFX / LC or 100BaseTX / RJ45

3) Refer next sheets for details of Binary Input and Output cards (BIO)

4) Connections shown are applicable with Open Delta (V) (Ph-Ph) connected VTs . Connections and configurations with WYE (along with Broken delta) VT connections are suggested in other parts of the application manual

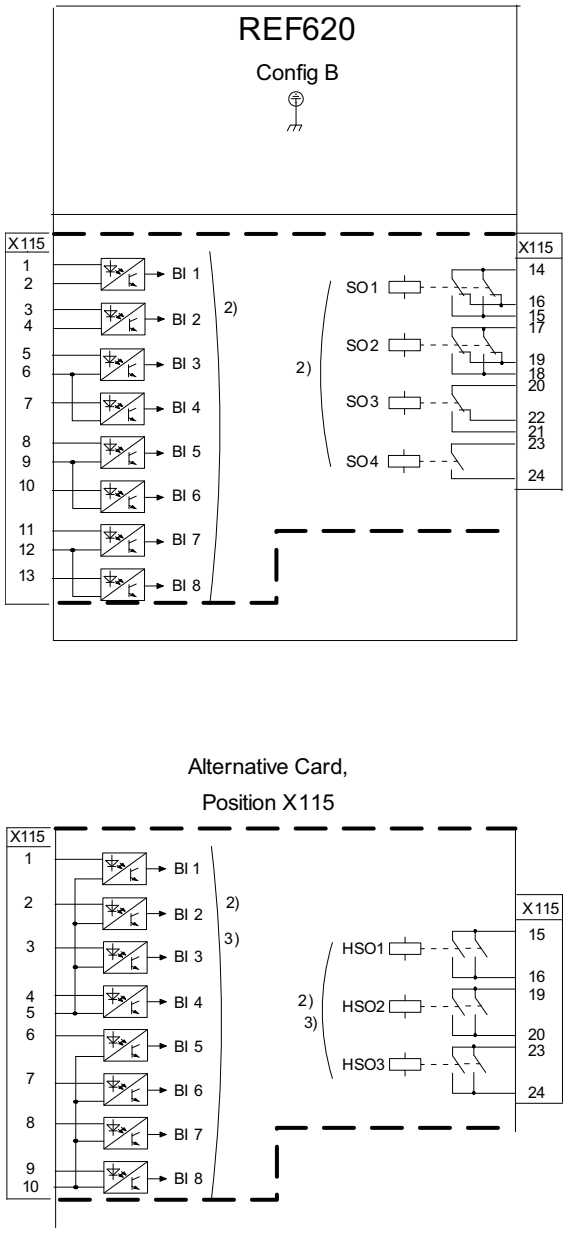
6) Synchronizing input is shown as Ph-Ph voltage input (Set as Delta in analog input channel configuration). Alternatively VA (Phase-Neutral) voltage input is possible, to be suitably configured in the IED

