Relion® 630 series

Feeder Protection and Control REF630 Product Guide

Power and productivity
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Contents

1. Description

REF630 is a comprehensive feeder management IED for protection, control, measuring and supervision of utility and industrial distribution substations. REF630 is a member of ABB's Relion® product family and a part of its 630 protection and control product series characterized by functional scalability and flexible configurability. REF630 also features necessary control functions constituting an ideal solution for feeder bay control.

The 630 series IEDs support the new IEC 61850 substation automation standard including horizontal GOOSE communication and the DNP3 communication protocol offering seamless connectivity to station automation and SCADA systems.

2. Application

REF630 provides main protection for overhead lines and cable feeders of distribution networks. The IED fits both isolated neutral networks and networks with resistance or impedance earthed neutral. Four pre-defined configurations to match typical feeder protection and control requirements are available. The pre-defined configurations can be used as such or easily adapted or extended with freely selectable add-on functions, by means of which the IED can be fine-tuned to exactly satisfy the specific requirements of your present application.

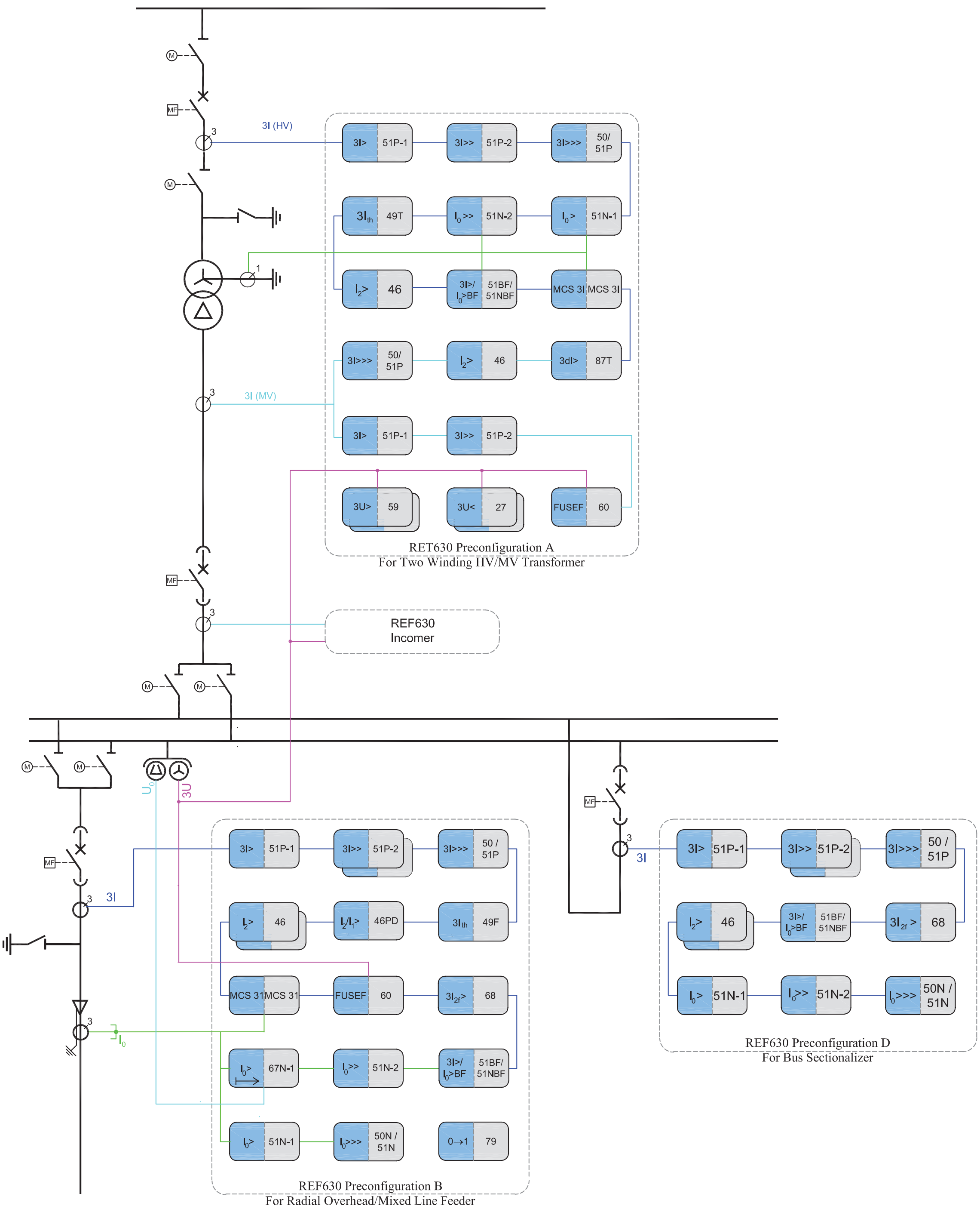

Figure 1. RET630 and REF630 IEDs applied for the incoming feeder and primary switchgear in a double busbar arrangement. The RET630 with preconfiguration A is used for protection and control of the power transformer, the REF630 with preconfiguration B protects and controls the outgoing feeder and the REF630 with preconfiguration D is used for the bus sectionalizer.

3. Preconfigurations

The 630 series IEDs are offered with optional factory-made application preconfigurations. The preconfigurations contribute to faster commissioning and less engineering of the IED. The preconfigurations include default functionality typically needed for a specific application. Each preconfiguration is adaptable using the Protection and Control IED Manager PCM600. By adapting the preconfiguration the IED can be configured to suit the particular application.

The adaptation of the preconfiguration may include adding or removing of protection, control and other functions according to the specific application, changing of the default parameter settings, configuration of the default alarms and event recorder settings including the texts shown in the HMI, configuration of the LEDs and function buttons, and adaptation of the default single-line diagram.

In addition, the adaptation of the preconfiguration always includes communication engineering to configure the communication according to the functionality of the IED. The communication engineering is done using the communication configuration function of PCM600.

If none of the offered preconfigurations fulfill the needs of the intended area of application the 630 series IEDs can also be ordered without any preconfiguration. This option enables full flexibility to configure the IED from the ground up.

Table 1. REF630 preconfigurations

Description	Preconfiguration				
Preconfiguration A for open/closed ring feeder	A				
Preconfiguration B for radial overhead/mixed line feeder		B			
Preconfiguration C for ring/meshed feeder			C		
Preconfiguration D for bus sectionalizer				D	
Number of instances available					N

Table 2. Supported functions

Functionality	A	B	C	D	N
Protection					
Three-phase non-directional overcurrent, low stage	1	1	1	1	1
Three-phase non-directional overcurrent, high stage	2	2	2	2	2
Three-phase non-directional overcurrent, instantaneous stage	1	1	1	1	1
Three-phase directional overcurrent, low stage	2	-	-	-	2
Three-phase directional overcurrent, high stage	1	-	-	-	1
Non-directional earth fault, low stage	-	1	-	1	1
Non-directional earth fault, high stage	1	1	1	1	1
Non-directional earth fault, instantaneous stage	-	1	-	1	1
Directional earth fault, low stage	2	1	3	-	3
Directional earth fault, high stage	1	-	1	-	1
Transient/intermittent earth fault	1	-	-	-	1
Negative-sequence overcurrent	2	2	2	2	2
Three-phase thermal overload for feeder	1	1	1	-	1
Phase discontinuity	1	1	1	-	1
Three-phase current inrush detection	1	1	1	1	1
Three-phase overvoltage	-	-	3	-	3
Three-phase undervoltage	-	-	3	-	3
Positive-sequence overvoltage[1)]	-	-	-	-	2
Positive-sequence undervoltage[1)]	-	-	-	-	2
Negative-sequence overvoltage [1)]	-	-	-	-	2
Residual overvoltage	-	-	3	-	3
Frequency gradient	-	-	-	-	5
Overfrequency	-	-	-	-	5
Underfrequency	-	-	-	-	5
Load shedding	-	-	-	-	6
Fault locator[1)]	-	-	-	-	1
Circuit-breaker failure	1	1	1	1	2
Autoreclosing	1	1	1	-	2
Tripping logic	1	1	1	1	2

Table 2. Supported functions, continued

Functionality	A	B	C	D	N
Distance protection[1)]	-	-	1	-	1
Automatic switch-onto-fault logic	-	-	1	-	2
Protection related functions					
Local accelerat. logic	-	-	1	-	1
Communication logic for residual OC	-	-	1	-	1
Scheme communic. logic	-	-	1	-	1
Current reversal and WEI logic	-	-	1	-	1
Current reversal and WEI logic for residual OC	-	-	1	-	1
Control					
Bay control	1	1	1	1	1
Interlocking interface	4	4	4	1	10
Circuit-breaker/disconnector control	4	4	4	1	10
Circuit breaker	1	1	1	1	2
Disconnector	3	3	3	-	8
Local/remote switch interface	-	-	-	-	1
Synchrocheck[1)]	-	-	-	-	1
Supervision and monitoring					
Circuit-breaker condition monitoring	1	1	1	1	2
Fuse failure supervision	1	1	1	-	2
Current-circuit supervision	1	1	1	-	2
Trip-circuit supervision	3	3	3	3	3
Station battery supervision	-	-	-	-	1
Energy monitoring	-	-	-	-	1
Generic measured values	-	-	-	-	3
Measured value limit supervision	-	-	-	-	9
Measurement					
Three-phase current	1	1	1	1	1
Three-phase voltage, phase-to-earth	1	1	1	1	1
Three-phase voltage, phase-to-phase	-	-	-	-	1
Residual current	1	1	1	1	1

Table 2. Supported functions, continued

Functionality	A	B	C	D	N
Residual voltage	1	1	1	-	1
Power monitoring with P, Q, S, power factor, frequency	1	1	1	1	1
Sequence current	1	1	1	1	1
Sequence voltage	1	1	1	1	1
Metering					
Pulse counter for energy metering	-	-	-	-	4
Disturbance recorder function					
Analog channels 1-10 (samples)	1	1	1	1	1
Analog channel 11-20 (samples)	-	-	-	-	1
Analog channel 21-30 (samples)	-	-	-	-	1
Analog channel 31-40 (calc val)	-	-	-	-	1
Binary channels 1-16	1	1	1	1	1
Binary channels 17-32	1	1	1	1	1
Binary channels 33-48	1	1	1	1	1
Binary channels 49-64	1	-	1	-	1

1) Optional functions, to be specified at ordering

4. Protection functions

The IED offers selective short-circuit and overcurrent protection including three-phase non-directional overcurrent protection with four independent stages, and three-phase directional overcurrent protection with three independent stages. In addition, the IED includes three-phase current inrush detection for blocking selected overcurrent protection stages or temporarily increasing the setting values. The included thermal overload protection function uses thermal models of overhead lines and cables. The negative-sequence overcurrent protection, with two independent stages, is used for phase-unbalance protection. In addition, the IED offers phase discontinuity protection.

Further, the IED features selective earth-fault and cross country fault protection for isolated neutral, and for resistance and/or impedance earthed neutral systems including solidly earthed neutral systems. The earth-fault protection includes non-directional earth-fault protection with three independent stages and directional earth-fault protection with four independent stages.

The included transient/intermittent earth-fault protection is based on detection of earth-fault transients related to continuous or intermittent faults. Intermittent earth-fault is special type of earth-fault encountered in compensated networks with underground cables. In solidly earthed or compensated networks the transient earth-fault protection function detects earth-faults with low fault resistance. The residual overvoltage protection, with three independent stages, is used for earth-fault protection of the substation bus and the incoming feeder, and for back-up protection of the outgoing feeders.

The IED offers distance protection including both circular (mho) and quadrilateral (quad) zone characteristics, three independent zones with separate reach settings for phase-to-phase and phase-to-earth measuring elements and two zones for controlling auto-reclosing of circuit breakers. Further, the IED offers automatic switch onto fault logic with voltage and current based detection options.

The IED offers voltage protection functions including three-phase undervoltage and overvoltage protection with three independent stages each, both with phase-to-phase or phase-to-earth measurement. The IED offers overfrequency, underfrequency and rate-of-change of frequency protection to be used in load shedding and network restoration applications.

In addition the IED offers three-pole multi-shot autoreclose functions for overhead line feeders.

The IED incorporates breaker failure protection for circuit breaker re-tripping or back-up tripping for the upstream breaker.

