RELION® 670 SERIES

Bay control REC670
Version 2.1
Product guide
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1. Application

The IED is used for the control, protection and monitoring of different types of bays in power networks. The IED is especially suitable for applications in control systems where the IEC 61850–8–1 Ed 1 or Ed 2 station bus features of the IED can be fully utilized. It is used for station-wide interlocking via GOOSE messages and vertical client-server MMS communication to a local station or remote SCADA operator workplace. This supports the architecture with distributed control IEDs in all bays with high demands on reliability. Redundant communication is obtained through the built-in PRP feature which can be used in star or ringbus architectures. The IED can be used on all voltage levels. It is suitable for the control of all apparatuses in any type of switchgear arrangement.

The control is performed from remote (SCADA/Station) through the IEC 61850–8–1 Ed1 or Ed2 station communication or from the built-in multi-display local HMI. Cyber security measures are implemented to secure safe autonomous operation of the protection and control functions even if simultaneous cyber attacks occur. For all common types of switchgear arrangements, there are different pre-configurations for control and interlocking. One control IED can be used for single bay or multi-bay applications. The control operation is based on the select-before-execute principle to give highest possible security. There are synchrocheck functions available to assist optimal breaker closing at the right instance in synchronous as well as asynchronous networks.

A number of protection functions are available for flexibility in use for different station types and busbar arrangements. To fulfil the user’s application requirements, the IED features, for example, up to six instantaneous phase and earth overcurrent functions, 4-step directional or non-directional delayed-phase and earth overcurrent functions, thermal overload and frequency functions, two instances of 2-step under- and overvoltage functions, autorecloser functions and several different measuring functions. This, together with the multi-display local HMI that can show one or more pages per feeder allows using the IED for protection and control for up to six bays in a substation.

The auto-reclose for single-, two-, and/or three-phase reclose includes priority circuits for multi-breaker arrangements. It co-operates with the synchrocheck function with high-speed or delayed reclosing. Several breaker failure functions are available to provide a breaker failure function independent from the protection IEDs, also for a complete one- and a half breaker diameter.

Disturbance recording and fault locator are available to allow independent post-fault analysis after primary disturbances in case of a failure in the protection system.

Duplex communication channels for transfer of up to 192 intertrip and binary signals are available on each remote-end data communication card (LDCM). Typical applications are the communication between IEDs inside the station or with IEDs in a remote station as remote I/O.

The IED can be used in applications with the IEC 61850-9-2LE process bus with up to six Merging Units (MU).

Logic is prepared with a graphical tool. The advanced logic capability allows special applications such as automatic opening of disconnectors in multi-breaker arrangements, closing of breaker rings, load transfer logics and so on. The graphical configuration tool ensures simple and fast testing and commissioning.

Forcing of binary inputs and outputs is a convenient way to test wiring in substations as well as testing configuration logic in the IEDs. Basically it means that all binary inputs and outputs on the IED I/O modules (BOM, BIM, IOM & SOM) can be forced to arbitrary values.

Central Account Management is an authentication infrastructure that offers a secure solution for enforcing access control to IEDs and other systems within a substation. This incorporates management of user accounts, roles and certificates and the distribution of such, a procedure completely transparent to the user.

Flexible Product Naming allows the customer to use an IED-vendor independent 61850 model of the IED. This customer model will be used as the IEC 61850 data model, but all other aspects of the IED will remain unchanged (e.g., names on the local HMI and names in the tools). This offers significant flexibility to adapt the IED to the customers system and standard solution.

Four packages have been defined for following applications:

- Single breaker (double or single bus) arrangement (A30)
- Bus coupler for double busbar (A31)
- Double breaker arrangement (B30)
- 1 ½ breaker arrangement for a complete diameter (C30)

Optional functions are available in PCM600 Application Configuration Tool and can be configured by the user. Interface to analog and binary IO:s are configurable without need of configuration changes. Analog and control circuits have been pre-defined. Other signals...
need to be applied as required for each application. The main differences between the packages above are the interlocking modules and the number of apparatuses to control.
Description of configuration A30

Figure 1. Configuration diagram for configuration A30
Description of configuration A31

Figure 2. Configuration diagram for configuration A31
Description of configuration B30

Figure 3. Configuration diagram for configuration B30
Description of configuration C30

Figure 4. Configuration diagram for configuration C30
2. Available functions

Main protection functions

Table 1. Example of quantities

| 2 | = number of basic instances |
| 0-3 | = option quantities |
| 3-A03 | = optional function included in packages A03 (refer to ordering details) |

<table>
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<tr>
<th>IEC 61850</th>
<th>ANSI</th>
<th>Function description</th>
<th>REC670 (Customized)</th>
<th>REC670 (A30)</th>
<th>REC670 (A31)</th>
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## Back-up protection functions

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**Multipurpose protection**
- CVGAPC: General current and voltage protection
  - ANSI: 0-9
  - Bay control: 4-F01 4-F01 4-F01 4-F01

**General calculation**
- SMAIHPC: Multipurpose filter
  - ANSI: 0-6

1) 67 requires voltage
2) 67N requires voltage
## Control and monitoring functions

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<tr>
<th>IEC 61850</th>
<th>ANSI</th>
<th>Function description</th>
<th>Bay control</th>
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Table 2. Total number of instances for basic configurable logic blocks

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Table 3. Total number of instances for configurable logic blocks Q/T

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Table 4. Total number of instances for extended logic package

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## Communication

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<tr>
<td>ACTIVLOG</td>
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<td>Activity logging parameters</td>
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<td>ALTRK</td>
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<td>Service Tracking</td>
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<tr>
<td>SINGLELCCH</td>
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<td>Single ethernet port link status</td>
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<tr>
<td>PRPSTATUS</td>
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<td>Dual ethernet port link status</td>
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<td>PRP</td>
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<td>IEC 62439-3 parallel redundancy protocol</td>
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<tr>
<td>Remote communication</td>
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<tr>
<td>Transmission of analog data from LDCM</td>
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<tr>
<td>Scheme communication</td>
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<tr>
<td>ZCPSCH</td>
<td>85</td>
<td>Scheme communication logic for distance or overcurrent protection</td>
<td>0-1</td>
</tr>
<tr>
<td>ZCRWPSCH</td>
<td>85</td>
<td>Current reversal and weak-end infeed logic for distance protection</td>
<td>0-1</td>
</tr>
<tr>
<td>IEC 61850</td>
<td>ANSI</td>
<td>Function description</td>
<td>Bay control</td>
</tr>
<tr>
<td>-----------</td>
<td>------</td>
<td>---------------------------------------------------------------------------------------</td>
<td>-------------------------------</td>
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<td>REC670 (Customized)</td>
<td>REC670 (A30)</td>
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<td>REC670 (A31)</td>
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<td>REC670 (B30)</td>
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<td>REC670 (C30)</td>
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<tr>
<td><strong>ZCLCP SCH</strong></td>
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<td>Local acceleration logic</td>
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<tr>
<td><strong>ECP SCH</strong></td>
<td>85</td>
<td>Scheme communication logic for residual overcurrent protection</td>
<td>0-1</td>
</tr>
<tr>
<td><strong>ECRWP SCH</strong></td>
<td>85</td>
<td>Current reversal and weak-end infeed logic for residual overcurrent protection</td>
<td>0-1</td>
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1) Only included for 9-2LE products
## Basic IED functions

Table 5. Basic IED functions

<table>
<thead>
<tr>
<th>IEC 61850 or function name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERRSIG</td>
<td>Self supervision with internal event list</td>
</tr>
<tr>
<td>SELFSUPEVLST</td>
<td>Time synchronization module</td>
</tr>
<tr>
<td>TIMESYNCHGEN</td>
<td>Time synchronization</td>
</tr>
<tr>
<td>BININPUT, SYNCHCAN, SYNCHGPS, SYNCHCMPPS, SYNCHLON, SYNCHPPH, SYNCHPPS, SNOT, SYNCHSPA</td>
<td>Time synchronization</td>
</tr>
<tr>
<td>TIMEZONE</td>
<td>Time synchronization</td>
</tr>
<tr>
<td>DSTBEGIN, DSTENABLE, DSTEND</td>
<td>GPS time synchronization module</td>
</tr>
<tr>
<td>IRIG-B</td>
<td>Time synchronization</td>
</tr>
<tr>
<td>SETGRPS</td>
<td>Number of setting groups</td>
</tr>
<tr>
<td>ACTVGRP</td>
<td>Parameter setting groups</td>
</tr>
<tr>
<td>TESTMODE</td>
<td>Test mode functionality</td>
</tr>
<tr>
<td>CHNGLCK</td>
<td>Change lock function</td>
</tr>
<tr>
<td>SMBI</td>
<td>Signal matrix for binary inputs</td>
</tr>
<tr>
<td>SMBO</td>
<td>Signal matrix for binary outputs</td>
</tr>
<tr>
<td>SMMI</td>
<td>Signal matrix for mA inputs</td>
</tr>
<tr>
<td>SMAI1 - SMAI2</td>
<td>Signal matrix for analog inputs</td>
</tr>
<tr>
<td>3PHSUM</td>
<td>Summation block 3 phase</td>
</tr>
<tr>
<td>ATHSTAT</td>
<td>Authority status</td>
</tr>
<tr>
<td>ATHCHCK</td>
<td>Authority check</td>
</tr>
<tr>
<td>AUTHMAN</td>
<td>Authority management</td>
</tr>
<tr>
<td>FTPACCS</td>
<td>FTP access with password</td>
</tr>
<tr>
<td>SPACOMMMAP</td>
<td>SPA communication mapping</td>
</tr>
<tr>
<td>SPATD</td>
<td>Date and time via SPA protocol</td>
</tr>
<tr>
<td>DOSFRNT</td>
<td>Denial of service, frame rate control for front port</td>
</tr>
<tr>
<td>DOSLANAB</td>
<td>Denial of service, frame rate control for OEM port AB</td>
</tr>
<tr>
<td>DOSLANCD</td>
<td>Denial of service, frame rate control for OEM port CD</td>
</tr>
<tr>
<td>DOSSCKT</td>
<td>Denial of service, socket flow control</td>
</tr>
<tr>
<td>GBASVAL</td>
<td>Global base values for settings</td>
</tr>
<tr>
<td>PRIMVAL</td>
<td>Primary system values</td>
</tr>
<tr>
<td>ALTMS</td>
<td>Time master supervision</td>
</tr>
<tr>
<td>ALTIM</td>
<td>Time management</td>
</tr>
<tr>
<td>MSTSER</td>
<td>DNP3.0 for serial communication protocol</td>
</tr>
<tr>
<td>PRODINF</td>
<td>Product information</td>
</tr>
</tbody>
</table>
3. Control

Synchrocheck, energizing check, and synchronizing SESRSYN

The Synchronizing function allows closing of asynchronous networks at the correct moment including the breaker closing time, which improves the network stability.