Figure 9. REF620 connection diagram config B



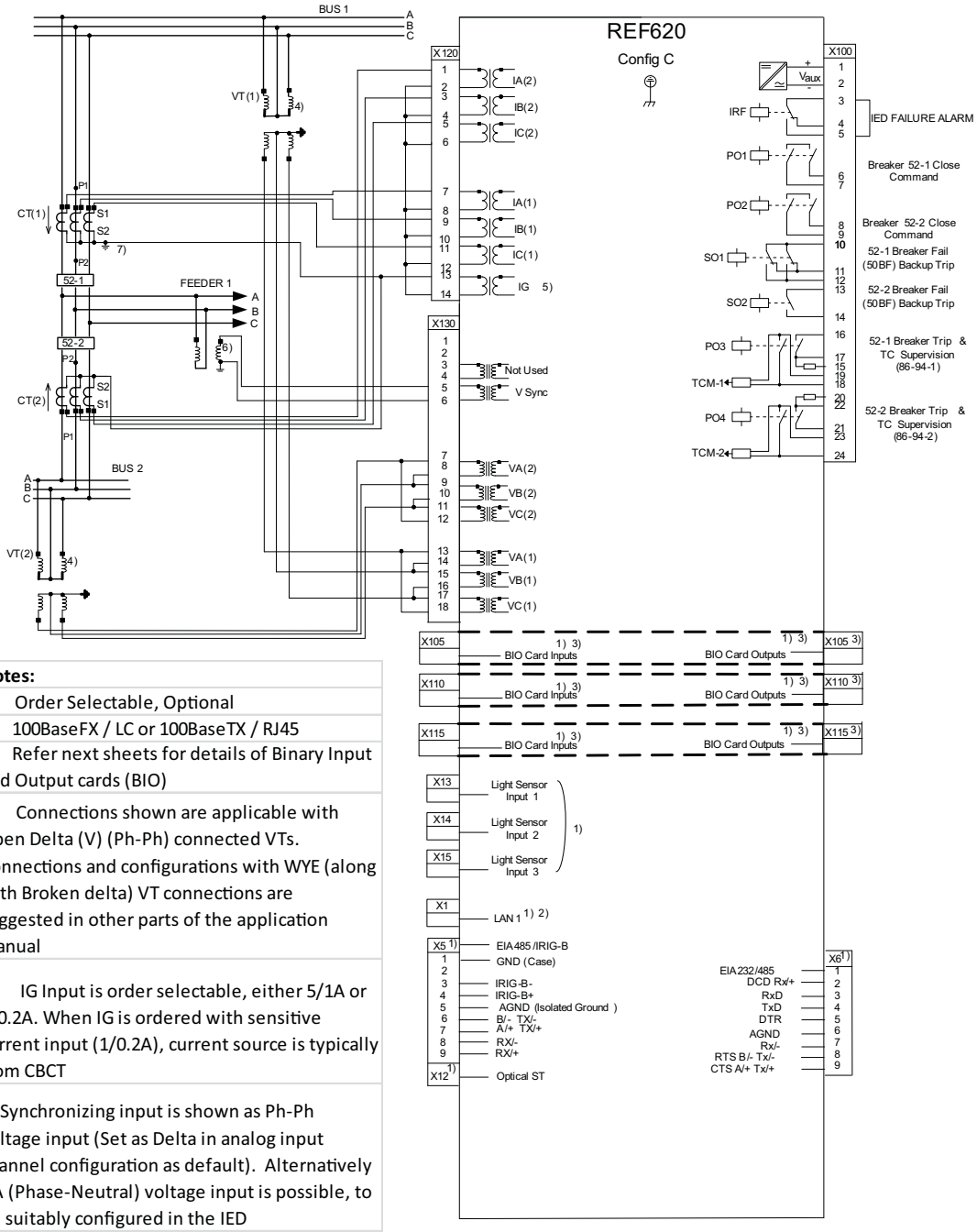
1) Order Selectable, Optional
2) Order Selectable, Optional alternatives
3) Default outputs configured with High Speed Outputs when Arc protection option is chosen

Figure 10. REF620 connection diagram config B



Notes:
2) Order Selectable, Optional alternatives
3) High speed BIO card in this slot only when X110 slot is equipped with High speed BIO card

Figure 11. REF620 connection diagram config C



Notes:
1) Order Selectable, Optional
2) 100BaseFX / LC or 100BaseTX / RJ45
3) Refer next sheets for details of Binary Input and Output cards (BIO)
4) Connections shown are applicable with Open Delta (V) (Ph-Ph) connected VTs. Connections and configurations with WYE (along with Broken delta) VT connections are suggested in other parts of the application manual
5) IG Input is order selectable, either 5/1A or 1/0.2A. When IG is ordered with sensitive current input (1/0.2A), current source is typically from CBCT
6) Synchronizing input is shown as Ph-Ph voltage input (Set as Delta in analog input channel configuration as default). Alternatively VA (Phase-Neutral) voltage input is possible, to be suitably configured in the IED
7) With paralleled CTs, CT neutral Point shall be grounded only at one point in the installation