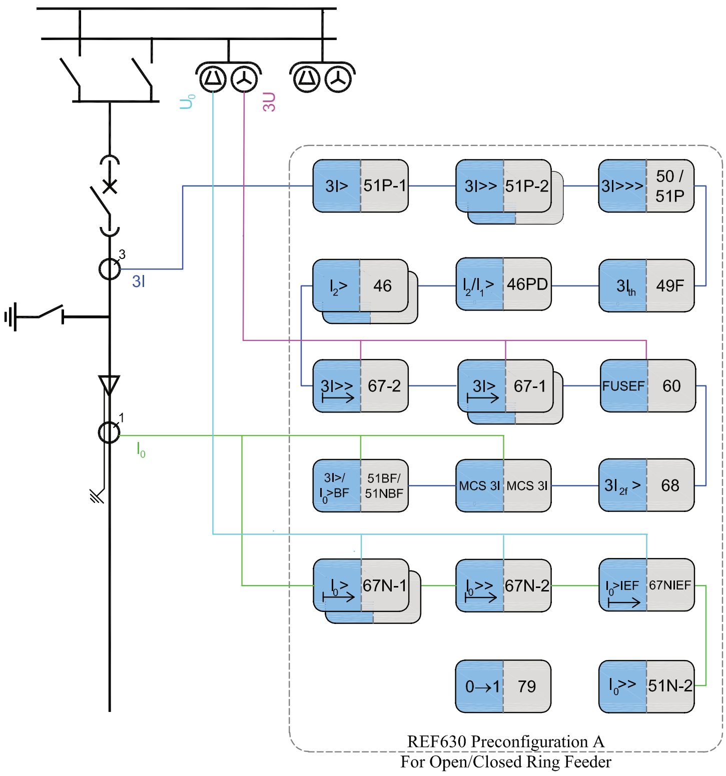

Figure 2. Protection function overview of preconfiguration A

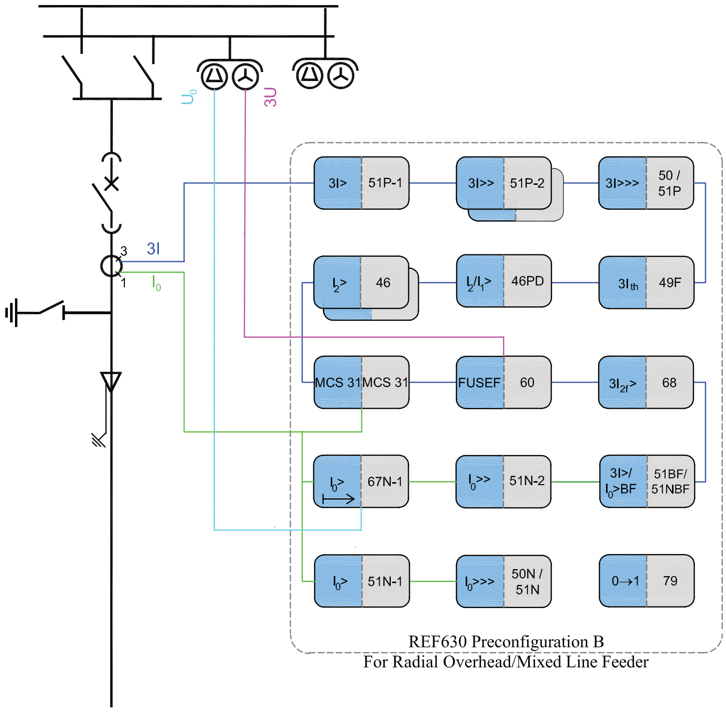

Figure 3. Protection function overview of preconfiguration B

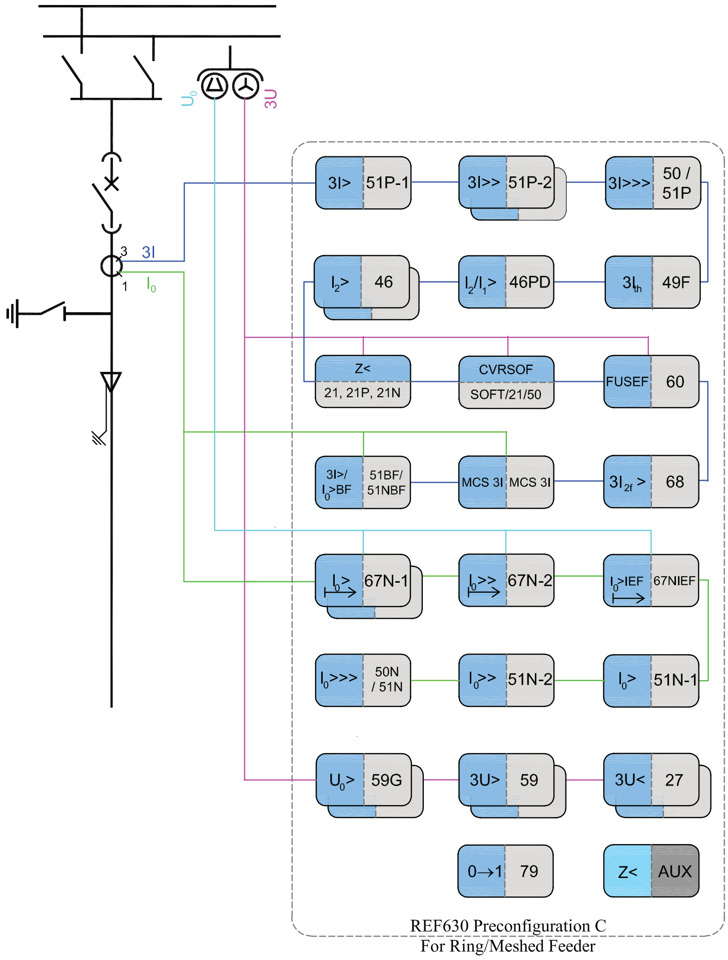

Figure 4. Protection function overview of preconfiguration C

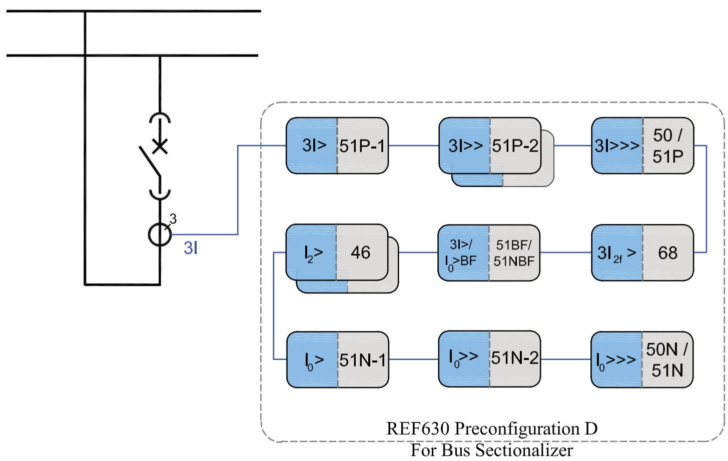

Figure 5. Protection function overview of preconfiguration D

5. Control

The IED incorporates local and remote control functions. The IED offers a number of freely assignable binary inputs/outputs and logic circuits for establishing bay control and interlocking functions for circuit breakers and motor operated switch-disconnectors. The IED supports both single and double busbar substation busbar layouts. The number of controllable primary apparatuses depends on the number of available inputs and outputs in the selected configuration. Besides conventional hardwired signaling also GOOSE messaging according to IEC 61850-8-1 can be used for signal interchange between IEDs to obtain required interlockings.

Further, the IED incorporates a synchro-check function to ensure that the voltage, phase angle and frequency on either side of an open circuit breaker satisfy the conditions for safe interconnection of two networks.

6. Fault location

REF630 features an impedance-measuring fault location function suitable for locating short-circuits in radial distribution systems. Earth faults can be located in effectively and low-resistance earthed networks. Under circumstances where the fault current magnitude is at least of the same order of magnitude or higher than the load current, earth faults can also be located in isolated neutral distribution networks. The fault location function identifies the type of the fault and then calculates the distance to the fault point. An estimate of the fault resistance value is also calculated. The estimate provides information about the possible fault cause and the accuracy of the estimated distance to the fault point.

7. Measurement

The IED continuously measures the phase currents, positive and negative sequence currents and the residual current. The IED also measures phase-to earth or phase-to-phase voltages, positive and negative sequence voltages and the residual voltage. In addition, the IED monitors active, reactive and apparent power, the power factor, power demand value over a user-selectable pre-set time frame as well as cumulative active and reactive energy of both directions. Line frequency, the calculated temperature of the feeder, and the phase unbalance value based on the ratio between the negative sequence and positive sequence current are also calculated. Cumulative and averaging calculations utilize the non-volatile memory available in the IED.

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

8. Disturbance recorder

The IED is provided with a disturbance recorder featuring up to 40 analog and 64 binary signal channels. The analog channels can be set to record the waveform of the currents and voltage measured. The analog channels can be set to trigger the recording 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. The binary channels are set to record external or internal IED signals, for example the start or operate signals of the protection functions, or external blocking or control signals. Binary IED signals such as a protection start or trip signal, or an external

IED control signal over a binary input can be set to trigger the recording. In addition, the disturbance recorder settings include pre and post triggering times.

The disturbance recorder can store up to 100 recordings. The number of recordings may vary depending on the length of the recording and the number of signals included. The disturbance recorder controls the Start and Trip LEDs on the front-panel user interface. The operation of the LEDs is fully configurable enabling activation when one or several criteria, i.e. protection function starting or tripping, are fulfilled.

The recorded information is stored in a non-volatile memory and can be uploaded for subsequent fault analysis.

9. Event log

The IED features an event log which enables logging of event information. The event log can be configured to log information according to user pre-defined criteria including IED signals. To collect sequence-of-events (SoE) information, the IED incorporates a non-volatile memory with a capacity of storing 1000 events with associated time stamps and user definable event texts. The non-volatile memory retains its data also in case the IED temporarily loses its auxiliary supply. The event log facilitates detailed pre- and post-fault analyses of faults and disturbances.

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

The logging of communication events is determined by the used communication protocol and the communication engineering. The communication events are automatically sent to station automation and SCADA systems once the required communication engineering has been done.

10. Disturbance report

The disturbance report includes information collected during the fault situation. The report includes general information such as recording time, pre-fault time and post fault time. Further, the report includes pre-fault magnitude, pre-fault angle, fault magnitude and fault angle trip values. By default, the disturbance reports are stored in a non-volatile memory. The numerical disturbance report can be accessed via the local front panel user interface. A more comprehensive disturbance report with waveforms is available using PCM600.

11. Circuit-breaker monitoring

The condition monitoring functions of the IED constantly monitors the performance and the condition of the circuit breaker. The monitoring comprises the spring charging time, SF6 gas pressure, the travel-time and the inactivity time of the circuit breaker.

The monitoring functions provide operational CB history data, which can be used for scheduling preventive CB maintenance.

12. Trip-circuit supervision

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

13. Self-supervision

The IED’s built-in self-supervision system continuously monitors the state of the IED hardware and the operation of the IED software. Any fault or malfunction detected will be used for alerting the operator.

Self-supervision events are saved into an internal event list which can be accessed locally via the user interface on the IED front panel. The event list can also be accessed using the web-browser based user interface or PCM600.

14. Fuse failure supervision

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

15. Current circuit supervision

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

16. Access control

To protect the IED from unauthorized access and to maintain information integrity the IED is provided with an authentication system including user management. Using the IED user management tool in the Protection and Control IED Manager PCM600, an individual password is assigned to each user by the administrator. Further, the user name is associated to one or more of the four available user groups: System Operator, Protection Engineer, Design Engineer and User Administrator. The user group association for each individual user enables the use of the IED according to the profile of the user group.

17. Inputs and outputs

Depending on the hardware configuration selected, the IED is equipped with three phase-current inputs and one or two residual-current inputs for earth-fault protection. The IED always includes one residual voltage input for directional earth-fault protection or residual voltage protection. Further, the IED includes three phase-voltage inputs for overvoltage, undervoltage and directional overcurrent protection and other voltage based protection functions. Depending on the hardware configuration, the IED also includes a dedicated voltage input for synchrocheck.

The phase-current inputs are rated 1/5 A. The IED is equipped with one or two alternative residual-current inputs, that is 1/5 A or 0.1/0.5 A. The 0.1/0.5 A input is normally used in applications requiring sensitive earth-fault protection and featuring a core-balance current transformer.