Synchrocheck, energizing check, and synchronizing SESRSYN function checks that the voltages on both sides of the circuit breaker are in synchronism, or with at least one side dead to ensure that closing can be done safely.

SESRSYN function includes a built-in voltage selection scheme for double bus and 1½ breaker or ring busbar arrangements.

Manual closing as well as automatic reclosing can be checked by the function and can have different settings.

For systems, which are running asynchronous, a synchronizing function is provided. The main purpose of the synchronizing function is to provide controlled closing of circuit breakers when two asynchronous systems are going to be connected. The synchronizing function evaluates voltage difference, phase angle difference, slip frequency and frequency rate of change before issuing a controlled closing of the circuit breaker. Breaker closing time is a parameter setting.

Autorecloser SMBRREC

The autorecloser SMBRREC function provides high-speed and/or delayed auto-reclosing for single or multi-breaker applications.

Up to five three-phase reclosing attempts can be included by parameter setting. The first attempt can be single-, two and/or three phase for single phase or multi-phase faults respectively.

Multiple autoreclosing functions are provided for multi-breaker arrangements. A priority circuit allows one

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Table 5. Basic IED functions, continued

<table>
<thead>
<tr>
<th>IEC 61850 or function name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RUNTIME</td>
<td>IED Runtime Comp</td>
</tr>
<tr>
<td>CAMCONFIG</td>
<td>Central account management configuration</td>
</tr>
<tr>
<td>CAMSTATUS</td>
<td>Central account management status</td>
</tr>
<tr>
<td>TOOLINF</td>
<td>Tools Information component</td>
</tr>
<tr>
<td>SAFEFILECOPY</td>
<td>Safe file copy function</td>
</tr>
</tbody>
</table>

Table 6. Local HMI functions

<table>
<thead>
<tr>
<th>IEC 61850 or function name</th>
<th>ANSI</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LHMICTRL</td>
<td></td>
<td>Local HMI signals</td>
</tr>
<tr>
<td>LANGUAGE</td>
<td></td>
<td>Local human machine language</td>
</tr>
<tr>
<td>SCREEN</td>
<td></td>
<td>Local HMI Local human machine screen behavior</td>
</tr>
<tr>
<td>FNKEYTY1–FNKEYTY5</td>
<td></td>
<td>Parameter setting function for HMI in PCM600</td>
</tr>
<tr>
<td>FNKEYMD1–FNKEYMD5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LEDGEN</td>
<td></td>
<td>General LED indication part for LHMI</td>
</tr>
<tr>
<td>OPENCLOSE_LED</td>
<td></td>
<td>LHMI LEDs for open and close keys</td>
</tr>
<tr>
<td>GRP1_LED1–GRP1_LED15</td>
<td></td>
<td>Basic part for CP HW LED indication module</td>
</tr>
<tr>
<td>GRP2_LED1–GRP2_LED15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRP3_LED1–GRP3_LED15</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For systems, which are running asynchronous, a synchronizing function is provided. The main purpose of the synchronizing function is to provide controlled closing of circuit breakers when two asynchronous systems are going to be connected. The synchronizing function evaluates voltage difference, phase angle difference, slip frequency and frequency rate of change before issuing a controlled closing of the circuit breaker. Breaker closing time is a parameter setting.

Autorecloser SMBRREC

The autorecloser SMBRREC function provides high-speed and/or delayed auto-reclosing for single or multi-breaker applications.

Up to five three-phase reclosing attempts can be included by parameter setting. The first attempt can be single-, two and/or three phase for single phase or multi-phase faults respectively.

Multiple autoreclosing functions are provided for multi-breaker arrangements. A priority circuit allows one
circuit breaker to close first and the second will only close if the fault proved to be transient.

Each autoreclosing function is configured to co-operate with the synchrocheck function.

The autoreclosing function provides high-speed and/or delayed three pole autoreclosing.

**Apparatus control APC**

The apparatus control functions are used for control and supervision of circuit breakers, disconnectors and earthing switches within a bay. Permission to operate is given after evaluation of conditions from other functions such as interlocking, synchrocheck, operator place selection and external or internal blockings.

Apparatus control features:
- Select-Execute principle to give high reliability
- Selection function to prevent simultaneous operation
- Selection and supervision of operator place
- Command supervision
- Block/deblock of operation
- Block/deblock of updating of position indications
- Substitution of position and quality indications
- Overriding of interlocking functions
- Overriding of synchrocheck
- Operation counter
- Suppression of mid position

Two types of command models can be used:
- Direct with normal security
- SBO (Select-Before-Operate) with enhanced security

Normal security means that only the command is evaluated and the resulting position is not supervised. Enhanced security means that the command is evaluated with an additional supervision of the status value of the control object. The command sequence with enhanced security is always terminated by a CommandTermination service primitive and an AddCause telling if the command was successful or if something went wrong.

Control operation can be performed from the local HMI with authority control if so defined.

Features of the apparatus control function are:
- Operation of primary apparatuses
- Select-Execute principle to give high reliability
- Selection and reservation function to prevent simultaneous operation
- Selection and supervision of operator place
- Command supervision
- Block/deblock of operation
- Block/deblock of updating of position indications
- Substitution of position indications
- Overriding of interlocking functions
- Overriding of synchrocheck
- Pole discordance supervision
- Operation counter

The apparatus control function is realized by means of a number of function blocks designated:
- Bay control QCBA
- Switch controller SCSWI
- Circuit breaker SXCBR
- Circuit switch SXSWI

The three latter functions are logical nodes according to IEC 61850-8-1. To realize the reservation function also the function blocks Reservation input (RESIN) and Bay reserve (QCRSV) are included in the apparatus control function.

**Interlocking**

The interlocking function blocks the possibility to operate primary switching devices, for instance when a disconnector is under load, in order to prevent material damage and/or accidental human injury.

Each apparatus control function has interlocking modules included for different switchyard arrangements, where each function handles interlocking of one bay. The interlocking function is distributed to each IED and is not dependent on any central function. For the station-wide interlocking, the IEDs communicate via the system-wide interbay bus (IEC 61850-8-1) or by using hard wired binary inputs/outputs. The interlocking conditions depend on the circuit configuration and apparatus position status at any given time.

For easy and safe implementation of the interlocking function, the IED is delivered with standardized and tested software interlocking modules containing logic for the interlocking conditions. The interlocking conditions can be altered, to meet the customer’s specific requirements, by adding configurable logic by means of the graphical configuration tool.

The following interlocking modules are available:
- Line for double and transfer busbars, ABC_LINE
- Bus coupler for double and transfer busbars, ABC_BC
- Transformer bay for double busbars, AB_TRAFO
- Bus-section breaker for double busbars, A1A2_BS
- Bus-section disconnector for double busbars, A1A2_DC
- Busbar earthing switch, BB_ES
- Double CB Bay, DB_BUS_A, DB_LINE, DB_BUS_B
- 1 1/2-CB diameter, BH_LINE_A, BH_CONN, BH_LINE_B
Switch controller SCSWI
The Switch controller (SCSWI) initializes and supervises all functions to properly select and operate switching primary apparatuses. The Switch controller may handle and operate on one three-phase device or up to three one-phase devices.

Circuit breaker SXCBR
The purpose of Circuit breaker (SXCBR) is to provide the actual status of positions and to perform the control operations, that is, pass all the commands to primary apparatuses in the form of circuit breakers via binary output boards and to supervise the switching operation and position.

Circuit switch SXSWI
The purpose of Circuit switch (SXSWI) function is to provide the actual status of positions and to perform the control operations, that is, pass all the commands to primary apparatuses in the form of disconnectors or earthing switches via binary output boards and to supervise the switching operation and position.

Reservation function QCRSV
The purpose of the reservation function is primarily to transfer interlocking information between IEDs in a safe way and to prevent double operation in a bay, switchyard part, or complete substation.

Reservation input RESIN
The Reservation input (RESIN) function receives the reservation information from other bays. The number of instances is the same as the number of involved bays (up to 60 instances are available).

Bay control QCBAY
The Bay control QCBAY function is used together with Local remote and local remote control functions to handle the selection of the operator place per bay. QCBAY also provides blocking functions that can be distributed to different apparatuses within the bay.

Local remote LOCREM/Local remote control LOCREMCTRL
The signals from the local HMI or from an external local/remote switch are connected via the function blocks LOCREM and LOCREMCTRL to the Bay control QCBAY function block. The parameter ControlMode in function block LOCREM is set to choose if the switch signals are coming from the local HMI or from an external hardware switch connected via binary inputs.

Voltage control TRIATCC, TR8ATCC, TCMYLTC and TCLYLTC
The voltage control functions, Automatic voltage control for tap changer, single control TRIATCC, Automatic voltage control for tap changer, parallel control TR8ATCC and Tap changer control and supervision, 6 binary inputs TCMYLTC as well as Tap changer control and supervision, 32 binary inputs TCLYLTC are used for control of power transformers with a on-load tap changer. The functions provide automatic regulation of the voltage on the secondary side of transformers or alternatively on a load point further out in the network.