Figure 12. REF620 connection diagram config C

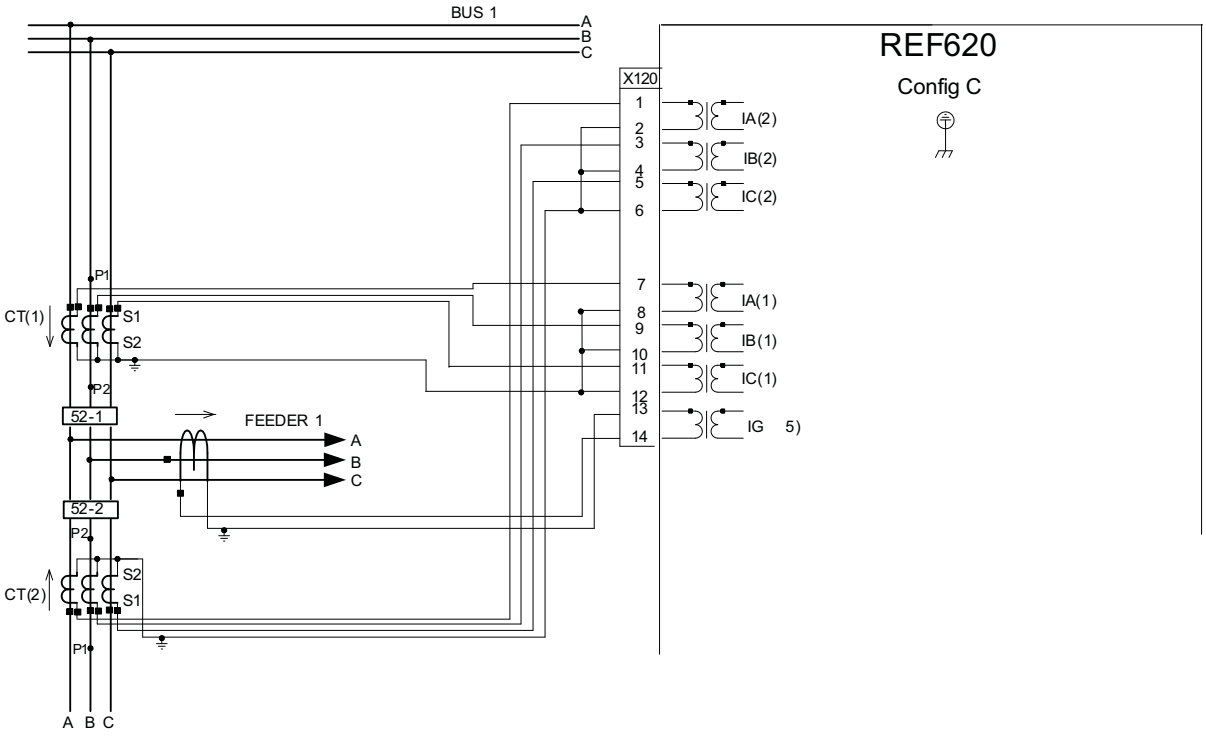
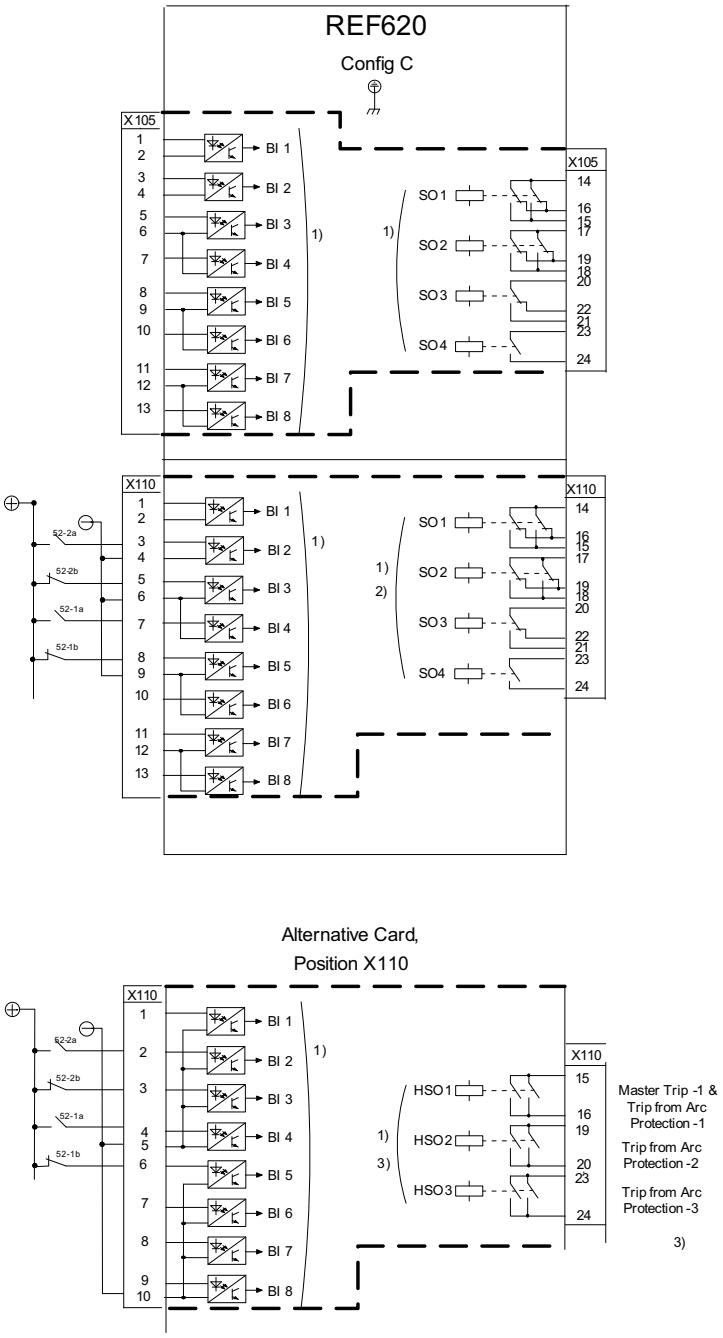