The three phase-voltage inputs, for either phase-to-phase voltages or phase-to-earth voltages, and the residual-voltage input cover the rated voltages 100 V, 110 V, 115 V and 120 V. The rated values of the current and voltage inputs are selected in the IED software.

In addition, the binary input thresholds are selected by adjusting the IED's parameter settings. The threshold voltage can be set separately for each binary input.

All binary input and output contacts are freely configurable using the signal matrix of the application condiguration function in PCM600.

Please refer to the Input/output overview tables, the selection and ordering data and the terminal diagrams for more detailed information about the inputs and outputs.

Table 3. Analog input options

Analog input configuration	CT (1/5 A)	CT sensitive (0.1/0.5 A)	VT
AA	4	-	5
AB	4	1	4
AC	3	1	5

Table 4. Binary input/output options

Binary input options	BI	BO
Default	14	9
With one optional binary I/O module	23	18
With two optional binary I/O modules	32	27

18. Communication

The IED supports the new IEC 61850 substation automation standard including horizontal GOOSE communication as well as the well-established DNP3 (TCP/IP) protocol. All operational information and controls are available through these protocols.

Disturbance files are accessed using the IEC 61850 protocol. Disturbance files are available to any Ethernet based application in the standard COMTRADE format. Further, the IED sends and receives binary signals from other IEDs using the IEC 61850-8-1 GOOSE profile. The IED meets the GOOSE performance requirements for tripping applications in distribution substations, as defined by the IEC 61850 standard. The IED interoperates with other IEC 61850 compliant IEDs, tools and systems and simultaneously reports events to five different clients on the IEC 61850 station bus. For a system using DNP3 over TCP/IP, events can be sent to four different masters.

All communication connectors, except for the front port connector, are placed on integrated communication modules. The IED is connected to Ethernet-based communication systems via the RJ-45 connector (10/100BASE-

TX) or the fibre-optic multimode LC connector (100BASE-FX).

The IED supports SNTP, DNP3 and IRIG-B time synchronization methods with a time-stamping resolution of 1 ms.

Ethernet based:

- SNTP (Simple Network Time Protocol)
- DNP3

With special time synchronization wiring:

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

Table 5. Supported communication interface and protocol alternatives

Interfaces/Protocols[1)]	Ethernet 100BASE-TX RJ-45	Ethernet 100BASE-FX LC
IEC 61850	●	●
DNP3	●	●

● = Supported

1) Please refer to the Selection and ordering data chapter for more information

19. Technical data

Table 6. Dimensions

Description	Type	Value
Width	half 19"	220 mm
Height	half 19"	177 mm (4U)
Depth	half 19"	249.5 mm
Weight	half 19" box	6.2 kg (4U)
	half 19" LHMI	1.0 kg (4U)

Table 7. Power supply

Description	Type 1	Type 2
U_{aux}nominal	100, 110, 120, 220, 240 V AC, 50 and 60 Hz	48, 60, 110, 125 V DC
	110, 125, 220, 250 V DC	
U_{aux}variation	85...110% of U_n (85...264 V AC)	80...120% of U_n (38.4...150 V DC)
	80...120% of U_n (88...300 V DC)	
Maximum load of auxiliary voltage supply	35 W	
Ripple in the DC auxiliary voltage	Max 15% of the DC value (at frequency of 100 Hz)	
Maximum interruption time in the auxiliary DC voltage without resetting the IED	50 ms at U_{aux}	
Power supply input must be protected by an external miniature circuit breaker	For example, type S282 UC-K	

Table 8. Energizing inputs

Description		Value	
Rated frequency		50/60 Hz	
Operating range		Rated frequency ± 5 Hz	
Current inputs	Rated current, I_n	0.1/0.5 A[1)]	1/5 A[2)]
	Thermal withstand capability: • Continuously • For 1 s • For 10 s	 4 A 100 A 20 A	 20 A 500 A 100 A
	Dynamic current withstand: • Half-wave value	 250 A	 1250 A
	Input impedance	<100 mΩ	<20 mΩ
Voltage inputs	Rated voltage	100 V/ 110 V/ 115 V/ 120 V (Parametrization)	
	Voltage withstand: • Continuous • For 10 s	 425 V 450 V	
	Burden at rated voltage	<0.05 VA	

1) Residual current
2) Phase currents or residual current

Table 9. Binary inputs

Description	Value
Operating range	Maximum input voltage 300 V DC
Rated voltage	24...250 V DC
Current drain	1.6...1.8 mA
Power consumption/input	<0.3 W
Threshold voltage	15...221 V DC (parametrizable in the range in steps of 1% of the rated voltage)

Table 10. Signal output and IRF output

IRF relay change over - type signal output relay	
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 U< 48/110/220 V DC	≤0.5 A/≤0.1 A/≤0.04 A
Minimum contact load	100 mA at 24 V AC/DC

Table 11. Power output relays, with or without TCS function

Description	Value
Rated voltage	250 V AC/DC
Continuous contact carry	8 A
Make and carry for 3.0 s	15 A
Make and carry for 0.5 s	30 A
Breaking capacity when the control-circuit time constant L/R<40 ms, at U< 48/110/220 V DC	≤1 A/≤0.3 A/≤0.1 A
Minimum contact load	100 mA at 24 V AC/DC

Table 12. Power output relays with TCS function

Description	Value
Control voltage range	20...250 V DC
Current drain through the supervision circuit	~1.0 mA
Minimum voltage over the TCS contact	20 V DC

Table 13. Ethernet interfaces

Ethernet interface	Protocol	Cable	Data transfer rate
LAN/HMI port (X0)[1)]	-	CAT 6 S/FTP or better	100 MBits/s
LAN1 (X1)	TCP/IP protocol	Shielded twisted pair CAT 5e cable with RJ-45 connector or fibre-optic cable with LC connector	100 MBits/s

1) Only available for the external HMI option.

Table 14. Fibre-optic communication link

Wave length	Fibre type	Connector	Permitted path attenuation[1)]	Distance
1300 nm	MM 62.5/125 μm glass fibre core	LC	<8 dB	2 km

1) Maximum allowed attenuation caused by connectors and cable together

Table 15. X4/IRIG-B interface

Type	Protocol	Cable
Screw terminal, pin row header	IRIG-B	Shielded twisted pair cable Recommended: CAT 5, Belden RS-485 (9841-9844) or Alpha Wire (Alpha 6222-6230)

Table 16. Serial rear interface

Type	Counter connector[1)]
Serial port (X9)	Optical ST connector or optical snap-in connector

1) For future use

Table 17. Degree of protection of flush-mounted IED

Description	Value
Front side	IP 40
Rear side, connection terminals	IP 20

Table 18. Degree of protection of the LHMI

Description	Value
Front and side	IP 42

Table 19. Environmental conditions

Description	Value
Operating temperature range	-25...+55°C (continuous)
Short-time service temperature range	-40...+85°C (<16h) Note: Degradation in MTBF and HMI performance outside the temperature range of -25...+55°C
Relative humidity	<93%, non-condensing
Atmospheric pressure	86...106 kPa
Altitude	up to 2000 m
Transport and storage temperature range	-40...+85°C

Table 20. Environmental tests

Description	Type test value	Reference
Dry heat test (humidity <50%)	• 96 h at +55°C • 16 h at +85°C	IEC 60068-2-2
Cold test	• 96 h at -25°C • 16 h at -40°C	IEC 60068-2-1
Damp heat test, cyclic	• 6 cycles at +25…55°C, humidity 93…95%	IEC 60068-2-30
Storage test	• 96 h at -40°C • 96 h at +85°C	IEC 60068-2-48

Table 21. Electromagnetic compatibility tests

Description	Type test value	Reference
100 kHz and 1 MHz burst disturbance test		IEC 61000-4-18 IEC 60255-22-1, level 3
• Common mode	2.5 kV	
• Differential mode	1.0 kV	
Electrostatic discharge test		IEC 61000-4-2 IEC 60255-22-2, level 4 IEEE C37.90.3
• Contact discharge	8 kV	
• Air discharge	15 kV	
Radio frequency interference tests		
• Conducted, common mode OK	10 V (emf), f=150 kHz...80 MHz	IEC 61000-4-6 IEC 60255-22-6, level 3
• Radiated, pulse-modulated	10 V/m, f=900 MHz	ENV 50204 IEC 60255-22-3
• Radiated, amplitude-modulated	20 V/m (rms), f=80...1000 MHz	IEEE C37.90.2-2004
	10 V/m, f=80...2700 MHz	IEC 61000-4-3 IEC 60255-22-3
Fast transient disturbance tests		IEC 61000-4-4 IEC 60255-22-4, class A
• Communication ports	2 kV	
• Other ports	4 kV	
Surge immunity test		IEC 61000-4-5 IEC 60255-22-5, level 4/3
• Binary inputs	2 kV line-to-earth, 1kV line-to-line	
• Communication	1 kV line-to-earth	
• Other ports	4 kV line-to-earth, 2 kV line-to-line	
Power frequency (50 Hz) magnetic field		IEC 61000-4-8, level 5

Table 21. Electromagnetic compatibility tests, continued

Description	Type test value	Reference
• 1...3 s • Continuous	1000 A/m 300 A/m	
Power frequency immunity test • Common mode • Differential mode	300 V rms 150 V rms	IEC 60255-22-7, class A IEC 61000-4-16
Voltage dips and short interruptions	30%/10 ms 40%/200 ms 60%/100 ms 60%/1000 ms 70%/500 ms >95%/5000 ms	IEC 60255-11 IEC 61000-4-11
Electromagnetic emission tests • Conducted, RF-emission (mains terminal) OK		EN 55011, class A IEC 60255-25
0.15...0.50 MHz	< 79 dB(µV) quasi peak < 66 dB(µV) average	
0.5...30 MHz	< 73 dB(µV) quasi peak < 60 dB(µV) average	
• Radiated RF -emission		
30...230 MHz	< 40 dB(µV/m) quasi peak, measured at 10 m distance	
230...1000 MHz	< 47 dB(µV/m) quasi peak, measured at 10 m distance	

Table 22. Insulation tests

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

Table 23. Mechanical tests

Description	Reference	Requirement
Vibration tests (sinusoidal)	IEC 60068-2-6 (test Fc) IEC 60255-21-1	Class 1
Shock and bump test	IEC 60068-2-27 (test Ea shock) IEC 60068-2-29 (test Eb bump) IEC 60255-21-2	Class 1
Seismic test	IEC 60255-21-3 (method A)	Class 1

Table 24. Product safety

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

Table 25. EMC compliance

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

Table 26. RoHS compliance

Description
Complies with RoHS directive 2002/95/EC

Protection functions

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

Characteristic		**Value**
Operation accuracy		At the frequency f = f_n
	PHLPTOC	±1.5% of the set value or ±0.002 x I_n
	PHHPTOC and PHIPTOC	±1.5% of set value or ±0.002 x I_n (at currents in the range of 0.1…10 x I_n) ±5.0% of the set value (at currents in the range of 10…40 x I_n)
Start time 1)2)	PHIPTOC: I_{Fault} = 2 x set *Start value* I_{Fault} = 10 x set *Start value*	Typical: 17 ms (±5 ms) Typical: 10 ms (±5 ms)
	PHHPTOC: I_{Fault} = 2 x set *Start value*	Typical: 19 ms (±5 ms)
	PHLPTOC: I_{Fault} = 2 x set *Start value*	Typical: 23 ms (±15 ms)
Reset time		< 45 ms
Reset ratio		Typical 0.96
Retardation time		< 30 ms
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms 3)
Suppression of harmonics		RMS: No suppression DFT: -50dB at f = n x f_n, where n = 2, 3, 4, 5, … Peak-to-Peak: No suppression P-to-P+backup: No suppression

1) Set *Operate delay time* = 0,02 s, *Operate curve type* = IEC definite time, *Measurement mode* = default (depends on stage), current before fault = 0.0 x In, fn = 50 Hz, fault current in one phase with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Includes the delay of the heavy-duty output contact