Control of a single transformer, as well as control of up to eight transformers in parallel is possible. For parallel control of power transformers, three alternative methods are available, the master-follower method, the circulating current method and the reverse reactance method. The first two methods require exchange of information between the parallel transformers and this is provided for within IEC 61850-8-1.

Voltage control includes many extra features such as possibility of to avoid simultaneous tapping of parallel transformers, hot stand by regulation of a transformer in a group which regulates it to a correct tap position even though the LV CB is open, compensation for a possible capacitor bank on the LV side bay of a transformer, extensive tap changer monitoring including contact wear and hunting detection, monitoring of the power flow in the transformer so that for example, the voltage control can be blocked if the power reverses etc.

Logic rotating switch for function selection and LHMI presentation SLGAPC
The logic rotating switch for function selection and LHMI presentation SLGAPC (or the selector switch function block) is used to get an enhanced selector switch functionality compared to the one provided by a hardware selector switch. Hardware selector switches are used extensively by utilities, in order to have different functions operating on pre-set values. Hardware switches are however sources for maintenance issues, lower system reliability and an extended purchase portfolio. The selector switch function eliminates all these problems.

Selector mini switch VSGAPC
The Selector mini switch VSGAPC function block is a multipurpose function used for a variety of applications, as a general purpose switch.

VSGAPC can be controlled from the menu or from a symbol on the single line diagram (SLD) on the local HMI.

Generic communication function for Double Point indication DPGAPC
Generic communication function for Double Point indication (DPGAPC) function block is used to send double point position indications to other systems, equipment or functions in the substation through IEC 61850-8-1 or other communication protocols. It is especially intended to be used in the interlocking station-wide logics.
Single point generic control 8 signals SPC8GAPC
The Single point generic control 8 signals SPC8GAPC function block is a collection of 8 single point commands, designed to bring in commands from REMOTE (SCADA) to those parts of the logic configuration that do not need extensive command receiving functionality (for example, SCSWI). In this way, simple commands can be sent directly to the IED outputs, without confirmation. Confirmation (status) of the result of the commands is supposed to be achieved by other means, such as binary inputs and SPGAPC function blocks. The commands can be pulsed or steady with a settable pulse time.

AutomationBits, command function for DNP3.0
AUTOBITS
AutomationBits function for DNP3 (AUTOBITS) is used within PCM600 to get into the configuration of the commands coming through the DNP3 protocol. The AUTOBITS function plays the same role as functions GOOSEBINRCV (for IEC 61850) and MULTICMDRCV (for LON).

Single command, 16 signals
The IEDs can receive commands either from a substation automation system or from the local HMI. The command function block has outputs that can be used, for example, to control high voltage apparatuses or for other user defined functionality.

4. Differential protection

High impedance differential protection, single phase HZPDIF
High impedance differential protection, single phase (HZPDIF) functions can be used when the involved CT cores have the same turns ratio and similar magnetizing characteristics. It utilizes an external CT secondary current summation by wiring. Actually all CT secondary circuits which are involved in the differential scheme are connected in parallel. External series resistor, and a voltage dependent resistor which are both mounted externally to the IED, are also required.

The external resistor unit shall be ordered under IED accessories in the Product Guide.

HZPDIF can be used to protect tee-feeders or busbars, reactors, motors, auto-transformers, capacitor banks and so on. One such function block is used for a high-impedance restricted earth fault protection. Three such function blocks are used to form three-phase, phase-segregated differential protection.

5. Current protection

Instantaneous phase overcurrent protection PHPIOC
The instantaneous three phase overcurrent function has a low transient overreach and short tripping time to allow use as a high set short-circuit protection function.

Four-step phase overcurrent protection OC4PTOC
The four step three-phase overcurrent protection function OC4PTOC has an inverse or definite time delay independent for step 1 to 4 separately.

All IEC and ANSI inverse time characteristics are available together with an optional user defined time characteristic.

The directional function needs voltage as it is voltage polarized with memory. The function can be set to be directional or non-directional independently for each of the steps.

A second harmonic blocking level can be set for the function and can be used to block each step individually.

Instantaneous residual overcurrent protection EFPIOC
The Instantaneous residual overcurrent protection EFPIOC has a low transient overreach and short tripping times to allow the use for instantaneous earth-fault protection, with the reach limited to less than the typical eighty percent of the line at minimum source impedance. EFPIOC is configured to measure the residual current from the three-phase current inputs and can be configured to measure the current from a separate current input.

Four step residual overcurrent protection, zero sequence and negative sequence direction EF4PTOC
The four step residual overcurrent protection EF4PTOC has an inverse or definite time delay independent for each step.

All IEC and ANSI time-delayed characteristics are available together with an optional user defined characteristic.

EF4PTOC can be set directional or non-directional independently for each of the steps.

IDir, UPol and IPol can be independently selected to be either zero sequence or negative sequence.

Second harmonic blocking can be set individually for each step.

EF4PTOC can be used as main protection for phase-to-earth faults.
EF4PTOC can also be used to provide a system back-up for example, in the case of the primary protection being out of service due to communication or voltage transformer circuit failure.

Directional operation can be combined together with corresponding communication logic in permissive or blocking teleprotection scheme. Current reversal and weak-end infeed functionality are available as well.

Residual current can be calculated by summing the three phase currents or taking the input from neutral CT

**Four step negative sequence overcurrent protection NS4PTOC**

Four step negative sequence overcurrent protection (NS4PTOC) has an inverse or definite time delay independent for each step separately.

All IEC and ANSI time delayed characteristics are available together with an optional user defined characteristic.

The directional function is voltage polarized.

NS4PTOC can be set directional or non-directional independently for each of the steps.

NS4PTOC can also be used as main protection for unsymmetrical fault; phase-phase short circuits, phase-phase-earth short circuits and single phase earth faults.

NS4PTOC can also be used to provide a system backup for example, in the case of the primary protection being out of service due to communication or voltage transformer circuit failure.

Directional operation can be combined together with corresponding communication logic in permissive or blocking teleprotection scheme. The same logic as for directional zero sequence current can be used. Current reversal and weak-end infeed functionality are available.

**Sensitive directional residual overcurrent and power protection SDEPSDE**

In isolated networks or in networks with high impedance earthing, the earth fault current is significantly smaller than the short circuit currents. In addition to this, the magnitude of the fault current is almost independent on the fault location in the network. The protection can be selected to use either the residual current or residual power component $3U0\cdot3I0\cdot\cos\phi$, for operating quantity with maintained short circuit capacity. There is also available one nondirectional 3I0 step and one 3U0 overvoltage tripping step.

No specific sensitive current input is needed. SDEPSDE can be set as low 0.25% of IBase.

**Thermal overload protection, one time constant LCPTTR/LFPTTR**

The increasing utilization of the power system closer to the thermal limits has generated a need of a thermal overload protection for power lines.

A thermal overload will often not be detected by other protection functions and the introduction of the thermal overload protection can allow the protected circuit to operate closer to the thermal limits.

The three-phase current measuring protection has an $i^2t$ characteristic with settable time constant and a thermal memory. The temperature is displayed in either Celsius or Fahrenheit, depending on whether the function used is LCPTTR (Celsius) or LFPTTR (Fahrenheit).

An alarm level gives early warning to allow operators to take action well before the line is tripped.

Estimated time to trip before operation, and estimated time to reclose after operation are presented.

**Thermal overload protection, two time constant TRPTTR**

If a power transformer reaches very high temperatures the equipment might be damaged. The insulation within the transformer will experience forced ageing. As a consequence of this the risk of internal phase-to-phase or phase-to-earth faults will increase.

The thermal overload protection estimates the internal heat content of the transformer (temperature) continuously. This estimation is made by using a thermal model of the transformer with two time constants, which is based on current measurement.

Two warning levels are available. This enables actions in the power system to be done before dangerous temperatures are reached. If the temperature continues to increase to the trip value, the protection initiates a trip of the protected transformer.

The estimated time to trip before operation is presented.

**Breaker failure protection CCRBRF**

Breaker failure protection (CCBRBF) ensures a fast backup tripping of the surrounding breakers in case the own breaker fails to open. CCRBRF can be current-based, contact-based or an adaptive combination of these two conditions.

A current check with extremely short reset time is used as check criterion to achieve high security against inadvertent operation.

Contact check criteria can be used where the fault current through the breaker is small.
CCRBRF can be single- or three-phase initiated to allow use with single phase tripping applications. For the three-phase version of CCRBRF the current criteria can be set to operate only if two out of four for example, two phases or one phase plus the residual current start. This gives a higher security to the back-up trip command.

CCRBRF function can be programmed to give a single- or three-phase re-trip of its own breaker to avoid unnecessary tripping of surrounding breakers at an incorrect initiation due to mistakes during testing.

**Stub protection STBPTOC**

When a power line is taken out of service for maintenance and the line disconnector is opened in multi-breaker arrangements the voltage transformers will mostly be outside on the disconnected part. The primary line distance protection will thus not be able to operate and must be blocked.

The stub protection STBPTOC covers the zone between the current transformers and the open disconnector. The three-phase instantaneous overcurrent function is released from a normally open, NO (b) auxiliary contact on the line disconnector.

**Pole discordance protection CCPDSC**

An open phase can cause negative and zero sequence currents which cause thermal stress on rotating machines and can cause unwanted operation of zero sequence or negative sequence current functions.

Normally the own breaker is tripped to correct such a situation. If the situation persists the surrounding breakers should be tripped to clear the unsymmetrical load situation.

The Pole discordance protection function CCPDSC operates based on information from auxiliary contacts of the circuit breaker for the three phases with additional criteria from unsymmetrical phase currents when required.

**Directional over/underpower protection GOPPDOP/GUPPDUP**

The directional over-/under-power protection GOPPDOP/GUPPDUP can be used wherever a high/low active, reactive or apparent power protection or alarming is required. The functions can alternatively be used to check the direction of active or reactive power flow in the power system. There are a number of applications where such functionality is needed. Some of them are:

- detection of reversed active power flow
- detection of high reactive power flow

Each function has two steps with definite time delay.