Figure 13. REF620 connection diagram config C

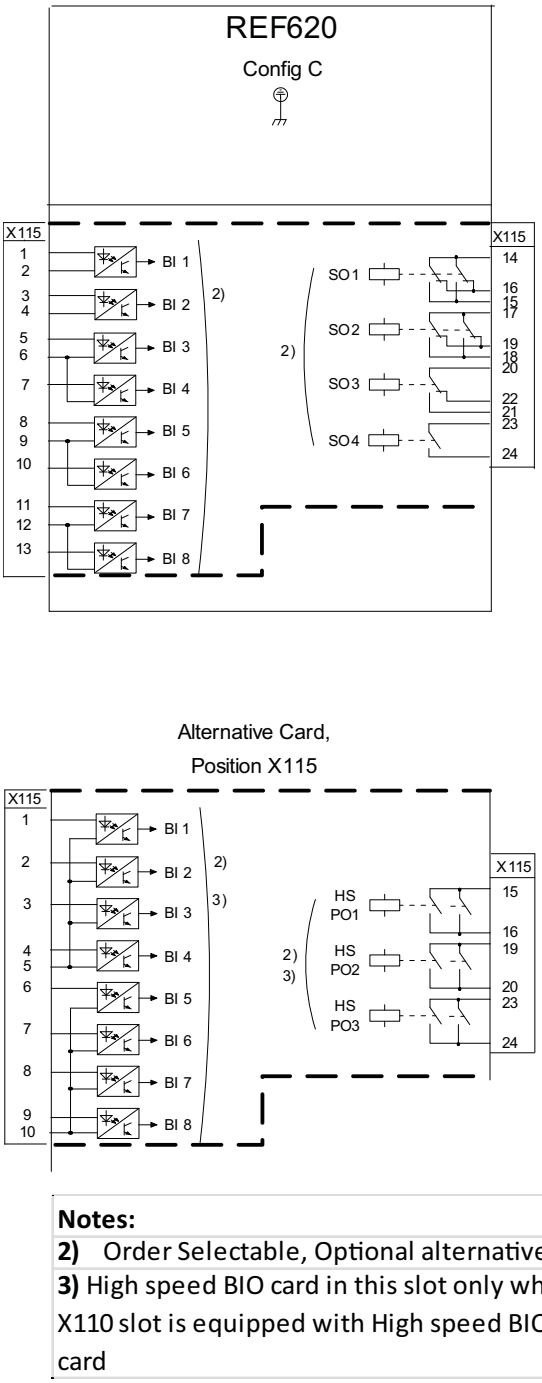


1) Order Selectable, Optional

2) Order Selectable, Optional alternatives

3) Default outputs configured with High Speed Outputs when Arc protection option is chosen

Figure 14. REF620 connection diagram config C



Notes:
2) Order Selectable, Optional alternatives
3) High speed BIO card in this slot only when X110 slot is equipped with High speed BIO card

30. Certificates

The REF620 is a UL Listed product, UL File/Sec. E103204

31. References

The download area on the right hand side of the product web page contains the latest product documentation, such as technical manual, installation manual, operator 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 feeder protection and control REF620 ANSI on the product web page.