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

Parameter	Function	Value (Range)	Step
Start Value	PHLPTOC	0.05...5.00 pu	0.01
	PHHPTOC	0.10...40.00 pu	0.01
	PHIPTOC	0.10...40.00 pu	0.01
Time multiplier	PHLPTOC	0.05...15.00	0.05
	PHHPTOC	0.05...15.00	0.05
Operate delay time	PHLPTOC	0.04…200.00 s	0.01
	PHHPTOC	0.02…200.00 s	0.01
	PHIPTOC	0.02…200.00 s	0.01
Operating curve type[1)]	PHLPTOC	Definite or inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
	PHHPTOC	Definite or inverse time Curve type: 1, 3, 5, 9, 10, 12, 15, 17	
	PHIPTOC	Definite time	

1) For further reference please refer to the Operating characteristics table

Table 29. Three-phase directional overcurrent protection (DPHxPDOC)

Characteristic		Value
Operation accuracy		At the frequency $f = f_n$
	DPHLPDOC	Current: ±1.5% of the set value or ±0.002 x I_n Voltage: ±1.5% of the set value or ±0.002 x U_n Phase angle: ±2°
	DPHHPDOC	Current: ±1.5% of the set value or ±0.002 x I_n (at currents in the range of 0.1…10 x I_n) ±5.0% of the set value (at currents in the range of 10…40 x I_n) Voltage: ±1.5% of the set value or ±0.002 x U_n Phase angle: ±2°
Start time[1)2)]	I_{Fault} = 2.0 x set *Start value*	Typical: 24 ms (±15 ms)
Reset time		< 40 ms
Reset ratio		Typical 0.96
Retardation time		< 35 ms
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms[3)]
Suppression of harmonics		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) *Measurement mode* = default (depends of stage), current before fault = 0.0 x I_n, f_n = 50 Hz, fault current in one phase with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Maximum *Start value* = 2.5 x I_n, *Start value* multiples in range of 1.5 to 20

Table 30. Three-phase directional overcurrent protection (DPHxPDOC) main settings

Parameter	Function	Value (Range)	Step
Start value	DPHxPDOC	0.05...5.00 pu	0.01
Time multiplier	DPHxPDOC	0.05...15.00	0.05
Operate delay time	DPHxPDOC	0.04...200.00 s	0.01
Directional mode	DPHxPDOC	1 = Non-directional 2 = Forward 3 = Reverse	
Characteristic angel	DPHxPDOC	-179...180 deg	1
Operating curve type[1)]	DPHLPDOC	Definite or inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
	DPHHPDOC	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

Table 31. Non-directional earth-fault protection (EFxPTOC)

Characteristic		Value
Operation accuracy		At the frequency $f = f_n$
	EFLPTOC	±1.5% of the set value or ±0.001 x I_n
	EFHPTOC and EFIPTOC	±1.5% of set value or ±0.002 x I_n (at currents in the range of 0.1…10 x I_n) ±5.0% of the set value (at currents in the range of 10…40 x I_n)
Start time 1)2)	EFIPTOC: I_{Fault} = 2 x set *Start value*	Typical 12 ms (±5 ms)
	EFHPTOC: I_{Fault} = 2 x set *Start value*	Typical 19 ms (±5 ms)
	EFLPTOC: I_{Fault} = 2 x set *Start value*	Typical 23 ms (±15 ms)
Reset time		< 45 ms
Reset ratio		Typical 0.96
Retardation time		< 30 ms
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms 3)
Suppression of harmonics		RMS: No suppression DFT: -50dB at f = n x f_n, where n = 2, 3, 4, 5, … Peak-to-Peak: No suppression

1) *Operate curve type* = IEC definite time, *Measurement mode* = default (depends on stage), current before fault = 0.0 x I_n, f_n = 50 Hz, earth-fault current with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Maximum *Start value* = 2.5 x I_n, *Start value* multiples in range of 1.5 to 20

Table 32. Non-directional earth-fault protection (EFxPTOC) main settings

Parameter	Function	Value (Range)	Step
Start value	EFLPTOC	0.010...5.000 pu	0.005
	EFHPTOC	0.10...40.00 pu	0.01
	EFIPTOC	0.10...40.00 pu	0.01
Time multiplier	EFLPTOC	0.05...15.00	0.05
	EFHPTOC	0.05...15.00	0.05
Operate delay time	EFLPTOC	0.04...200.00 s	0.01
	EFHPTOC	0.02...200.00 s	0.01
	EFIPTOC	0.02...200.00 s	0.01
Operating curve type[1)]	EFLPTOC	Definite or inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
	EFHPTOC	Definite or inverse time Curve type: 1, 3, 5, 9, 10, 12, 15, 17	
	EFIPTOC	Definite time	

1) For further reference please refer to the Operating characteristics table

Table 33. Directional earth-fault protection (DEFxPDEF)

Characteristic		Value
Operation accuracy		At the frequency f = f_n
	DEFLPDEF	Current: ±1.5% of the set value or ±0.002 x I_n Voltage ±1.5% of the set value or ±0.002 x U_n Phase angle: ±2°
	DEFHPDEF	Current: ±1.5% of the set value or ±0.002 x I_n (at currents in the range of 0.1…10 x I_n) ±5.0% of the set value (at currents in the range of 10…40 x I_n) Voltage: ±1.5% of the set value or ±0.002 x U_n Phase angle: ±2°
Start time [1)2)]	DEFHPDEF and DEFLPTDEF: I_{Fault} = 2 x set *Start value*	Typical 54 ms (±15 ms)
Reset time		< 40 ms
Reset ratio		Typical 0.96
Retardation time		< 30 ms
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms [3)]
Suppression of harmonics		RMS: No suppression DFT: -50dB at f = n x f_n, where n = 2, 3, 4, 5, … Peak-to-Peak: No suppression

1) Set *Operate delay time* = 0.06 s,*Operate curve type* = IEC definite time, *Measurement mode* = default (depends on stage), current before fault = 0.0 x I_n, f_n = 50 Hz, earth-fault current with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Maximum *Start value* = 2.5 x I_n, *Start value* multiples in range of 1.5 to 20

Table 34. Directional earth-fault protection (DEFxPDEF) main settings

Parameter	Function	Value (Range)	Step
Start Value	DEFLPDEF	0.010...5.000 pu	0.005
	DEFHPDEF	0.10...40.00 pu	0.01
Directional mode	DEFLPDEF and DEFHPDEF	1=Non-directional 2=Forward 3=Reverse	
Time multiplier	DEFLPDEF	0.05...15.00	0.05
	DEFHPDEF	0.05...15.00	0.05
Operate delay time	DEFLPDEF	0.06...200.00 s	0.01
	DEFHPDEF	0.06...200.00 s	0.01
Operating curve type[1)]	DEFLPDEF	Definite or inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	
	DEFHPDEF	Definite or inverse time Curve type: 1, 3, 5, 15, 17	
Operation mode	DEFLPDEF and DEFHPDEF	1=Phase angle 2=I_0Sin 3=I_0Cos 4=Phase angle 80 5=Phase angle 88	

1) For further reference please refer to the Operating characteristics table

Table 35. Transient/intermittent earth-fault protection (INTRPTEF)

Characteristic	Value
Operation accuracy (U_0 criteria with transient protection)	At the frequency $f = f_n$
	±1.5% of the set value or ±0.002 × U_n
Operate time accuracy	±1.0% of the set value or ±20 ms
Suppression of harmonics	DFT: -50dB at $f = n \times f_n$, where n = 2, 3, 4, 5

Table 36. Transient/intermittent earth-fault protection (INTRPTEF) main settings

Parameter	Function	Value (Range)	Step
Directional mode	INTRPTEF	1=Non-directional 2=Forward 3=Reverse	-
Operate delay time	INTRPTEF	0.04...1200.00 s	0.01
Voltage start value (voltage start value for transient EF)	INTRPTEF	0.005...0.500 pu	0.001
Operation mode	INTRPTEF	1=Intermittent EF 2=Transient EF	-
Peak counter limit (Min requirement for peak counter before start in IEF mode)	INTRPTEF	2...20	1

Table 37. Negative phase-sequence overcurrent protection (NSPTOC)

Characteristic		Value
Operation accuracy		At the frequency $f = f_n$
		±1.5% of the set value or $\pm 0.002 \times I_n$
Start time [1)2)]	$I_{Fault} = 2 \times$ set *Start value* $I_{Fault} = 10 \times$ set *Start value*	Typical 23 ms (±15 ms) Typical 16 ms (±15 ms)
Reset time		< 40 ms
Reset ratio		Typical 0.96
Retardation time		< 35 ms
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms [3)]
Suppression of harmonics		DFT: -50dB at $f = n \times f_n$, where n = 2, 3, 4, 5, …

1) *Operate curve type* = IEC definite time, negative sequence current before fault = 0.0, f_n = 50Hz
2) Includes the delay of the signal output contact
3) Maximum *Start value* = 2.5 × I_n, *Start value* multiples in range of 1.5 to 20

Table 38. Negative phase-sequence overcurrent protection (NSPTOC) main settings

Parameter	Function	Value (Range)	Step
Start value	NSPTOC	0.01...5.00 pu	0.01
Time multiplier	NSPTOC	0.05...15.00	0.05
Operate delay time	NSPTOC	0.04...200.00 s	0.01
Operating curve type[1)]	NSPTOC	Definite or inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19	

1) For further reference please refer to the Operating characteristics table

Table 39. Three-phase thermal overload (T1PTTR)

Characteristic	Value
Operation accuracy	At the frequency $f = f_n$
	Current measurement: ±0.5% of the set value or ±0.002 x I_n (at currents in the range of 0.01...4.00 x I_n)
Operate time accuracy[1)]	±2.0% or ±0.50 s

1) Overload current > 1.2 x Operate level temperature, *Current reference* > 0.50 p.u.

Table 40. Three-phase thermal overload (T1PTTR) main settings

Parameter	Function	Value (Range)	Step
Env temperature Set (Ambient temperature used when the AmbSens is set to Off)	T1PTTR	-50...100 deg	1
Current multiplier (Current multiplier when function is used for parallel lines)	T1PTTR	1...5	1
Current reference	T1PTTR	0.05...4.00 pu	0.01
Temperature rise (End temperature rise above ambient)	T1PTTR	0.0...200.0 deg	0.1
Time constant (Time constant of the line in seconds)	T1PTTR	1...1000 min	1
Maximum temperature (temperature level for operate)	T1PTTR	20.0...200.0 deg	0.1
Alarm value (Temperature level for start (alarm)	T1PTTR	20.0...150.0 deg	0.1
Reclose temperature (Temperature for reset of block reclose after operate)	T1PTTR	20.0...150.0 deg	0.1
Initial temperature (Temperature raise above ambient temperature at startup)	T1PTTR	-50.0...100.0 deg	0.1

Table 41. Phase discontinuity protection (PDNSPTOC)

Characteristic	Value
Operation accuracy	At the frequency f = f_n
	±2% of the set value
Start time	Typical 15 ms
Reset time	< 40 ms
Reset ratio	Typical 0.96
Retardation time	< 35 ms
Operate time accuracy in definite time mode	±1.0% of the set value or ±20 ms
Suppression of harmonics	DFT: -50dB at f = n x f_n, where n = 2, 3, 4, 5, …

Table 42. Phase discontinuity protection (PDNSPTOC) main settings

Parameter	Function	Value (Range)	Step
Start value (Current ratio setting I_2/I_1)	PDNSPTOC	10...100 %	1
Operate delay time	PDNSPTOC	0.100...30.000 s	0.001
Min phase current	PDNSPTOC	0.05...0.30 pu	0.01

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

Characteristic	Value
Operation accuracy	At the frequency f = f_n
	Current measurement: ±1.5% of the set value or ±0.002 x I_n Ratio I2f/I1f measurement: ±5.0% of the set value
Reset time	+35 ms / -0 ms
Reset ratio	Typical 0.96
Operate time accuracy	+30 ms / -0 ms

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

Parameter	Function	Value (Range)	Step
Start value (Ratio of the 2nd to the 1st harmonic leading to restraint)	INRPHAR	5...100 %	1
Operate delay time	INRPHAR	0.02...60.00 s	0.001

Table 45. Three-phase overvoltage protection (PHPTOV)

Characteristic		Value
Operation accuracy		At the frequency $f = f_n$
		±1.5% of the set value or $\pm 0.002 \times U_n$
Start time[1)2)]	U_{Fault} = 2.0 x set *Start value*	Typical 17 ms (±15ms)
Reset time		< 40 ms
Reset ratio		Depends of the set *Relative hysteresis*
Retardation time		< 35 ms
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms[3)]
Suppression of harmonics		DFT: -50 dB at $f = n \times f_n$, where n = 2, 3, 4, 5, …