**Broken conductor check BRCPTOC**

The main purpose of the function Broken conductor check (BRCPTOC) is the detection of broken conductors on protected power lines and cables (series faults). Detection can be used to give alarm only or trip the line breaker.

**Voltage-restrained time overcurrent protection VRPVOC**

Voltage-restrained time overcurrent protection (VRPVOC) function can be used as generator backup protection against short-circuits.

The overcurrent protection feature has a settable current level that can be used either with definite time or inverse time characteristic. Additionally, it can be voltage controlled/restrained.

One undervoltage step with definite time characteristic is also available within the function in order to provide functionality for overcurrent protection with undervoltage seal-in.

**Capacitor bank protection (CBPGAPC)**

Shunt Capacitor Banks (SCB) are used in a power system to provide reactive power compensation and power factor correction. They are as well used as integral parts of Static Var Compensators (SVC) or Harmonic Filters installations. Capacitor bank protection (CBPGAPC) function is specially designed to provide protection and supervision features for SCBs.

### 6. Voltage protection

**Two step undervoltage protection UV2PTUV**

Undervoltages can occur in the power system during faults or abnormal conditions. Two step undervoltage protection (UV2PTUV) function can be used to open circuit breakers to prepare for system restoration at power outages or as long-time delayed back-up to primary protection.

UV2PTUV has two voltage steps, each with inverse or definite time delay.

UV2PTUV has a high reset ratio to allow settings close to system service voltage.

**Two step overvoltage protection OV2PTOV**

Overvoltages may occur in the power system during abnormal conditions such as sudden power loss, tap changer regulating failures, and open line ends on long lines.

Two step overvoltage protection (OV2PTOV) function can be used to detect open line ends, normally then
combined with a directional reactive over-power function to supervise the system voltage. When triggered, the function will cause an alarm, switch in reactors, or switch out capacitor banks.

OV2PTOV has two voltage steps, each of them with inverse or definite time delayed.

OV2PTOV has a high reset ratio to allow settings close to system service voltage.

Two step residual overvoltage protection ROV2PTOV
Residual voltages may occur in the power system during earth faults.

Two step residual overvoltage protection ROV2PTOV function calculates the residual voltage from the three-phase voltage input transformers or measures it from a single voltage input transformer fed from an open delta or neutral point voltage transformer.

ROV2PTOV has two voltage steps, each with inverse or definite time delay.

Reset delay ensures operation for intermittent earth faults.

Voltage differential protection VDCPTOV
A voltage differential monitoring function is available. It compares the voltages from two three phase sets of voltage transformers and has one sensitive alarm step and one trip step. Alternatively, it can be used as voltage differential protection (VDCPTOV) for shunt capacitor banks.

Loss of voltage check LOVPTUV
Loss of voltage check LOVPTUV is suitable for use in networks with an automatic system restoration function. LOVPTUV issues a three-pole trip command to the circuit breaker, if all three phase voltages fall below the set value for a time longer than the set time and the circuit breaker remains closed.

The operation of LOVPTUV is supervised by the fuse failure supervision FUFSVPVC.

7. Frequency protection

Underfrequency protection SAPTUF
Underfrequency occurs as a result of a lack of generation in the network.

Underfrequency protection SAPTUF measures frequency with high accuracy, and is used for load shedding systems, remedial action schemes, gas turbine startup and so on. Separate definite time delays are provided for operate and restore.

SAPTUF is provided with undervoltage blocking.

The operation is based on positive sequence voltage measurement and requires two phase-phase or three phase-neutral voltages to be connected. For information about how to connect analog inputs, refer to Application manual/IED application/Analog inputs/ Setting guidelines

Overfrequency protection SAPTOF
Overfrequency protection function SAPTOF is applicable in all situations, where reliable detection of high fundamental power system frequency is needed.

Overfrequency occurs because of sudden load drops or shunt faults in the power network. Close to the generating plant, generator governor problems can also cause over frequency.

SAPTOF measures frequency with high accuracy, and is used mainly for generation shedding and remedial action schemes. It is also used as a frequency stage initiating load restoring. A definite time delay is provided for operate.

SAPTOF is provided with an undervoltage blocking.

The operation is based on positive sequence voltage measurement and requires two phase-phase or three phase-neutral voltages to be connected. For information about how to connect analog inputs, refer to Application manual/IED application/Analog inputs/ Setting guidelines

Rate-of-change frequency protection SAPFRC
The rate-of-change frequency protection function SAPFRC gives an early indication of a main disturbance in the system. SAPFRC measures frequency with high accuracy, and can be used for generation shedding, load shedding and remedial action schemes. SAPFRC can discriminate between a positive or negative change of frequency. A definite time delay is provided for operate.

SAPFRC is provided with an undervoltage blocking. The operation is based on positive sequence voltage measurement and requires two phase-phase or three phase-neutral voltages to be connected. For information about how to connect analog inputs, refer to Application manual/IED application/Analog inputs/ Setting guidelines.

Frequency time accumulation protection FTAQFVR
Frequency time accumulation protection FTAQFVR is based on measured system frequency and time counters. FTAQFVR for generator protection provides the START output for a particular settable frequency limit, when the system frequency falls in that settable frequency band limit and positive sequence voltage within settable voltage band limit. The START signal
triggers the individual event timer, which is the continuous time spent within the given frequency band, and the accumulation timer, which is the cumulative time spent within the given frequency band. Once the timers reach their limit, an alarm or trip signal is activated to protect the turbine against the abnormal frequency operation. This function is blocked during generator start-up or shut down conditions by monitoring the circuit breaker position and current threshold value. The function is also blocked when the system positive sequence voltage magnitude deviates from the given voltage band limit which can be enabled by EnaVoltCheck setting.

It is possible to create functionality with more than one frequency band limit by using multiple instances of the function. This can be achieved by a proper configuration based on the turbine manufacturer specification.

8. Multipurpose protection

General current and voltage protection CVGAPC
The General current and voltage protection (CVGAPC) can be utilized as a negative sequence current protection detecting unsymmetrical conditions such as open phase or unsymmetrical faults.

CVGAPC can also be used to improve phase selection for high resistive earth faults, outside the distance protection reach, for the transmission line. Three functions are used, which measures the neutral current and each of the three phase voltages. This will give an independence from load currents and this phase selection will be used in conjunction with the detection of the earth fault from the directional earth fault protection function.

Voltage-restrained time overcurrent protection VRPVOC
Voltage-restrained time overcurrent protection (VRPVOC) function can be used as generator backup protection against short-circuits.

The overcurrent protection feature has a settable current level that can be used either with definite time or inverse time characteristic. Additionally, it can be voltage controlled/restrained.

One undervoltage step with definite time characteristic is also available within the function in order to provide functionality for overcurrent protection with undervoltage seal-in.

9. Secondary system supervision

Current circuit supervision CCSSPVC
Open or short circuited current transformer cores can cause unwanted operation of many protection functions such as differential, earth-fault current and negative-sequence current functions.

Current circuit supervision (CCSSPVC) compares the residual current from a three phase set of current transformer cores with the neutral point current on a separate input taken from another set of cores on the current transformer.

A detection of a difference indicates a fault in the circuit and is used as alarm or to block protection functions expected to give inadvertent tripping.

Fuse failure supervision FUFSPVC
The aim of the fuse failure supervision function FUFSPVC is to block voltage measuring functions at failures in the secondary circuits between the voltage transformer and the IED in order to avoid inadvertent operations that otherwise might occur.

The fuse failure supervision function basically has three different detection methods, negative sequence and zero sequence based detection and an additional delta voltage and delta current detection.

The negative sequence detection algorithm is recommended for IEDs used in isolated or high-impedance earthed networks. It is based on the negative-sequence quantities.

The zero sequence detection is recommended for IEDs used in directly or low impedance earthed networks. It is based on the zero sequence measuring quantities.

The selection of different operation modes is possible by a setting parameter in order to take into account the particular earthing of the network.

A criterion based on delta current and delta voltage measurements can be added to the fuse failure supervision function in order to detect a three phase fuse failure, which in practice is more associated with voltage transformer switching during station operations.

Fuse failure supervision VDSPVC
Different protection functions within the protection IED operates on the basis of measured voltage at the relay point. Some example of protection functions are:
• Distance protection function.
• Undervoltage function.
• Energisation function and voltage check for the weak infeed logic.

These functions can operate unintentionally, if a fault occurs in the secondary circuits between voltage instrument transformers and the IED. These unintentional operations can be prevented by VDSPVC.

VDSPVC is designed to detect fuse failures or faults in voltage measurement circuit, based on phase wise comparison of voltages of main and pilot fused circuits. VDSPVC blocking output can be configured to block functions that need to be blocked in case of faults in the voltage circuit.

Multipurpose filter SMAIHPAC
The multi-purpose filter function block, SMAIHPAC, is arranged as a three-phase filter. It has very much the same user interface (e.g. inputs and outputs) as the standard pre-processing function block SMAI. However the main difference is that it can be used to extract any frequency component from the input signal. Thus it can, for example, be used to build sub-synchronous resonance protection for synchronous generator.

10. Scheme communication

Scheme communication logic with delta based blocking scheme signal transmit ZCPSCH
To achieve instantaneous fault clearance for all line faults, scheme communication logic is provided. All types of communication schemes for permissive underreaching, permissive overreaching, blocking, delta based blocking, unblocking and intertrip are available.

The built-in communication module (LDCM) can be used for scheme communication signaling when included.

Current reversal and weak-end infeed logic for distance protection ZCRWPSCH
The ZCRWPSCH function provides the current reversal and weak end infeed logic functions that supplement the standard scheme communication logic. It is not suitable for standalone use as it requires inputs from the distance protection functions and the scheme communications function included within the terminal.

On verification of a weak end infeed condition, the weak end infeed logic provides an output for sending the received teleprotection signal back to the remote sending end and other output(s) for local tripping. For terminals equipped for single- and two-pole tripping, outputs for the faulted phase(s) are provided. Undervoltage detectors are used to detect the faulted phase(s).