32. Functions, codes and symbols

Table 95. REF620 Functions, codes and symbols

	IEC61850	ANSI/C37.2	IEC60617
Protection			
Three-phase non-directional overcurrent protection, low stage, instance 1	PHLPTOC1	51P	3I> (1)
Three-phase non-directional overcurrent protection, high stage, instance 1	PHHPTOC1	50P-1	3I>> (1)
Three-phase non-directional overcurrent protection, high stage, instance 2	PHHPTOC2	50P-2	3I>> (2)
Three-phase non-directional overcurrent protection, instantaneous stage, instance 1	PHIPTOC1	50P-3	3I>>> (1)
Three-phase non-directional long time overcurrent protection, low stage, instance 1	PHLTPTOC1	51LT	3I> (3)
Three-phase directional overcurrent protection, low stage, instance 1	DPHLPDOC1	67/51P	3I> -> (1)
Three-phase directional overcurrent protection, high stage, instance 1	DPHHPDOC1	67/50P-1	3I>> -> (1)
Three-phase directional overcurrent protection, high stage, instance 2	DPHHPDOC2	67/50P-2	3I>> -> (2)
Non-directional ground-fault protection, low stage, instance 1	EFLPTOC1	51G	Io> (1)
Non-directional ground-fault protection, low stage, instance 2	EFLPTOC2	51N-1	Io> (2)
Non-directional ground-fault protection, low stage, instance 4	EFLPTOC4	50SEF	Io> (4)
Non-directional ground-fault protection, high stage, instance 1	EFHPTOC1	50G-1	Io>> (1)
Non-directional ground-fault protection, high stage, instance 2	EFHPTOC2	50G-2	Io>> (2)
Non-directional ground-fault protection, high stage, instance 3	EFHPTOC3	50N-1	Io>> (3)
Non-directional ground-fault protection, high stage, instance 4	EFHPTOC4	50N-2	Io>> (4)
Non-directional ground-fault protection, instantaneous stage, instance 1	EFIPTOC1	50G-3	Io>>> (1)
Non-directional ground-fault protection, instantaneous stage, instance 2	EFIPTOC2	50N-3	Io>>> (2)
Directional ground-fault protection, low stage, instance 1	DEFLPDEF1	67/51N	Io> -> (1)
Directional ground-fault protection, high stage, instance 1	DEFHPDEF1	67/50N-1	Io>> -> (1)
Directional ground-fault protection, high stage, instance 2	DEFHPDEF2	67/50N-2	Io>> -> (2)
Three phase directional power protection, instance 1	DPSRDIR1	32P-1	I1-> (1)
Ground directional power protection, instance 1	DNZSRDIR1	32N-1	I2 ->, Io-> (1)
Phase distance protection, instance 1	PHDSTPDIS1	21P	Z<
Negative-sequence overcurrent protection, instance 1	NSPTOC1	46-1	I2> (1)
Negative-sequence overcurrent protection, instance 2	NSPTOC2	46-2	I2> (2)
Phase discontinuity protection	PDNSPTOC1	46PD	I2/I1>
Residual overvoltage protection, instance 1	ROVPTOV1	59G	Uo> (1)
Residual overvoltage protection, instance 2	ROVPTOV2	59N-1(1)	Uo> (2)
Residual overvoltage protection, instance 3	ROVPTOV3	59N-1(2)	Uo> (3)
Three-phase undervoltage protection, instance 1	PHPTUV1	27-1(1)	3U< (1)
Three-phase undervoltage protection, instance 2	PHPTUV2	27-2(1)	3U< (2)
Three-phase undervoltage protection, instance 3	PHPTUV3	27-1(2)	3U< (3)

Table 95. REF620 Functions, codes and symbols (continued)