1) *Start value* = $1.0 \times U_n$, Voltage before fault = $0.9 \times U_n$, f_n = 50 Hz, overvoltage in one phase-to-phase with nominal frequency injected from random phase angle
2) Includes the delay of the signal output contact
3) Maximum *Start value* = $1.20 \times U_n$, *Start value* multiples in range of 1.10 to 2.00

Table 46. Three-phase overvoltage protection (PHPTOV) main settings

Parameter	Function	Value (Range)	Step
Start value	PHPTOV	0.05...1.60 pu	0.01
Time multiplier	PHPTOV	0.05...15.00	0.05
Operate delay time	PHPTOV	0.40...300.000 s	0.10
Operating curve type[1)]	PHPTOV	Definite or inverse time Curve type: 5, 15, 17, 18, 19, 20	

1) For further reference please refer to the Operating characteristics table

Table 47. Three phase undervoltage protection (PHPTUV)

Characteristic		Value
Operation accuracy		At the frequency $f = f_n$
		±1.5% of the set value or $\pm 0.002 \times U_n$
Start time[1)2)]	U_{Fault} = 0.9 x set *Start value*	Typical 24 ms (±15ms)
Reset time		< 40 ms
Reset ratio		Depends of the set *Relative hysteresis*
Retardation time		< 35 ms
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms
Operate time accuracy in inverse time mode		±5.0% of the theoretical value or ±20 ms[3)]
Suppression of harmonics		DFT: -50 dB at $f = n \times f_n$, where n = 2, 3, 4, 5, …

1) *Start value* = $1.0 \times U_n$, Voltage before fault = $1.1 \times U_n$, f_n = 50 Hz, undervoltage in one phase-to-phase with nominal frequency injected from random phase angle
2) Includes the delay of the signal output contact
3) Minimum *Start value* = $0.50 \times U_n$, *Start value* multiples in range of 0.90 to 0.20

Table 48. Three-phase undervoltage protection (PHPTUV) main settings

Parameter	Function	Value (Range)	Step
Start value	PHPTUV	0.05...1.20 pu	0.01
Time multiplier	PHPTUV	0.05...15.00	0.05
Operate delay time	PHPTUV	0.040...300.000 s	0.010
Operating curve type[1)]	PHPTUV	Definite or inverse time Curve type: 5, 15, 21, 22, 23	

1) For further reference please refer to the Operating characteristics table

Table 49. Positive-sequence overvoltage protection (PSPTOV)

Characteristic		Value
Operation accuracy		At the frequency $f = f_n$
		±1.5% of the set value or ±0.002 x U_n
Start time[1)2)]	U_{Fault} = 1.1 x set *Start value* U_{Fault} = 2.0 x set *Start value*	Typical: 29 ms (±15 ms) Typical: 24 ms (±15 ms)
Reset time		< 40 ms
Reset ratio		Typical 0.96
Retardation time		< 35 ms
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms
Suppression of harmonics		DFT: -50 dB at $f = n \times f_n$, 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
2) Includes the delay of the signal output contact

Table 50. Positive-sequence overvoltage protection (PSPTOV) main settings

Parameter	Function	Value (Range)	Step
Start value	PSPTOV	0.800...1.600 pu	0.001
Operate delay time	PSPTOV	0.040...120.000 s	0.001

Table 51. Positive sequence undervoltage protection (PSPTUV)

Characteristic		Value
Operation accuracy		At the frequency $f = f_n$
		±1.5% of the set value or $\pm 0.002 \times U_n$
Start time[1)2)]	U_{Fault} = 0.9 x set *Start value*	Typical 28 ms (±15ms)
Reset time		< 40 ms
Reset ratio		Typical 0.96
Retardation time		< 35 ms
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms
Suppression of harmonics		DFT: -50 dB at $f = n \times f_n$, where n = 2, 3, 4, 5, …

1) Residual voltage before fault = $1.1 \times U_n$, f_n = 50 Hz, residual voltage with nominal frequency injected from random phase angle
2) Includes the delay of the signal output contact

Table 52. Positive sequence undervoltage protection (PSPTUV) main settings

Parameter	Function	Value (Range)	Step
Start value	PSPTUV	0.010...1.200 pu	0.001
Operate delay time	PSPTUV	0.040...120.000 s	0.001
Voltage block value	PSPTUV	0.01...1.0 pu	0.01

Table 53. Negative sequence overvoltage protection (NSPTOV)

Characteristic		Value
Operation accuracy		At the frequency $f = f_n$
		±1.5% of the set value or ±0.002 × U_n
Start time[1)2)]	U_{Fault} = 1.1 x set *Start value*	Typical 29 ms (±15ms)
	U_{Fault} = 2.0 x set *Start value*	Typical 24 ms (±15ms)
Reset time		< 40 ms
Reset ratio		Typical 0.96
Retardation time		< 35 ms
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms
Suppression of harmonics		DFT: -50 dB at $f = n \times f_n$, where n = 2, 3, 4, 5, …

1) Residual voltage before fault = 0.0 × U_n, f_n = 50 Hz, residual overvoltage with nominal frequency injected from random phase angle
2) Includes the delay of the signal output contact

Table 54. Negative sequence overvoltage protection (NSPTOV) main settings

Parameter	Function	Value (Range)	Step
Start value	NSPTOV	0.010...1.000 pu	0.001
Operate delay time	NSPTOV	0.040...120.000 s	0.001

Table 55. Residual overvoltage protection (ROVPTOV)

Characteristic		Value
Operation accuracy		At the frequency $f = f_n$
		±1.5% of the set value or $\pm 0.002 \times U_n$
Start time[1)2)]	U_{Fault} = 1.1 x set *Start value*	Typical 27 ms (± 15 ms)
Reset time		< 40 ms
Reset ratio		Typical 0.96
Retardation time		< 35 ms
Operate time accuracy in definite time mode		±1.0% of the set value or ±20 ms
Suppression of harmonics		DFT: -50 dB at $f = n \times f_n$, where n = 2, 3, 4, 5, …

1) Residual voltage before fault = $0.0 \times U_n$, f_n = 50 Hz, residual voltage with nominal frequency injected from random phase angle
2) Includes the delay of the signal output contact

Table 56. Residual overvoltage protection (ROVPTOV) main settings

Parameter	Function	Value (Range)	Step
Start value	ROVPTOV	0.010...1.000 pu	0.001
Operate delay time	ROVPTOV	0.040...300.000 s	0.001

Table 57. Frequency gradient protection (DAPFRC)

Characteristic		Value
Operation accuracy		df/dt < ± 10 Hz/s: ±10 mHz/s Undervoltage blocking: ±1.5% of the set value or $\pm 0.002 \times U_n$
Start time[1)2)]	*Start value* = 0.05 Hz/s df/dt_{FAULT} = ±1.0 Hz/s	Typical 110 ms (±15 ms)
Reset time		< 150 ms
Operate time accuracy in definite time mode		±1.0% of the set value or ±30 ms
Suppression of harmonics		DFT: -50 dB at $f = n \times f_n$, where n = 2, 3, 4, 5, …

1) Frequency before fault = $1.0 \times f_n$, f_n = 50 Hz
2) Includes the delay of the signal output contact

Table 58. Frequency gradient protection (DAPFRC) main settings

Parameter	Function	Value (Range)	Step
Start value	DAPFRC	-10.00...10.00 Hz/s	0.01
Operate delay time	DAPFRC	0.120...60.000 s	0.001

Table 59. Overfrequency protection (DAPTOF)

Characteristic		Value
Operation accuracy		At the frequency f = 35 to 66 Hz
		± 0.003 Hz
Start time[1)2)]	f_{Fault} = 1.01 × set *Start value*	Typical < 190 ms
Reset time		< 190 ms
Operate time accuracy in definite time mode		±1.0% of the set value or ±30 ms
Suppression of harmonics		DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5, …

1) Frequency before fault = 0.99 × f_n, f_n = 50 Hz
2) Includes the delay of the signal output contact

Table 60. Overfrequency protection (DAPTOF) main settings

Parameter	Function	Value (Range)	Step
Start value	DAPTOF	35.0...64.0 Hz	0.1
Operate delay time	DAPTOF	0.170...60.000 s	0.001

Table 61. Underfrequency protection (DAPTUF)

Characteristic		Value
Operation accuracy		At the frequency f = 35 to 66 Hz
		± 0.003 Hz
Start time[1)2)]	f_{Fault} = 0.99 × set *Start value*	Typical < 190 ms
Reset time		< 190 ms
Operate time accuracy in definite time mode		±1.0% of the set value or ±30 ms
Suppression of harmonics		DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5, …

1) Frequency before fault = 1.01 × f_n, f_n = 50 Hz
2) Includes the delay of the signal output contact

Table 62. Underfrequency protection (DAPTUF) main settings

Parameter	Function	Value (Range)	Step
Start value	DAPTUF	35.0...64.0 Hz	0.1
Operate delay time	DAPTUF	0.170...60.000 s	0.001

Table 63. Load shedding (LSHDPFRQ)

Characteristic		Value
Operation accuracy		At the frequency f = 35 to 66 Hz ± 0.003 Hz
Start time[1)2)]	*Load shed mode*	
	Freq<: f_{Fault} = 0.80 × set *Start value* freq< AND dfdt>: df/dt = 0.3 Hz/s	Typical 175 ms (±15ms) Typical 250 ms (±15ms)
Reset time		< 190 ms
Operate time accuracy in definite time mode		±1.0% of the set value or ±30 ms
Suppression of harmonics		DFT: -50 dB at f = n × f_n, where n = 2, 3, 4, 5, …

1) Frequency before fault = 1.2 × f_n, f_n = 50 Hz
2) Includes the delay of the signal output contact

Table 64. Load shedding (LSHDPFRQ) main settings

Parameter	Function	Value (Range)	Step
Load shed mode	LSHDPFRQ	Freq< freq< AND dfdt> Freq< OR dfdt>	-
Restore mode	LSHDPFRQ	Disabled Auto Manual	-
Start Val frequency	LSHDPFRQ	35.00...60.00 Hz	0.01
Start value df/dt	LSHDPFRQ	0.10...10.00 Hz/s	0.01
Restore start Val	LSHDPFRQ	45.00...60.00 Hz	0.01
Frequency Op delay	LSHDPFRQ	0.170...60.000 s	0.001
Df/dt operate delay	LSHDPFRQ	0.170...60.000 s	0.001
Restore delay time	LSHDPFRQ	0.170...60.000 s	0.001

Table 65. Fault locator (SCEFRFLO)

Characteristic	Value
Operation accuracies	At the frequency f = f_n
	Current: ±1.5% of the set value or ±0.002 × I_n Voltage: ±1.5% of the set value or ±0.002 × U_n Fault location accuracy: ±2.5% of the line length Actual fault location accuracy depends on the fault and the power system characteristics.
Suppression of harmonics	DFT: -50 dB at f = n x f_n, where n = 2, 3, 4, 5, …

Table 66. Fault locator (SCEFRFLO) main settings

Parameter	Function	Values (Range)	Step
Phase voltage Meas	SCEFRFLO	Accurate PP without Uo	-
Calculation Trg mode	SCEFRFLO	External Internal Continuous	-
Pre fault time	SCEFRFLO	0.100...300.000 s	0.001
Z Max phase load	SCEFRFLO	1.00...10000.00 ohm	0.01
Ph leakage Ris	SCEFRFLO	1...1000000 ohm	1
Ph capacitive React	SCEFRFLO	1...1000000 ohm	1
R1 line section A	SCEFRFLO	0.001...1000.000 ohm/pu	0.001
X1 line section A	SCEFRFLO	0.001...1000.000 ohm/pu	0.001
R0 line section A	SCEFRFLO	0.001...1000.000 ohm/pu	0.001
X0 line section A	SCEFRFLO	0.001...1000.000 ohm/pu	0.001
Line Len section A	SCEFRFLO	0.001...1000.000 pu	0.001

Table 67. Circuit breaker failure protection (CCBRBRF)

Characteristic	Value
Operation accuracy	At the frequency $f = f_n$
	±1.5% of the set value or $\pm 0.002 \times I_n$
Operate time accuracy	±1.0% of the set value or ±30 ms