Local acceleration logic ZCLCPSCH
To achieve fast clearing of faults on the whole line, when no communication channel is available, local acceleration logic ZCLCPSCH can be used. This logic enables fast fault clearing and re-closing during certain conditions, but naturally, it can not fully replace a communication channel.

The logic can be controlled either by the autorecloser (zone extension) or by the loss-of-load current (loss-of-load acceleration).

Scheme communication logic for residual overcurrent protection ECPSCH
To achieve fast fault clearance of earth faults on the part of the line not covered by the instantaneous step of the residual overcurrent protection, the directional residual overcurrent protection can be supported with a logic that uses communication channels.

In the directional scheme, information of the fault current direction must be transmitted to the other line end. With directional comparison, a short operate time of the protection including a channel transmission time, can be achieved. This short operate time enables rapid autoreclosing function after the fault clearance.

The communication logic module for directional residual current protection enables blocking as well as permissive under/overreaching, and unblocking schemes. The logic can also be supported by additional logic for weak-end infeed and current reversal, included in Current reversal and weak-end infeed logic for residual overcurrent protection ECRWPSCH function.

Current reversal and weak-end infeed logic for residual overcurrent protection ECRWPSCH
The Current reversal and weak-end infeed logic for residual overcurrent protection ECRWPSCH is a supplement to Scheme communication logic for residual overcurrent protection ECPSCH.

To achieve fast fault clearing for all earth faults on the line, the directional earth fault protection function can be supported with logic that uses tele-protection channels.

This is why the IEDs have available additions to the scheme communication logic.
If parallel lines are connected to common busbars at both terminals, overreaching permissive communication schemes can trip unselectively due to fault current reversal. This unwanted tripping affects the healthy line when a fault is cleared on the other line. This lack of security can result in a total loss of interconnection between the two buses. To avoid this type of disturbance, a fault current reversal logic (transient blocking logic) can be used.

Permissive communication schemes for residual overcurrent protection can basically operate only when the protection in the remote IED can detect the fault. The detection requires a sufficient minimum residual fault current, out from this IED. The fault current can be too low due to an opened breaker or high-positive and/or zero-sequence source impedance behind this IED. To overcome these conditions, weak-end infeed (WEI) echo logic is used. The weak-end infeed echo is limited to 200 ms to avoid channel lockup.

11. Logic

Tripping logic SMPPTRC
A function block for protection tripping is always provided as basic for each circuit breaker involved in the tripping of the fault. It provides a settable pulse prolongation to ensure a trip pulse of sufficient length, as well as all functionality necessary for correct co-operation with autoreclosing functions.

The trip function block also includes a settable latch functionality for evolving faults and breaker lock-out.

Trip matrix logic TMAGAPC
The trip matrix logic TMAGAPC function is used to route trip signals and other logical output signals to different output contacts on the IED.

The trip matrix logic function has 3 output signals and these outputs can be connected to physical tripping outputs according to the specific application needs for settable pulse or steady output.

Group alarm logic function ALMCALH
The group alarm logic function ALMCALH is used to route several alarm signals to a common indication, LED and/or contact, in the IED.

Group warning logic function WRNCALH
The group warning logic function WRNCALH is used to route several warning signals to a common indication, LED and/or contact, in the IED.

Group indication logic function INDCALH
The group indication logic function INDCALH is used to route several indication signals to a common indication, LED and/or contact, in the IED.

Basic configurable logic blocks
The basic configurable logic blocks do not propagate the time stamp and quality of signals (have no suffix QT at the end of their function name). A number of logic blocks and timers are always available as basic for the user to adapt the configuration to the specific application needs. The list below shows a summary of the function blocks and their features.

- **AND** function block. Each block has four inputs and two outputs where one is inverted.
- **GATE** function block is used for whether or not a signal should be able to pass from the input to the output.
- **INVERTER** function block that inverts one input signal to the output.
- **LLD** function block. Loop delay used to delay the output signal one execution cycle.
- **OR** function block. Each block has up to six inputs and two outputs where one is inverted.
- **PULSETIMER** function block can be used, for example, for pulse extensions or limiting of operation of outputs, settable pulse time.
- **RSMEMORY** function block is a flip-flop that can reset or set an output from two inputs respectively. Each block has two outputs where one is inverted. The memory setting controls if, after a power interruption, the flip-flop resets or returns to the state it had before the power interruption. RESET input has priority.
- **SRMEMORY** function block is a flip-flop that can set or reset an output from two inputs respectively. Each block has two outputs where one is inverted. The memory setting controls if, after a power interruption, the flip-flop resets or returns to the state it had before the power interruption. The SET input has priority.
- **TIMERSET** function has pick-up and drop-out delayed outputs related to the input signal. The timer has a settable time delay.
• XOR function block. Each block has two outputs where one is inverted.

Extension logic package
The logic extension block package includes additional trip matrix logic and configurable logic blocks.

Logic rotating switch for function selection and LHMI presentation SLGAPC
The logic rotating switch for function selection and LHMI presentation SLGAPC (or the selector switch function block) is used to get an enhanced selector switch functionality compared to the one provided by a hardware selector switch. Hardware selector switches are used extensively by utilities, in order to have different functions operating on pre-set values. Hardware switches are however sources for maintenance issues, lower system reliability and an extended purchase portfolio. The selector switch function eliminates all these problems.

Selector mini switch VSGAPC
The Selector mini switch VSGAPC function block is a multipurpose function used for a variety of applications, as a general purpose switch.

Fixed signal function block
The Fixed signals function FXDSIGN generates nine pre-set (fixed) signals that can be used in the configuration of an IED, either for forcing the unused inputs in other function blocks to a certain level/value, or for creating certain logic. Boolean, integer, floating point, string types of signals are available.

One FXDSIGN function block is included in all IEDs.

Elapsed time integrator with limit transgression and overflow supervision (TEIGAPC)
The Elapsed time integrator function TEIGAPC is a function that accumulates the elapsed time when a given binary signal has been high.

The main features of TEIGAPC
• Applicable to long time integration (≤999 999.9 seconds).
• Supervision of limit transgression conditions and overflow.
• Possibility to define a warning or alarm with the resolution of 10 milliseconds.
• Retaining of the integration value.
• Possibilities for blocking and reset.
• Reporting of the integrated time.

Boolean 16 to Integer conversion B16I
Boolean 16 to integer conversion function B16I is used to transform a set of 16 binary (logical) signals into an integer.

Boolean to integer conversion with logical node representation, 16 bit BTIGAPC
Boolean to integer conversion with logical node representation, 16 bit (BTIGAPC) is used to transform a set of 16 boolean (logical) signals into an integer. The block input will freeze the output at the last value.

Integer to Boolean 16 conversion IB16
Integer to boolean 16 conversion function IB16 is used to transform an integer into a set of 16 binary (logical) signals.

Integer to Boolean 16 conversion with logic node representation ITBGAPC
Integer to boolean conversion with logical node representation function ITBGAPC is used to transform an integer which is transmitted over IEC 61850 and received by the function to 16 binary coded (logic) output signals.

ITBGAPC function can only receive remote values over IEC 61850 when the R/L (Remote/Local) push button on the front HMI, indicates that the control mode for the operator is in position R (Remote i.e. the LED adjacent to R is lit ), and the corresponding signal is connected to the input PSTO ITBGAPC function block. The input BLOCK will freeze the output at the last received value and blocks new integer values to be received and converted to binary coded outputs.

Comparator for integer inputs INTCOMP
The function gives the possibility to monitor the level of integer values in the system relative to each other or to a fixed value. It is a basic arithmetic function that can be used for monitoring, supervision, interlocking and other logics.

Comparator for real inputs REALCOMP
The function gives the possibility to monitor the level of real value signals in the system relative to each other or to a fixed value. It is a basic arithmetic function that can be used for monitoring, supervision, interlocking and other logics.

12. Monitoring

Measurements CVMMXN, CMMXU, VNMMXU, VMMXU, CMSQI, VMSQI
The measurement functions are used to get on-line information from the IED. These service values make it possible to display on-line information on the local HMI and on the Substation automation system about:
• measured voltages, currents, frequency, active, reactive and apparent power and power factor
• measured analog values from merging units
• primary phasors
• positive, negative and zero sequence currents and voltages
• mA, input currents
• pulse counters

Supervision of mA input signals
The main purpose of the function is to measure and process signals from different measuring transducers. Many devices used in process control represent various parameters such as frequency, temperature and DC battery voltage as low current values, usually in the range 4-20 mA or 0-20 mA.

Alarm limits can be set and used as triggers, e.g. to generate trip or alarm signals.

The function requires that the IED is equipped with the mA input module.

Disturbance report DRPRDRE
Complete and reliable information about disturbances in the primary and/or in the secondary system together with continuous event-logging is accomplished by the disturbance report functionality.

Disturbance report DRPRDRE, always included in the IED, acquires sampled data of all selected analog input and binary signals connected to the function block with a, maximum of 40 analog and 352 binary signals.

The Disturbance report functionality is a common name for several functions:
• Event list
• Indications
• Event recorder
• Trip value recorder
• Disturbance recorder
• Fault locator

The Disturbance report function is characterized by great flexibility regarding configuration, starting conditions, recording times, and large storage capacity.

A disturbance is defined as an activation of an input to the AnRADR or BnRBDR function blocks, which are set to trigger the disturbance recorder. All connected signals from start of pre-fault time to the end of post-fault time will be included in the recording.

Every disturbance report recording is saved in the IED in the standard Comtrade format as a reader file HDR, a configuration file CFG, and a data file DAT. The same applies to all events, which are continuously saved in a ring-buffer. The local HMI is used to get information about the recordings. The disturbance report files may be uploaded to PCM600 for further analysis using the disturbance handling tool.

Event list DRPRDRE
Continuous event-logging is useful for monitoring the system from an overview perspective and is a complement to specific disturbance recorder functions.