	IEC61850	ANSI/C37.2	IEC60617
Protection			
Three-phase non-directional overcurrent protection, low stage, instance 1	PHLPTOC1	51P	3I> (1)
Three-phase non-directional overcurrent protection, high stage, instance 1	PHHPTOC1	50P-1	3I>> (1)
Three-phase non-directional overcurrent protection, high stage, instance 2	PHHPTOC2	50P-2	3I>> (2)
Three-phase non-directional overcurrent protection, instantaneous stage, instance 1	PHIPTOC1	50P-3	3I>>> (1)
Three-phase non-directional long time overcurrent protection, low stage, instance 1	PHLTPTOC1	51LT	3I> (3)
Three-phase directional overcurrent protection, low stage, instance 1	DPHLPDOC1	67/51P	3I> -> (1)
Three-phase directional overcurrent protection, high stage, instance 1	DPHHPDOC1	67/50P-1	3I>> -> (1)
Three-phase directional overcurrent protection, high stage, instance 2	DPHHPDOC2	67/50P-2	3I>> -> (2)
Non-directional ground-fault protection, low stage, instance 1	EFLPTOC1	51G	Io> (1)
Non-directional ground-fault protection, low stage, instance 2	EFLPTOC2	51N-1	Io> (2)
Non-directional ground-fault protection, low stage, instance 4	EFLPTOC4	50SEF	Io> (4)
Non-directional ground-fault protection, high stage, instance 1	EFHPTOC1	50G-1	Io>> (1)
Non-directional ground-fault protection, high stage, instance 2	EFHPTOC2	50G-2	Io>> (2)
Non-directional ground-fault protection, high stage, instance 3	EFHPTOC3	50N-1	Io>> (3)
Non-directional ground-fault protection, high stage, instance 4	EFHPTOC4	50N-2	Io>> (4)
Non-directional ground-fault protection, instantaneous stage, instance 1	EFIPTOC1	50G-3	Io>>> (1)
Non-directional ground-fault protection, instantaneous stage, instance 2	EFIPTOC2	50N-3	Io>>> (2)
Directional ground-fault protection, low stage, instance 1	DEFLPDEF1	67/51N	Io> -> (1)
Directional ground-fault protection, high stage, instance 1	DEFHPDEF1	67/50N-1	Io>> -> (1)
Directional ground-fault protection, high stage, instance 2	DEFHPDEF2	67/50N-2	Io>> -> (2)
Three phase directional power protection, instance 1	DPSRDIR1	32P-1	I1-> (1)
Ground directional power protection, instance 1	DNZSRDIR1	32N-1	I2 ->, Io-> (1)
Phase distance protection, instance 1	PHDSTPDIS1	21P	Z<
Negative-sequence overcurrent protection, instance 1	NSPTOC1	46-1	I2> (1)
Negative-sequence overcurrent protection, instance 2	NSPTOC2	46-2	I2> (2)
Phase discontinuity protection	PDNSPTOC1	46PD	I2/I1>
Residual overvoltage protection, instance 1	ROVPTOV1	59G	Uo> (1)
Residual overvoltage protection, instance 2	ROVPTOV2	59N-1(1)	Uo> (2)
Residual overvoltage protection, instance 3	ROVPTOV3	59N-1(2)	Uo> (3)
Three-phase undervoltage protection, instance 1	PHPTUV1	27-1(1)	3U< (1)
Three-phase undervoltage protection, instance 2	PHPTUV2	27-2(1)	3U< (2)
Three-phase undervoltage protection, instance 3	PHPTUV3	27-1(2)	3U< (3)
Three-phase undervoltage protection, instance 4	PHPTUV4	27-2(2)	3U< (4)
Three-phase overvoltage protection, instance 1	PHPTOV1	59-1(1)	3U> (1)
Three-phase overvoltage protection, instance 2	PHPTOV2	59-2(1)	3U> (2)
Three-phase overvoltage protection, instance 3	PHPTOV3	59-1(2)	3U> (3)
Three-phase overvoltage protection, instance 4	PHPTOV4	59-2(2)	3U> (4)
Negative-sequence overvoltage protection, instance 1	NSPTOV1	47-1(1)	U2> (1)
Negative-sequence overvoltage protection, instance 2	NSPTOV2	47-2(1)	U2> (2)
Negative-sequence overvoltage protection, instance 3	NSPTOV3	47-1(2)	U2> (3)
Negative-sequence overvoltage protection, instance 4	NSPTOV4	47-2(2)	U2> (4)
Frequency protection, instance 1	FRPFRQ1	81-1	f>/f<,df/dt (1)
Frequency protection, instance 2	FRPFRQ2	81-2	f>/f<,df/dt (2)
Voltage per hertz protection, instance 1	OEPVPH1	24	U/f> (1)
Three-phase thermal protection for feeders, cables and distribution transformers, Instance 1	T1PTTR1	49F	3Ith>F (1)
Phase current sets summing function	CMSUM1	CSUM	CSUM
Three phase measurement switching	VMSWI1	VSWI	VSWI
Numerical stabilized low impedance restricted ground-fault protection	LREFPNDF1	87LOZREF	dIoLo>
Circuit breaker failure protection, instance 1	CCBRBRF1	50BF-1	3I>/Io>BF (1)
Circuit breaker failure protection, instance 2	CCBRBRF2	50BF-2	3I>/Io>BF (2)
Three-phase inrush detector, instance 1	INRPHAR1	INR	3I2f> (1)

33. Document revision history

Rev. A, V2.0

34. Notes

Contact us

ABB Inc.
Distribution Automation
4300 Coral Ridge Drive
Coral Springs, Florida 33065
Phone: +1 954 752 6700
Fax: +1 954 345 5329

www.abb.com/substationautomation

1MAC506635-PG Rev B November 2013

Power and productivity
for a better world™