Table 68. Circuit breaker failure protection (CCBRBRF) main settings

Parameter	Function	Value (Range)	Step
Current value (Operating phase current)	CCBRBRF	0.05...1.00 pu	0.05
Current value Res (Operating residual current)	CCBRBRF	0.05...1.00 pu	0.05
CB failure mode (Operating mode of function)	CCBRBRF	1=Current 2=Breaker status 3=Both	-
CB fail trip mode	CCBRBRF	1=Off 2=Without check 3=Current check	-
Retrip time	CCBRBRF	0.00...60.00 s	0.01
CB failure delay	CCBRBRF	0.00...60.00 s	0.01
CB fault delay	CCBRBRF	0.00...60.00 s	0.01

Table 69. Distance protection (DSTPDIS)

Characteristic	Value
Operation accuracy	At the frequency f = f_n
	Current: ±1.5% of the set value or ±0.002 x I_n Voltage: ±1.5% of the set value or ±0.002 x U_n Impedance: ±2.0% static accuracy Phase angle: ±2°
Start time [1)2)] SIR[3)]: 0.1–60	Typical 50 ms (±15 ms)
Transient overreach SIR = 0.1 – 60	< 6%
Reset time	< 50 ms
Reset ratio	Typical 0.96
Operate time accuracy in definite time mode	±1.0% of the set value or ±20 ms

1) Includes the delay of the signal output contact
2) Relates to start signals of the Zone Z1–Zone ZAR2
3) SIR = Source impedance ratio

Table 70. Distance protection (DSTPDIS) main settings

Parameter	Function	Value (Range)	Steps
Phase voltage Meas	DSTPDIS	Accurate PP without Uo	-
System grounding GFC	DSTPDIS	High impedance Low impedance From input	-
Phase Sel mode GFC	DSTPDIS	Overcurrent Voltdep overcur Under impedance Overcur/underZ	-
EF detection Mod GFC	DSTPDIS	Io Io OR Uo Io AND Uo Io AND Ioref	-
Operate delay GFC	DSTPDIS	0.100 - 60.000 s	0.001
Ph Str A Ph Sel GFC	DSTPDIS	0.10 - 10.00 pu	0.01
Ph Lo A Ph Sel GFC	DSTPDIS	0.10 - 10.00 pu	0.01
Ph V Ph Sel GFC	DSTPDIS	0.10 - 1.00 pu	0.01
PP V Ph Sel GFC	DSTPDIS	0.10 - 1.00 pu	0.01
Z Chr Mod Ph Sel GFC	DSTPDIS	Quadrilateral Mho (circular)	-
Load Dsr mode GFC	DSTPDIS	Off On	-
X Gnd Fwd reach GFC	DSTPDIS	0.01 - 3000.00 ohm	0.01
X Gnd Rv reach GFC	DSTPDIS	0.01 - 3000.00 ohm	0.01
Ris Gnd Rch GFC	DSTPDIS	0.01 - 500.00 ohm	0.01
X PP Fwd reach GFC	DSTPDIS	0.01 - 3000.00 ohm	0.01
X PP Rv reach GFC	DSTPDIS	0.01 - 3000.00 ohm	0.01
Resistive PP Rch GFC	DSTPDIS	0.01 - 100.00 ohm	0.01
Ris reach load GFC	DSTPDIS	1.00 - 3000.00 ohm	0.01
Angle load area GFC	DSTPDIS	5 - 45 deg	1
Z Max Ph load GFC	DSTPDIS	1.00 - 10000.00 ohm	0.01
Gnd Op current GFC	DSTPDIS	0.01 - 10.00 pu	0.01
Gnd Op A Ref GFC	DSTPDIS	0.01 - 10.00 pu	0.01

Table 70. Distance protection (DSTPDIS) main settings, continued

Parameter	Function	Value (Range)	Steps
Gnd Str voltage GFC	DSTPDIS	0.02 - 1.00 pu	0.01
Ph Prf mode Hi Z GFC	DSTPDIS	No filter No preference Cyc A-B-C-A Cyc A-C-B-A Acyc A-B-C Acyc A-C-B Acyc B-A-C Acyc B-C-A Acyc C-A-B Acyc C-B-A	-
Ph Prf mode Lo Z GFC	DSTPDIS	All loops PE only PP only BLK leading PE BLK lagging PE	-
Gnd Op A XC GFC	DSTPDIS	0.10 - 10.00 pu	0.01
PP voltage XCF GFC	DSTPDIS	0.10 - 1.00 pu	0.01
Cross-country Dl GFC	DSTPDIS	0.00 - 10.00 s	0.01
Impedance mode Zn	DSTPDIS	Rectangular Polar	-
Impedance Chr Gnd Zn	DSTPDIS	Quadrilateral Mho (circular) Mho dir line Offset dir line Bullet (combi)	-
Impedance Chr PP Zn	DSTPDIS	Quadrilateral Mho (circular) Mho dir line Offset dir line Bullet (combi)	-
Max phase angle zone	DSTPDIS	0 - 45 deg	1
Min phase angle zone	DSTPDIS	90 - 135 deg	1
Pol quantity zone	DSTPDIS	Pos. seq. volt. Self pol Cross Pol	-
Directional mode Zn1	DSTPDIS	Non-directional Forward Reverse	-

Table 70. Distance protection (DSTPDIS) main settings, continued

Parameter	Function	Value (Range)	Steps
Op Mod PP loops Zn1	DSTPDIS	Disabled Enabled	-
PP Op delay Mod Zn1	DSTPDIS	Disabled Enabled	-
R1 zone 1	DSTPDIS	0.01 - 3000.00 ohm	0.01
X1 zone 1	DSTPDIS	0.01 - 3000.00 ohm	0.01
X1 reverse zone 1	DSTPDIS	0.01 - 3000.00 ohm	0.01
Z1 zone 1	DSTPDIS	0.01 - 3000.00 ohm	0.01
Z1 angle zone 1	DSTPDIS	15 - 90 deg	1
Z1 reverse zone 1	DSTPDIS	0.01 - 3000.00 ohm	0.01
Min Ris PP Rch Zn1	DSTPDIS	0.01 - 100.00 ohm	0.01
Max Ris PP Rch Zn1	DSTPDIS	0.01 - 100.00 ohm	0.01
R0 zone 1	DSTPDIS	0.01 - 3000.00 ohm	0.01
X0 zone 1	DSTPDIS	0.01 - 3000.00 ohm	0.01
Factor K0 zone 1	DSTPDIS	0.0 - 4.0	0.1
Factor K0 angle Zn1	DSTPDIS	-135 - 135 deg	1
Min Ris Gnd Rch Zn1	DSTPDIS	0.01 - 500.00 ohm	0.01
Max Ris Gnd Rch Zn1	DSTPDIS	0.01 - 500.00 ohm	0.01
Gnd operate Dl Zn1	DSTPDIS	0.030 - 60.000 s	0.001

Table 71. Switch onto fault function (CVRSOF)

Characteristic	Value
Operation accuracies	At the frequency $f = f_n$
	Current: ±1.5% of the set value or ±0.002 × I_n Voltage: ±1.5% of the set value or ±0.002 × U_n
Operate time accuracy	±1.0% of the set value or ±35 ms
Suppression of harmonics	DFT: -50 dB at f = n x f_n, where n = 2, 3, 4, 5, …

Table 72. Local acceleration logic (DSTPLAL)

Characteristic	Value
Operation accuracy	At the frequency $f = f_n$
	±1.5% of the set value or ±0.002 × I_n
Operate time accuracy	±1.0% of the set value or ±20 ms
Suppression of harmonics	DFT: -50 dB at $f = n \times f_n$, where n = 2, 3, 4, 5, …

Table 73. Local acceleration logic (DSTPLAL) main settings

Parameter	Function	Value (Range)	Step
Load current value	DSTPLAL	0.01...1.00 pu	0.01
Minimum current	DSTPLAL	0.01...1.00 pu	0.01
Minimum current time	DSTPLAL	0.000...60.000 s	0.001
Load release on time	DSTPLAL	0.000...60.000 s	0.001
Load release off Tm	DSTPLAL	0.000...60.000 s	0.001
Loss of load Op	DSTPLAL	Disabled Enabled	-
Zone extension	DSTPLAL	Disabled Enabled	-

Table 74. Communication logic for residual overcurrent (RESCPSCH)

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

Table 75. Communication logic for residual overcurrent (RESCPSCH) main settings

Parameter	Function	Value (Range)	Step
Scheme type	RESCPSCH	Off Intertrip Permissive UR Permissive OR Blocking	-
Coordination time	RESCPSCH	0.000...60.000 s	0.001
Carrier Min Dur	RESCPSCH	0.000...60.000 s	0.001

Table 76. Scheme communication logic (DSOCPSCH)

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

Table 77. Scheme communication logic (DSOCPSCH) main settings

Parameter	Function	Value (Range)	Step
Scheme type	DSOCPSCH	Off Intertrip Permissive UR Permissive OR Blocking	-
Coordination time	DSOCPSCH	0.000...60.000 s	0.001
Carrier dur time	DSOCPSCH	0.000...60.000 s	0.001

Table 78. Current reversal and WEI logic (CRWPSCH)

Characteristic	Value
Operation accuracy	At the frequency f = f_n
	±1.5% of the set value or ±0.002 × U_n
Operate time accuracy	±1.0% of the set value or ±20 ms
Suppression of harmonics	DFT: -50 dB at f = n x f_n, where n = 2, 3, 4, 5, …

Table 79. Current reversal and WEI logic (CRWPSCH) main settings

Parameter	Function	Value (Range)	Step
Reversal mode	CRWPSCH	Off On	-
Wei mode	CRWPSCH	Off Echo Echo & Trip	-
PhV level for Wei	CRWPSCH	0.10...0.90 pu	0.01
PPV level for Wei	CRWPSCH	0.10...0.90 pu	0.01
Reversal time	CRWPSCH	0.000...60.000 s	0.001
Reversal reset time	CRWPSCH	0.000...60.000 s	0.001
Wei Crd time	CRWPSCH	0.000...60.000 s	0.001

Table 80. Current reversal and WEI logic for residual overcurrent (RCRWPSCH)

Characteristic	Value
Operation accuracy	At the frequency $f = f_n$
	±1.5% of the set value or $\pm 0.002 \times U_n$
Operate time accuracy	±1.0% of the set value or ±20 ms

Table 81. Current reversal and WEI logic for residual overcurrent (RCRWPSCH) main settings

Parameter	Function	Value (Range)	Step
Reversal mode	RCRWPSCH	Off On	-
Wei mode	RCRWPSCH	Off Echo Echo & Trip	-
Residual voltage Val	RCRWPSCH	0.05...0.70 pu	0.01
Reversal time	RCRWPSCH	0.000...60.000 s	0.001
Reversal reset time	RCRWPSCH	0.000...60.000 s	0.001
Wei Crd time	RCRWPSCH	0.000...60.000 s	0.001

Table 82. Operation characteristics

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

Control functions

Table 83. Autoreclosure (DARREC)

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

Table 84. Synchrocheck (SYNCRSYN)

Characteristic	Value
Operation accuracy	At the frequency f = f_n
	Voltage: ±1.0% or ±0.002 x U_n Frequency: ±10 mHz Phase angle ±2°
Reset time	< 50 ms
Reset ratio	Typical 0.96
Operate time accuracy	±1.0% of the set value or ±20 ms

Measurement functions

Table 85. Three-phase current measurement (CMMXU)

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

Table 86. Three-phase voltage measurement (VPHMMXU)

Characteristic	Value
Operation accuracy	At the frequency f = f_n
	±0.5% or ±0.002 x U_n (at voltages in the range of 0.01...1.15 × U_n)
Suppression of harmonics	DFT: -50dB at f = n × f_n, where n = 2, 3, 4, 5, … RMS: No suppression

Table 87. Three-phase voltage measurement (VPPMMXU)

Characteristic	Value
Operation accuracy	At the frequency f = f_n
	±0.5% or ±0.002 x U_n (at voltages in the range of 0.01...1.15 × U_n)
Suppression of harmonics	DFT: -50dB at f = n × f_n, where n = 2, 3, 4, 5, … RMS: No suppression

Table 88. Residual current measurement (RESCMMXU)

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

Table 89. Residual voltage measurement (RESVMMXU)

Characteristic	Value
Operation accuracy	At the frequency f = f_n
	±0.5% or ±0.002 × U_n
Suppression of harmonics	DFT: -50dB at f = n × f_n, where n = 2, 3, 4, 5, … RMS: No suppression

Table 90. Three-phase power measurement (PWRMMXU)

Characteristic	Value
Operation accuracy	At all three currents in range 0.10…1.20 x In_n At all three voltages in range 0.50…1.15 x U_n At the frequency $f = f_n$ 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
Suppression of harmonics	DFT: -50dB at $f = n \times f_n$, where n = 2, 3, 4, 5, …

Table 91. Current sequence components (CSMSQI)

Characteristic	Value
Operation accuracy	At the frequency $f = f_n$
	±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 $f = n \times f_n$, where n = 2, 3, 4, 5, …

Table 92. Voltage sequence components (VSMSQI)

Characteristic	Value
Operation accuracy	At the frequency $f = f_n$
	±1.0% or ±0.002 x U_n At voltages in range of 0.01…1.15 x U_n
Suppression of harmonics	DFT: -50 dB at $f = n \times f_n$, where n = 2, 3, 4, 5, …

Table 93. Energy monitoring (EPDMMTR)

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

Supervision functions

Table 94. Circuit breaker condition monitoring (SSCBR)

Characteristic	Value
Current measuring accuracy	At the frequency f = f_n
	±1.5% or ±0.002 × I_n (at currents in the range of 0.1…10 × I_n) ±5.0% (at currents in the range of 10…40 × I_n)
Operate time accuracy	±1.0% of the set value or ±20 ms
Traveling time measurement	±10 ms

Table 95. Current circuit supervision (CCRDIF)

Characteristic	Value
Operate time[1)]	< 30 ms

1) Including the delay of the output contact.