The event list logs all binary input signals connected to the Disturbance recorder function. The list may contain up to 1000 time-tagged events stored in a ring-buffer.

Indications DRPRDRE
To get fast, condensed and reliable information about disturbances in the primary and/or in the secondary system it is important to know, for example binary signals that have changed status during a disturbance. This information is used in the short perspective to get information via the local HMI in a straightforward way.

There are three LEDs on the local HMI (green, yellow and red), which will display status information about the IED and the Disturbance recorder function (triggered).

The Indication list function shows all selected binary input signals connected to the Disturbance recorder function that have changed status during a disturbance.

Event recorder DRPRDRE
Quick, complete and reliable information about disturbances in the primary and/or in the secondary system is vital, for example, time-tagged events logged during disturbances. This information is used for different purposes in the short term (for example corrective actions) and in the long term (for example functional analysis).

The event recorder logs all selected binary input signals connected to the Disturbance recorder function. Each recording can contain up to 150 time-tagged events.

The event recorder information is available for the disturbances locally in the IED.

The event recording information is an integrated part of the disturbance record (Comtrade file).

Trip value recorder DRPRDRE
Information about the pre-fault and fault values for currents and voltages are vital for the disturbance evaluation.

The Trip value recorder calculates the values of all selected analog input signals connected to the Disturbance recorder function. The result is magnitude and phase angle before and during the fault for each analog input signal.
The trip value recorder information is available for the disturbances locally in the IED.

The trip value recorder information is an integrated part of the disturbance record (Comtrade file).

**Disturbance recorder DRPRDRE**
The Disturbance recorder function supplies fast, complete and reliable information about disturbances in the power system. It facilitates understanding system behavior and related primary and secondary equipment during and after a disturbance. Recorded information is used for different purposes in the short perspective (for example corrective actions) and long perspective (for example functional analysis).

The Disturbance recorder acquires sampled data from selected analog- and binary signals connected to the Disturbance recorder function (maximum 40 analog and binary signals). The binary signals available are the same as for the event recorder function.

The function is characterized by great flexibility and is not dependent on the operation of protection functions. It can record disturbances not detected by protection functions. Up to ten seconds of data before the trigger instant can be saved in the disturbance file.

The disturbance recorder information for up to 100 disturbances are saved in the IED and the local HMI is used to view the list of recordings.

**Event function**
When using a Substation Automation system with LON or SPA communication, time-tagged events can be sent at change or cyclically from the IED to the station level. These events are created from any available signal in the IED that is connected to the Event function (EVENT). The event function block is used for LON and SPA communication.

Analog and double indication values are also transferred through EVENT function.

**Generic communication function for Single Point indication SPGAPC**
Generic communication function for Single Point indication SPGAPC is used to send one single logical signal to other systems or equipment in the substation.

**Generic communication function for Measured Value MVGAPC**
Generic communication function for Measured Value MVGAPC function is used to send the instantaneous value of an analog signal to other systems or equipment in the substation. It can also be used inside the same IED, to attach a RANGE aspect to an analog value and to permit measurement supervision on that value.

**Measured value expander block RANGE_XP**
The current and voltage measurements functions (CVMMXN, CMMXU, VMMXU and VNMMXU), current and voltage sequence measurement functions (CMSQI and VMSQI) and IEC 61850 generic communication I/O functions (MVGAPC) are provided with measurement supervision functionality. All measured values can be supervised with four settable limits: low-low limit, low limit, high limit and high-high limit. The measure value expander block (RANGE_XP) has been introduced to enable translating the integer output signal from the measuring functions to 5 binary signals: below low-low limit, below low limit, normal, above high limit or above high-high limit. The output signals can be used as conditions in the configurable logic or for alarming purpose.

**Gas medium supervision SSIMG**
Gas medium supervision SSIMG is used for monitoring the circuit breaker condition. Binary information based on the gas pressure in the circuit breaker can be used as input signals to the function. In addition, the function generates alarms based on received information.

**Liquid medium supervision SSIML**
Liquid medium supervision SSIML is used for monitoring the circuit breaker condition. Binary information based on the oil level in the circuit breaker is used as input signals to the function. In addition, the function generates alarms based on received information.

**Breaker monitoring SSCBR**
The breaker monitoring function SSCBR is used to monitor different parameters of the breaker condition. The breaker requires maintenance when the number of operations reaches a predefined value. For a proper functioning of the circuit breaker, it is essential to monitor the circuit breaker operation, spring charge indication or breaker wear, travel time, number of operation cycles and estimate the accumulated energy during arcing periods.

**Fault locator LMBRFLO**
The accurate fault locator is an essential component to minimize the outages after a persistent fault and/or to pin-point a weak spot on the line.

The fault locator is an impedance measuring function giving the distance to the fault in km, miles or % of line length. The main advantage is the high accuracy achieved by compensating for load current and for the mutual zero-sequence effect on double circuit lines.

The compensation includes setting of the remote and local sources and calculation of the distribution of fault currents from each side. This distribution of fault current, together with recorded load (pre-fault)
currents, is used to exactly calculate the fault position. The fault can be recalculated with new source data at the actual fault to further increase the accuracy.

Especially on heavily loaded long lines, where the source voltage angles can be up to 35-40 degrees apart, the accuracy can be still maintained with the advanced compensation included in fault locator.

Event counter with limit supervision L4UFCNT
The 30 limit counter L4UFCNT provides a settable counter with four independent limits where the number of positive and/or negative flanks on the input signal are counted against the setting values for limits. The output for each limit is activated when the counted value reaches that limit.

Overflow indication is included for each up-counter.

Running hour-meter TEILGAPC
The Running hour-meter (TEILGAPC) function is a function that accumulates the elapsed time when a given binary signal has been high.

The main features of TEILGAPC are:

- Applicable to very long time accumulation (≤ 99999.9 hours)
- Supervision of limit transgression conditions and rollover/overflow
- Possibility to define a warning and alarm with the resolution of 0.1 hours
- Retain any saved accumulation value at a restart
- Possibilities for blocking and reset
- Possibility for manual addition of accumulated time
- Reporting of the accumulated time

13. Metering

Pulse-counter logic PCFCNT
Pulse-counter logic (PCFCNT) function counts externally generated binary pulses, for instance pulses coming from an external energy meter, for calculation of energy consumption values. The pulses are captured by the binary input module and then read by the PCFCNT function. A scaled service value is available over the station bus. The special Binary input module with enhanced pulse counting capabilities must be ordered to achieve this functionality.

Function for energy calculation and demand handling (ETPMMTR)
Measurements function block (CVMMXN) can be used to measure active as well as reactive power values. Function for energy calculation and demand handling (ETPMMTR) uses measured active and reactive power as input and calculates the accumulated active and reactive energy pulses, in forward and reverse direction. Energy values can be read or generated as pulses. Maximum demand power values are also calculated by the function. This function includes zero point clamping to remove noise from the input signal. As output of this function: periodic energy calculations, integration of energy values, calculation of energy pulses, alarm signals for limit violation of energy values and maximum power demand, can be found.

The values of active and reactive energies are calculated from the input power values by integrating them over a selected time $t_{Energy}$. The integration of active and reactive energy values will happen in both forward and reverse directions. These energy values are available as output signals and also as pulse outputs. Integration of energy values can be controlled by inputs (STARTACC and STOPACC) and $EnaAcc$ setting and it can be reset to initial values with RSTACC input.

The maximum demand for active and reactive powers are calculated for the set time interval $t_{Energy}$ and these values are updated every minute through output channels. The active and reactive maximum power demand values are calculated for both forward and reverse direction and these values can be reset with RSTDMD input.
14. Human machine interface

Local HMI

The LHMI of the IED contains the following elements:
- Graphical display capable of showing a user defined single line diagram and provide an interface for controlling switchgear.
- Navigation buttons and five user defined command buttons to shortcuts in the HMI tree or simple commands.
- 15 user defined three-color LEDs.
- Communication port for PCM600.

The LHMI is used for setting, monitoring and controlling.

15. Basic IED functions

Time synchronization

The time synchronization function is used to select a common source of absolute time for the synchronization of the IED when it is a part of a control and a protection system. This makes it possible to compare events and disturbance data between all IEDs within a station automation system and in between sub-stations.

16. Station communication

Communication protocols

Each IED is provided with a communication interface, enabling it to connect to one or many substation level systems or equipment, either on the Substation Automation (SA) bus or Substation Monitoring (SM) bus.

Available communication protocols are:
- IEC 61850-8-1 communication protocol
- IEC 61850-9-2LE communication protocol
- LON communication protocol
- SPA or IEC 60870-5-103 communication protocol
- DNP3.0 communication protocol

Several protocols can be combined in the same IED.

IEC 61850-8-1 communication protocol

IEC 61850 Ed.1 or Ed.2 can be chosen by a setting in PCM600. The IED is equipped with single or double optical Ethernet rear ports (order dependent) for IEC 61850-8-1 station bus communication. The IEC 61850-8-1 communication is also possible from the electrical Ethernet front port. IEC 61850-8-1 protocol allows intelligent electrical devices (IEDs) from different vendors to exchange information and simplifies system engineering. IED-to-IED communication using GOOSE and client-server communication over MMS are supported. Disturbance recording file (COMTRADE) uploading can be done over MMS or FTP.

IEC 61850-9-2LE communication protocol

IEC 61850-9-2LE for process bus is provided. IEC 61850-9-2LE allows Non Conventional Instrument Transformers (NCIT) with Merging Units (MU) or stand alone Merging Units to exchange information with the IED and simplifies SA engineering.

LON communication protocol

Existing stations with ABB station bus LON can be extended with use of the optical LON interface. This allows full SA functionality including peer-to-peer messaging and cooperation between the IEDs.

SPA communication protocol

A single glass or plastic port is provided for the ABB SPA protocol. This allows extensions of simple substation automation systems but the main use is for Substation Monitoring Systems SMS.