Table 96. Current circuit supervision (CCRDIF) main settings

Parameter	Function	Values (Range)	Step
Start value	CCRDIF	0.05...2.00 pu	0.01
Maximum operate current	CCRDIF	0.05...5.00 pu	0.01

Table 97. Fuse failure supervision (SEQRFUF)

Characteristic	Value	
Operation accuracy	At the frequency $f = f_n$	
	Current: ±1.5% of the set value or $\pm 0.002 \times I_n$ Voltage: ±1.5% of the set value or $\pm 0.002 \times U_n$	
Operate time[1)]		
• NPS function	U_{Fault} = 1.1 x set *Neg Seq voltage Lev*	Typical 35 ms (±15 ms)
	U_{Fault} = 5.0 x set *Neg Seq voltage Lev*	Typical 25 ms (±15 ms)
• Delta function	ΔU = 1.1 x set *Voltage change rate*	Typical 35 ms (±15 ms)
	ΔU = 2.0 x set *Voltage change rate*	Typical 28 ms (±15 ms)

1) Includes the delay of the signal output contact, f_n = 50 Hz, fault voltage with nominal frequency injected from random phase angle

Table 98. Station battery supervision (SPVNZBAT)

Characteristic	Value
Operation accuracy	±1.0% of the set value
Operate time accuracy	±1.0% of the set value or ±40 ms

20. Front panel user interface

The 630 series IEDs can be ordered with an integrated or detached front-panel user interface (HMI). The local HMI includes a large graphical monochrome LCD with a resolution of 320 x 240 pixels (width x height). The amount of characters and rows fitting the view depends on the character size as the characters' width and height may vary.

In addition, the local HMI includes dedicated open/close operating buttons and five programmable function buttons with LED indicators. The 15 programmable alarm LEDs can indicate a total of 45 alarms. The local HMI offers full front-panel user-interface functionality with menu navigation, menu views and operational data. In addition, the local HMI can, using PCM600, be configured to show a single-line diagram (SLD). The SLD view displays the status of the primary apparatus such as circuit breakers and disconnectors, selected measurement values and busbar arrangements.

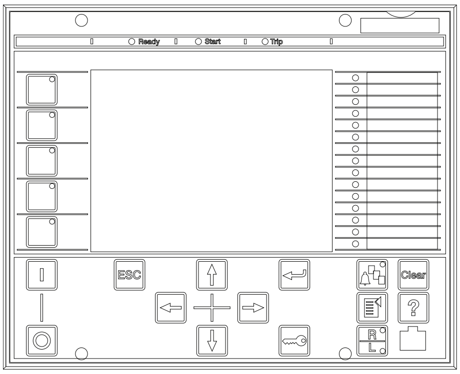

Figure 6. Local user interface

21. Mounting methods

By means of appropriate mounting accessories the standard IED case for the 630 series IEDs can be flush mounted, semi-flush mounted or wall mounted. If the IED is delivered with a detached local HMI, the HMI can be mounted on the door, and the IED case in the low-voltage compartment of the switchgear. Further, the IEDs can be mounted in any standard 19” instrument cabinet by means of 19” rack mounting accessories.

For the routine testing purposes, the IED cases can be installed with RTXP test switches (RTXP8, RTXP18 or RTXP24) which can be mounted side by side with the IED case in a 19” rack.

Mounting methods:

- Flush mounting
- Semi-flush mounting
- Overhead/ceiling mounting
- 19” rack mounting
- Wall mounting
- Mounting with a RTXP8, RTXP18 or RTXP24 test switch to a 19”rack
- Door mounting of the local HMI, IED case mounted in the low-voltage compartment of the switchgear

For further information regarding cut-outs and templates for different mounting options please refer to the 630 series Installation Manual 1MRS755958.

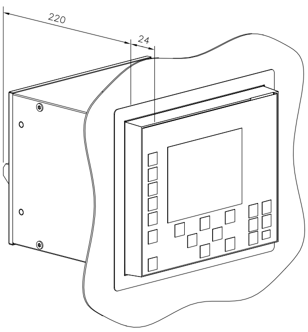

Figure 7. Flush mounting

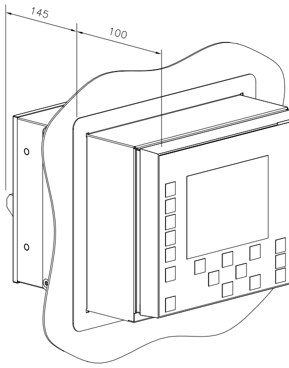

Figure 8. Semi-flush mounting

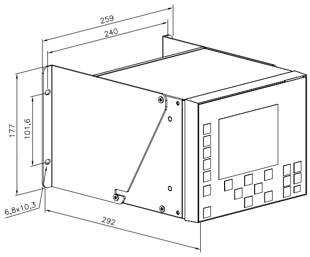

Figure 9. Wall mounting

22. Selection and ordering data

The IED type and serial number label identifies the protection and control IED. The label placed is on the side of the IED case. The IED labels include a set of smaller size labels, one label for each module in the IED.

The module labels state the type and serial number of each module.

The order number consists of a string of codes generated from the hardware and software modules of the IED. Use the ordering key information in tables to generate the order number when ordering protection and control IEDs.

S B F B A B A C B B B Z A Z N A X A

#	DESCRIPTION	
1	**IED**	
	630 series IED, 4U half 19” housing	S
2	**Standard**	
	IEC	B
3	**Main application**	
	Feeder protection and control	F

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

S B F **B A B A C** B B B Z A Z N A X A

#	DESCRIPTION
4-8	**Functional application, preconfigurations:** A = Preconfiguration A for open/closed ring feeder B = Preconfiguration B for radial overhead/mixed line feeder C = Preconfiguration C for ring/meshed feeder [1)] D = Preconfiguration D for bus sectionalizer N = None

Pre-conf. # 4	Available analog inputs options # 5-6	Available binary in-puts/output options # 7-8
A	**AB** = 4 I (I_0 1/5A) + 1 I (I_0 0.1/0.5A) + 4 U	**AB** = 23 BI + 18 BO or **AC** = 32 BI + 27 BO
B	**AB** = 4 I (I_0 1/5A) + 1 I (I_0 0.1/0.5A) + 4U	**AB** = 23 BI + 18 BO or **AC** = 32 BI + 27 BO
C [1)]	**AB** = 4 I (I_0 1/5A) + 1 I (I_0 0.1/0.5A) + 4 U	**AB** = 23 BI + 18 BO or **AC** = 32 BI + 27 BO
D	**AB** = 4 I (I_0 1/5A) + 1 I (I_0 0.1/0.5A) + 4 U	**AB** = 23 BI + 18 BO or **AC** = 32 BI + 27 BO
N	**AA** = 4 I (I_0 1/5A) + 5 U or **AB** = 4 I (I_0 1/5A) + 1 I (I_0 0.1/0.5A) + 4 U or **AC** = 3 I (I_0 1/5A) + 1 I (I_0 0.1/0.5A) + 5 U	**AA** = 14 BI + 9 BO or **AB** = 23 BI + 18 BO or **AC** = 32 BI + 27 BO

[1)] Preconfiguration C requires that the Distance protection option is chosen for digit #14 or digit #15

S B T B A B A C B B B Z A A N A X A

#	DESCRIPTION	
9	**Communication serial** [1]	
	Glass fibre (ST connector)	A
	Plastic fibre (snap-in connector)	B
10	**Communication Ethernet**	
	Ethernet 100BaseFX (LC)	A
	Ethernet 100BaseTX (RJ-45)	B
11	**Communication protocol**	
	IEC 61850	A
	IEC 61850 and DNP3 TCP/IP	B

[1] For future use

S B F B A B A C B B B Z A Z N A X A

#	DESCRIPTION	
12	**Language**	
	English and Chinese	[Z]
13	**Front panel**	
	Integrated local HMI	[A]
	Detached local HMI, 1 m cable	B
	Detached local HMI, 2 m cable	C
	Detached local HMI, 3 m cable	D
	Detached local HMI, 4 m cable	E
	Detached local HMI, 5 m cable	F
	No local HMI	N
14	**Option 1**	
	Fault locator and synchro-check [1]	A
	Fault locator and phase-sequence voltage functions [2]	B
	Synchro-check and phase-sequence voltage functions [3]	C
	Fault locator, synchro-check and phase-sequence voltage functions [4]	D
	Distance protection and fault locator [5]	E
	Distance protection, fault locator and synchro-check [6]	F
	All options [7]	[Z]
	None	N
15	**Option 2**	
	Fault locator	A
	Synchro-check	B
	Phase-sequence voltage functions	C
	Distance protection	D
	None	[N]
16	**Power supply**	
	48...125 V DC	[A]
	110...250 V DC, 100...240 V AC	B
17	**Vacant digit**	
	Vacant	[X]
18	**Version**	
	Version 1.0	[A]

[1] Available options for digit 15 restricted to: N, C or D
[2] Available options for digit 15 restricted to: N, B or D
[3] Available options for digit 15 restricted to: N, A or D
[4] Available options for digit 15 restricted to: N or D
[5] Available options for digit 15 restricted to: N, B or C
[6] Available options for digit 15 restricted to: N or C
[7] Available options for digit 15 restricted to: N

Example code: S B F B A B A C B B B Z A Z N A X A

Your ordering code:

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

Figure 10. Ordering key for complete IEDs

23. Accessories

Table 99. Mounting accessories

Item	Order number
Flush mounting kit for one 4U half 19” housing IED	1KHL400040R0001
Semi-flush mounting kit for one 4U half 19” housing IED	1KHL400041R0001
Wall-mounting kit (cabling towards the mounting wall) for one 4U half 19” housing IED	1KHL400067R0001
Wall-mounting kit (cabling to the front) for one 4U half 19” housing IED	1KHL400039R0001
19" rack mounting kit for one 4U half 19” housing IED	1KHL400236R0001
19" rack mounting kit for two 4U half 19” housing IEDs	1KHL400237R0001
Overhead/ceiling mounting kit (with cable space) for one 4U half 19” housing IED	1KHL400038P0001

Table 100. Test switch mounting accessories

Item	Order number
19" rack mounting kit for one RTXP8 test switch (the test switch is not included in the delivery)	1KHL400176R0001
19" rack mounting kit for one RTXP18 test switch (the test switch is not included in the delivery)	1KHL400177R0001
19" rack mounting kit for one RTXP24 test switch (the test switch is not included in the delivery)	1KHL400178R0001

Table 101. Connector sets

Item	Order number
Connector set for one 4U half 19" housing IED including analog input variant 4I + 5U (Io 1/5A), 5I + 4U (Io 0.1/0.5A) or 4I + 5U (Io 0.1/0.5A)	2RCA021735

24. Tools

The IED is delivered either with or without an optional factory made preconfiguration. The default parameter setting values can be changed from the front-panel user interface, the web-browser based user interface (WebHMI) or the PCM600 tool in combination with the IED specific connectivity package.