IEC 60870-5-103 communication protocol

A single glass or plastic port is provided for the IEC 60870-5-103 standard. This allows design of simple substation automation systems including equipment from different vendors. Disturbance files uploading is provided.
DNP3.0 communication protocol
An electrical RS485 and an optical Ethernet port is available for the DNP3.0 communication. DNP3.0 Level 2 communication with unsolicited events, time synchronizing and disturbance reporting is provided for communication to RTUs, Gateways or HMI systems.

Multiple command and transmit
When IEDs are used in Substation Automation systems with LON, SPA or IEC 60870-5-103 communication protocols, the Event and Multiple Command function blocks are used as the communication interface for vertical communication to station HMI and gateway, and as interface for horizontal peer-to-peer communication (over LON only).

IEC 62439-3 Parallel Redundancy Protocol
Redundant station bus communication according to IEC 62439-3 Edition 1 and IEC 62439-3 Edition 2 parallel redundancy protocol (PRP) are available as options when ordering IEDs. Redundant station bus communication according to IEC 62439-3 uses both port AB and port CD on the OEM module.

17. Remote communication

Analog and binary signal transfer to remote end
Three analog and eight binary signals can be exchanged between two IEDs. This functionality is mainly used for the line differential protection. However it can be used in other products as well. An IED can communicate with up to 4 remote IEDs.

Binary signal transfer to remote end, 192 signals
If the communication channel is used for transfer of binary signals only, up to 192 binary signals can be exchanged between two IEDs. For example, this functionality can be used to send information such as status of primary switchgear apparatus or intertripping signals to the remote IED. An IED can communicate with up to 4 remote IEDs.

Line data communication module, short and medium range LDCM
The line data communication module (LDCM) is used for communication between the IEDs situated at distances <110 km/68 miles or from the IED to optical to electrical converter with G.703 or G.703E1 interface located on a distances < 3 km/1.9 miles away. The LDCM module sends and receives data, to and from another LDCM module. The IEEE/ANSI C37.94 standard format is used.

Galvanic X.21 line data communication module X.21-LDCM
A module with built-in galvanic X.21 converter which e.g. can be connected to modems for pilot wires is also available.

Galvanic interface G.703 resp G.703E1
The external galvanic data communication converter G.703/G.703E1 makes an optical-to-galvanic conversion for connection to a multiplexer. These units are designed for 64 kbit/s resp 2Mbit/s operation. The converter is delivered with 19" rack mounting accessories.

18. Hardware description

Hardware modules

Power supply module PSM
The power supply module is used to provide the correct internal voltages and full isolation between the IED and the battery system. An internal fail alarm output is available.

Binary input module BIM
The binary input module has 16 optically isolated inputs and is available in two versions, one standard and one with enhanced pulse counting capabilities on the inputs to be used with the pulse counter function. The binary inputs are freely programmable and can be used for the input of logical signals to any of the functions. They can also be included in the disturbance recording and event-recording functions. This enables extensive monitoring and evaluation of operation of the IED and for all associated electrical circuits.

Binary output module BOM
The binary output module has 24 independent output relays and is used for trip output or any signaling purpose.

Static binary output module SOM
The static binary output module has six fast static outputs and six change over output relays for use in applications with high speed requirements.

Binary input/output module IOM
The binary input/output module is used when only a few input and output channels are needed. The ten standard output channels are used for trip output or any signaling purpose. The two high speed signal output channels are used for applications where short operating time is essential. Eight optically isolated binary inputs cater for required binary input information.

mA input module MIM
The milli-ampere input module is used to interface transducer signals in the –20 to +20 mA range from for example OLTC position, temperature or pressure
transducers. The module has six independent, galvanically separated channels.

**Optical ethernet module OEM**
The optical fast-ethernet module is used for fast and interference-free communication of synchrophasor data over IEEE C37.118 and/or IEEE 1344 protocols. It is also used to connect an IED to the communication buses (like the station bus) that use the IEC 61850-8-1 protocol (OEM rear port A, B). The process bus use the IEC 61850-9-2LE protocol (OEM rear port C, D). The module has one or two optical ports with ST connectors.

**Serial and LON communication module SLM, supports SPA/IEC 60870-5-103, LON and DNP 3.0**
The serial and LON communication module (SLM) is used for SPA, IEC 60870-5-103, DNP3 and LON communication. The module has two optical communication ports for plastic/plastic, plastic/glass or glass/glass. One port is used for serial communication (SPA, IEC 60870-5-103 and DNP3 port) and one port is dedicated for LON communication.

**Line data communication module LDCM**
Each module has one optical port, one for each remote end to which the IED communicates.

Alternative cards for Long range (1550 nm single mode), Medium range (1310 nm single mode) and Short range (850 nm multi mode) are available.

**Galvanic X.21 line data communication module X.21-LDCM**
The galvanic X.21 line data communication module is used for connection to telecommunication equipment, for example leased telephone lines. The module supports 64 kbit/s data communication between IEDs.

Examples of applications:
- Line differential protection
- Binary signal transfer

**Galvanic RS485 serial communication module**
The Galvanic RS485 communication module (RS485) is used for DNP3.0 and IEC 60870-5-103 communication. The module has one RS485 communication port. The RS485 is a balanced serial communication that can be used either in 2-wire or 4-wire connections. A 2-wire connection uses the same signal for RX and TX and is a multidrop communication with no dedicated Master or slave. This variant requires however a control of the output. The 4-wire connection has separated signals for RX and TX multidrop communication with a dedicated Master and the rest are slaves. No special control signal is needed in this case.

**GPS time synchronization module GTM**
This module includes a GPS receiver used for time synchronization. The GTM has one SMA contact for connection to an antenna. It also includes an optical PPS ST-connector output.

**IRIG-B Time synchronizing module**
The IRIG-B time synchronizing module is used for accurate time synchronization of the IED from a station clock.

The Pulse Per Second (PPS) input shall be used for synchronizing when IEC 61850-9-2LE is used.

Electrical (BNC) and optical connection (ST) for 0XX and 12X IRIG-B support.

**Transformer input module TRM**
The transformer input module is used to galvanically separate and adapt the secondary currents and voltages generated by the measuring transformers. The module has twelve inputs in different combinations of currents and voltage inputs.

Alternative connectors of Ring lug or Compression type can be ordered.

**High impedance resistor unit**
The high impedance resistor unit, with resistors for pick-up value setting and a voltage dependent resistor, is available in a single phase unit and a three phase unit. Both are mounted on a 1/1 19 inch apparatus plate with compression type terminals.

**Layout and dimensions**

Figure 6. Case with rear cover
Figure 7. Case with rear cover and 19" rack mounting kit

<table>
<thead>
<tr>
<th>Case size (mm)/(inches)</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>J</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>6U, 1/2 x 19&quot;</td>
<td>265.9/10.47</td>
<td>223.7/8.81</td>
<td>242.1/9.53</td>
<td>255.8/10.07</td>
<td>205.7/8.10</td>
<td>190.5/7.50</td>
<td>203.7/8.02</td>
<td>-</td>
<td>228.6/9.00</td>
<td>-</td>
</tr>
<tr>
<td>6U, 3/4 x 19&quot;</td>
<td>265.9/10.47</td>
<td>336.0/13.23</td>
<td>242.1/9.53</td>
<td>255.8/10.07</td>
<td>318.0/12.52</td>
<td>190.5/7.50</td>
<td>316.0/12.4</td>
<td>-</td>
<td>228.6/9.00</td>
<td>-</td>
</tr>
<tr>
<td>6U, 1/1 x 19&quot;</td>
<td>265.9/10.47</td>
<td>448.3/17.65</td>
<td>242.1/9.53</td>
<td>255.8/10.07</td>
<td>430.3/16.86</td>
<td>190.5/7.50</td>
<td>428.3/16.86</td>
<td>465.1/18.31</td>
<td>228.6/9.00</td>
<td>482.6/19.00</td>
</tr>
</tbody>
</table>

The H and K dimensions are defined by the 19" rack mounting kit.

Mounting alternatives
- 19" rack mounting kit
- Flush mounting kit with cut-out dimensions:
  - 1/2 case size (h) 254.3 mm/10.01" (w) 210.1 mm/8.27"
  - 3/4 case size (h) 254.3 mm/10.01" (w) 322.4 mm/12.69"
  - 1/1 case size (h) 254.3 mm/10.01" (w) 434.7 mm/17.11"
- Wall mounting kit

See ordering for details about available mounting alternatives.
19. Connection diagrams

Connection diagrams
The connection diagrams are delivered on the IED Connectivity package DVD as part of the product delivery.

The latest versions of the connection diagrams can be downloaded from http://www.abb.com/substationautomation.

Connection diagrams for Customized products
Connection diagram, 670 series 2.1 MRK002801-AF

Connection diagrams for Configured products
Connection diagram, REC670 2.1, A30 MRK002803-FA
Connection diagram, REC670 2.1, A31 MRK002803-FD
Connection diagram, REC670 2.1, B30 MRK002803-FB
Connection diagram, REC670 2.1, C30 MRK002803-FC

Connection diagrams for Customized products
Connection diagram, 670 series 2.1 MRK002802-AF
20. Technical data

General

<table>
<thead>
<tr>
<th>Definitions</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference value</td>
<td>The specified value of an influencing factor to which are referred the characteristics of the equipment</td>
</tr>
<tr>
<td>Nominal range</td>
<td>The range of values of an influencing quantity (factor) within which, under specified conditions, the equipment meets the specified requirements</td>
</tr>
<tr>
<td>Operative range</td>
<td>The range of values of a given energizing quantity for which the equipment, under specified conditions, is able to perform its intended functions according to the specified requirements</td>
</tr>
</tbody>
</table>

Presumptions for Technical Data
The technical data stated in this document are only valid under the following circumstances:

1. Main current transformers with 1 A or 2 A secondary rating are wired to the IED 1 A rated CT inputs.
2. Main current transformer with 5 A secondary rating are wired to the IED 5 A rated CT inputs.
3. CT and VT ratios in the IED are set in accordance with the associated main instrument transformers. Note that for functions which measure an analogue signal which do not have corresponding primary quantity the 1:1 ratio shall be set for the used analogue inputs on the IED. Example of such functions are: HZPDIF, ROTIPHIZ and STTIPHIZ.
4. Parameter IBase used by the tested function is set equal to the rated CT primary current.
5. Parameter UBase used by the tested function is set equal to the rated primary phase-to-phase voltage.
6. Parameter SBase used by the tested function is set equal to:
   \[ \sqrt{3} \times I_{\text{Base}} \times U_{\text{Base}} \]
7. The rated secondary quantities have the following values:
   - Rated secondary phase current \( I_r \) is either 1 A or 5 A depending on selected TRM.
   - Rated secondary phase-to-phase voltage \( U_r \) is within the range from 100 V to 120 V.
   - Rated secondary power for three-phase system \( S_r = \sqrt{3} \times U_r \times I_r \)
8. For operate and reset time testing, the default setting values of the function are used if not explicitly stated otherwise.
9. During testing, signals with rated frequency have been injected if not explicitly stated otherwise.