PCM600 offers extensive IED configuration functions such as IED application configuration, signal configuration, DNP3 communication configuration and IEC 61850 communication configuration including horizontal communication, GOOSE.

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

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

Table 102. Tools

Configuration and setting tools	Version
PCM600	2.1
Web-browser based user interface	IE 7.0 or later
REF630 Connectivity Package	1.0 or later

Table 103. Supported functions

Function	WebHMI	PCM600	PCM600 Engineering	PCM600 Engineering Pro
Parameter setting	●	●	●	●
Disturbance handling	●	●	●	●
Signal monitoring	●	●	●	●
Event viewer	●	●	●	●
Alarm LED viewing	●	●	●	●
Hardware configuration	-	●	●	●
Signal matrix	-	●	●	●
Graphical display editor	-	●	●	●
IED configuration templates	-	●	●	●
Communication management	-	●	●	●
Disturbance record analysis	-	●	●	●
IED user management	-	●	●	●
User management	-	●	●	●
Creating/handling projects	-	●	●	●
Graphical application configuration	-	-	●	●
IEC 61850 communication configuration, incl. GOOSE	-	-	-	●

25. Supported ABB solutions

ABB's 630 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 630 series IEDs offer 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 implementation of the IEC 61850 substation automation standard.

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

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

Table 104. Supported ABB solutions

Product	Version
Station Automation COM600	3.3 or later
MicroSCADA Pro	9.2 SP1 or later
RTU 560	9.5.1 or later
System 800xA	5.0 Service Pack 2

26. Terminal diagram

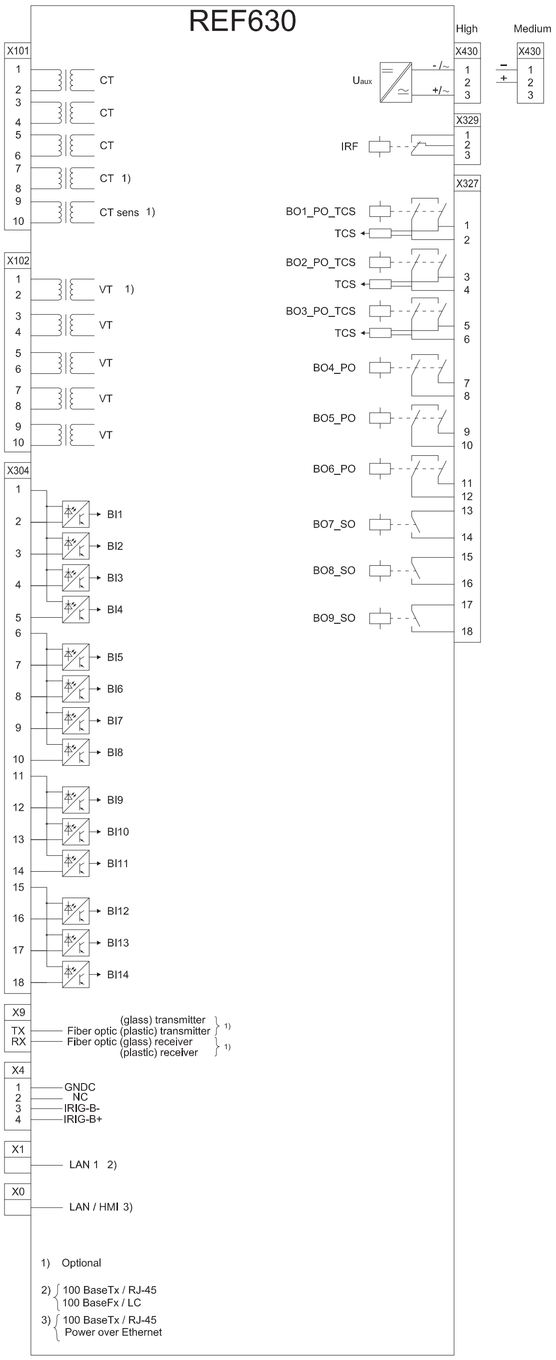

Figure 11. REF630 terminal diagram

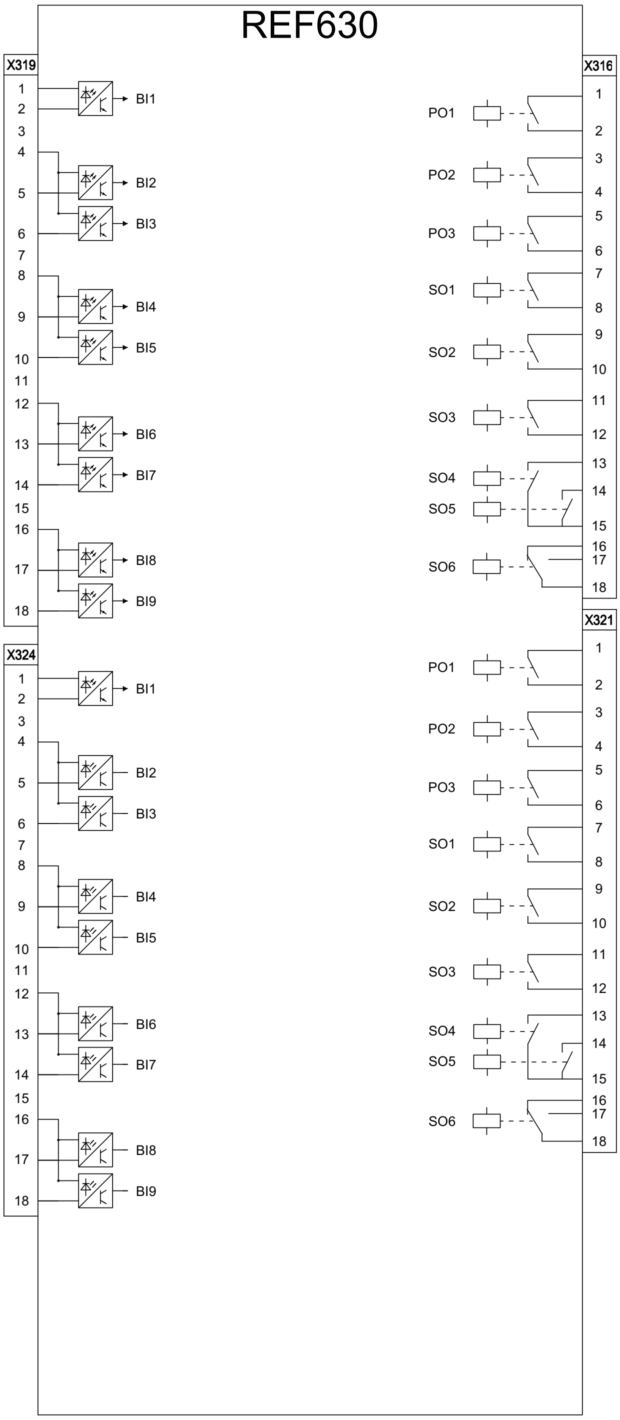

Figure 12. Terminal diagram option for REF630

27. References

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

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

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

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

28. Functions, codes and symbols

Table 105. Functions included in REF630

Functionality	IEC 61850	IEC 60617	ANSI
Protection			
Three-phase non-directional overcurrent, low stage	PHLPTOC	3I>	51P-1
Three-phase non-directional overcurrent, high stage	PHHPTOC	3I>>	51P-2
Three-phase non-directional overcurrent, instantaneous stage	PHIPTOC	3I>>>	50P/51P
Three-phase directional overcurrent, low stage	DPHLPDOC	3I> →	67-1
Three-phase directional overcurrent, high stage	DPHHPDOC	3I>> →	67-2
Non-directional earth fault, low stage	EFLPTOC	I_0>	51N-1
Non-directional earth fault, high stage	EFHPTOC	I_0>>	51N-2
Non-directional earth fault, instantaneous stage	EFIPTOC	I_0>>>	50N/51N
Directional earth fault, low stage	DEFLPDEF	I_0> →	67N-1
Directional earth fault, high stage	DEFHPDEF	I_0>> →	67N-2
Transient/intermittent earth fault	INTRPTEF	I_0> → IEF	67NIEF
Negative-sequence overcurrent	NSPTOC	I_2>	46
Three-phase thermal overload for feeder	T1PTTR	3Ith>F	49F
Three-phase overvoltage	PHPTOV	3U>	59
Three-phase undervoltage	PHPTUV	3U<	27
Positive-sequence overvoltage	PSPTOV	U1>	47O+
Positive-sequence undervoltage	PSPTUV	U_1<	47U+
Negative-sequence overvoltage	NSPTOV	U_2>	47O-
Residual overvoltage	ROVPTOV	U_0>	59G
Frequency gradient	DAPFRC	df/dt>	81R
Overfrequency	DAPTOF	f>	81O
Underfrequency	DAPTUF	f<	81U
Load shedding	LSHDPFRQ	UFLS/R	81LSH

Table 105. Functions included in REF630, continued

Functionality	IEC 61850	IEC 60617	ANSI
Fault locator	SCEFRFLO	FLOC	21FL
Distance protection	DSTPDIS	Z<	21, 21P, 21N
Automatic switch-onto-fault logic	CVRSOF	SOTF	SOTF
Phase discontinuity	PDNSPTOC	I_2/I_1>	46PD
Three-phase current inrush detection	INRPHAR	3I2f>	68
Circuit-breaker failure	CCBRBRF	3I>/I_0>BF	51BF/51NBF
Autoreclosing	DARREC	O → I	79
Tripping logic	TRPPTRC	I → O	94/86
Protection related functions			
Local acceleration logic	DSTPLAL	LAL	LAL
Communication logic for residual overcurrent	RESCPSCH	CLN	85N
Scheme communication logic	DSOCPSCH	CL	85
Current reversal and WEI logic	CRWPSCH	CLCRW	85CRW
Current reversal and WEI logic for residual overcurrent	RCRWPSCH	CLCRWN	85NCRW
Control			
Bay control	QCCBAY	CBAY	CBAY
Interlocking interface	SCILO	3	3
Circuit-breaker/disconnector control	GNRLCSWI	I ↔ O CB/DC	I ↔ O CB/DC
Circuit breaker	DAXCBR	I ↔ O CB	I ↔ O CB
Disconnector	DAXSWI	I ↔ O DC	I ↔ O DC
Local/remote switch interface	LOCREM	R/L	R/L
Synchrocheck	SYNCRSYN	SYNC	25
Supervision and monitoring			
Circuit-breaker condition monitoring	SSCBR	CBCM	CBCM
Fuse failure supervision	SEQRFUF	FUSEF	60
Current-circuit supervision	CCRDIF	MCS 3I	MCS 3I
Trip-circuit supervision	TCSSCBR	TCS	TCM
Generic measured values	MVGGIO		

Table 105. Functions included in REF630, continued

Functionality	IEC 61850	IEC 60617	ANSI
Measured value limit supervision	MVEXP		
Station battery supervision	SPVNZBAT	U<>	U<>
Energy monitoring	EPDMMTR	E	E
Measurement			
Three-phase current	CMMXU	3I	3I
Three-phase voltage, phase-to-earth voltages (RMS)	VPHMMXU	3Upe	3Upe
Three-phase voltage, phase-to-phase voltages (RMS)	VPPMMXU	3Upp	3Upp
Residual current	RESCMMXU	I_0	I_0
Residual voltage	RESVMMXU	U_0	V_n
Sequence current	CSMSQI	I_1,I_2	I_1,I_2
Sequence voltage	VSMSQI	U_1,U_2	V_1,V_2
Power monitoring with P, Q, S, power factor, frequency	PWRMMXU	PQf	PQf
Metering			
Pulse counter for energy metering	PCGGIO		
Disturbance recorder function			
Disturbance recorder	DRRDRE	DREC	DREC
Analog channels 1-10 (samples)	A1RADR	ACH1	ACH1
Analog channel 11-20 (samples)	A2RADR	ACH2	ACH2
Analog channel 21-30 (samples)	A3RADR	ACH3	ACH3
Analog channel 31-40 (calc. val.)	A4RADR	ACH4	ACH4
Binary channel 1-16	B1RBDR	BCH1	BCH1
Binary channel 17-32	B2RBDR	BCH2	BCH2
Binary channel 33-48	B3RBDR	BCH3	BCH3
Binary channel 49-64	B4RBDR	BCH4	BCH4

29. Document revision history

Document revision/ date	Product version	History
A/15.09.2009	1.0	First release

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