Energizing quantities, rated values and limits
### Analog inputs

Table 7. TRM - Energizing quantities, rated values and limits for protection transformer

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency</strong></td>
<td></td>
</tr>
<tr>
<td>Rated frequency $f_r$</td>
<td>50/60 Hz</td>
</tr>
<tr>
<td>Operating range</td>
<td>$f_r \pm 10%$</td>
</tr>
<tr>
<td><strong>Current inputs</strong></td>
<td></td>
</tr>
<tr>
<td>Rated current $I_r$</td>
<td>1 or 5 A</td>
</tr>
<tr>
<td>Operating range</td>
<td>$(0-100) \times I_r$</td>
</tr>
<tr>
<td>Thermal withstand</td>
<td>$100 \times I_r$ for 1 s *)</td>
</tr>
<tr>
<td></td>
<td>$30 \times I_r$ for 10 s</td>
</tr>
<tr>
<td></td>
<td>$10 \times I_r$ for 1 min</td>
</tr>
<tr>
<td></td>
<td>$4 \times I_r$ continuously</td>
</tr>
<tr>
<td>Dynamic withstand</td>
<td>$250 \times I_r$ one half wave</td>
</tr>
<tr>
<td>Burden</td>
<td>$&lt; 20 \text{ mVA at } I_r = 1 \text{ A}$</td>
</tr>
<tr>
<td></td>
<td>$&lt; 150 \text{ mVA at } I_r = 5 \text{ A}$</td>
</tr>
</tbody>
</table>

*) max. 350 A for 1 s when COMBITEST test switch is included.

<table>
<thead>
<tr>
<th>**Voltage inputs **)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage $U_r$</td>
<td>110 or 220 V</td>
</tr>
<tr>
<td>Operating range</td>
<td>$0 - 340 \text{ V}$</td>
</tr>
<tr>
<td>Thermal withstand</td>
<td>$450 \text{ V for 10 s}$</td>
</tr>
<tr>
<td></td>
<td>$420 \text{ V continuously}$</td>
</tr>
<tr>
<td>Burden</td>
<td>$&lt; 20 \text{ mVA at } 110 \text{ V}$</td>
</tr>
<tr>
<td></td>
<td>$&lt; 80 \text{ mVA at } 220 \text{ V}$</td>
</tr>
</tbody>
</table>

**) all values for individual voltage inputs

Note! All current and voltage data are specified as RMS values at rated frequency
Table 8. TRM - Energizing quantities, rated values and limits for measuring transformer

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td></td>
</tr>
<tr>
<td>Rated frequency $f_r$</td>
<td>50/60 Hz</td>
</tr>
<tr>
<td>Operating range</td>
<td>$f_r \pm 10%$</td>
</tr>
<tr>
<td>Current inputs</td>
<td></td>
</tr>
<tr>
<td>Rated current $I_r$</td>
<td>1A</td>
</tr>
<tr>
<td>Operating range</td>
<td>$(0-1.8) \times I_r$</td>
</tr>
<tr>
<td>Thermal withstand</td>
<td>$80 \times I_r$ for 1 s</td>
</tr>
<tr>
<td></td>
<td>$25 \times I_r$ for 10 s</td>
</tr>
<tr>
<td></td>
<td>$10 \times I_r$ for 1 min</td>
</tr>
<tr>
<td></td>
<td>$1.8 \times I_r$ for 30 min</td>
</tr>
<tr>
<td></td>
<td>$1.1 \times I_r$, continuously</td>
</tr>
<tr>
<td>Burden</td>
<td>$&lt; 200$ mVA at $I_r$</td>
</tr>
<tr>
<td>Voltage inputs *)</td>
<td></td>
</tr>
<tr>
<td>Rated voltage $U_r$</td>
<td>110 or 220 V</td>
</tr>
<tr>
<td>Operating range</td>
<td>0 - 340 V</td>
</tr>
<tr>
<td>Thermal withstand</td>
<td>$450$ V for 10 s</td>
</tr>
<tr>
<td></td>
<td>$420$ V continuously</td>
</tr>
<tr>
<td>Burden</td>
<td>$&lt; 20$ mVA at 110 V</td>
</tr>
<tr>
<td></td>
<td>$&lt; 80$ mVA at 220 V</td>
</tr>
</tbody>
</table>

*) all values for individual voltage inputs

Note! All current and voltage data are specified as RMS values at rated frequency

Table 9. MIM - mA input module

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Rated value:</th>
<th>Nominal range:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input resistance</td>
<td>$R_{in} = 194$ Ohm</td>
<td>-</td>
</tr>
<tr>
<td>Input range</td>
<td>$\pm 5$, $\pm 10$, $\pm 20$mA</td>
<td>-</td>
</tr>
<tr>
<td>Power consumption</td>
<td></td>
<td></td>
</tr>
<tr>
<td>each mA-board</td>
<td>$\leq 2$ W</td>
<td></td>
</tr>
<tr>
<td>each mA input</td>
<td>$\leq 0.1$ W</td>
<td></td>
</tr>
</tbody>
</table>

Table 10. OEM - Optical ethernet module

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Rated value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of channels</td>
<td>1 or 2 (port A, B for IEC 61850-8-1 / IEEE C37.118 and port C, D for IEC 61850-9-2LE / IEEE C37.118)</td>
</tr>
<tr>
<td>Standard</td>
<td>IEEE 802.3u 100BASE-FX</td>
</tr>
<tr>
<td>Type of fiber</td>
<td>62.5/125 µm multimode fiber</td>
</tr>
<tr>
<td>Wave length</td>
<td>1300 nm</td>
</tr>
<tr>
<td>Optical connector</td>
<td>Type ST</td>
</tr>
<tr>
<td>Communication speed</td>
<td>Fast Ethernet 100 Mbit/s</td>
</tr>
</tbody>
</table>
### Auxiliary DC voltage

**Table 11. PSM - Power supply module**

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Rated value</th>
<th>Nominal range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auxiliary dc voltage, EL (input)</td>
<td>EL = (24 - 60) V</td>
<td>EL ±20%</td>
</tr>
<tr>
<td></td>
<td>EL = (90 - 250) V</td>
<td>EL ±20%</td>
</tr>
<tr>
<td>Power consumption</td>
<td>50 W typically</td>
<td>-</td>
</tr>
<tr>
<td>Auxiliary DC power in-rush</td>
<td>&lt; 10 A during 0.1 s</td>
<td>-</td>
</tr>
</tbody>
</table>

### Binary inputs and outputs

**Table 12. BIM - Binary input module**

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Rated value</th>
<th>Nominal range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binary inputs</td>
<td>16</td>
<td>-</td>
</tr>
<tr>
<td>DC voltage, RL</td>
<td>24/30 V</td>
<td>RL ±20%</td>
</tr>
<tr>
<td></td>
<td>48/60 V</td>
<td>RL ±20%</td>
</tr>
<tr>
<td></td>
<td>110/125 V</td>
<td>RL ±20%</td>
</tr>
<tr>
<td></td>
<td>220/250 V</td>
<td>RL ±20%</td>
</tr>
<tr>
<td>Power consumption</td>
<td>max. 0.05 W/input</td>
<td>-</td>
</tr>
<tr>
<td>24/30 V, 50 mA</td>
<td>max. 0.1 W/input</td>
<td></td>
</tr>
<tr>
<td>48/60 V, 50 mA</td>
<td>max. 0.2 W/input</td>
<td></td>
</tr>
<tr>
<td>110/125 V, 50 mA</td>
<td>max. 0.4 W/input</td>
<td></td>
</tr>
<tr>
<td>220/250 V, 50 mA</td>
<td>max. 0.5 W/input</td>
<td></td>
</tr>
<tr>
<td>Counter input frequency</td>
<td>10 pulses/s max</td>
<td>-</td>
</tr>
<tr>
<td>Oscillating signal discriminator</td>
<td>Blocking settable 1–40 Hz</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Release settable 1–30 Hz</td>
<td></td>
</tr>
<tr>
<td>Debounce filter</td>
<td>Settable 1–20 ms</td>
<td></td>
</tr>
<tr>
<td>Binary input operate time</td>
<td>3 ms</td>
<td>-</td>
</tr>
<tr>
<td>(Debounce filter set to 0 ms)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Maximum 176 binary input channels may be activated simultaneously with influencing factors within nominal range.

The stated operate time for functions include the operating time for the binary inputs and outputs.

Table 13. BIM - Binary input module with enhanced pulse counting capabilities

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Rated value</th>
<th>Nominal range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binary inputs</td>
<td>16</td>
<td>-</td>
</tr>
<tr>
<td>DC voltage, RL</td>
<td></td>
<td>RL ±20%</td>
</tr>
<tr>
<td></td>
<td>24/30 V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>48/60 V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>110/125 V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>220/250 V</td>
<td></td>
</tr>
<tr>
<td>Power consumption</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24/30 V</td>
<td>max. 0.05 W/input</td>
<td></td>
</tr>
<tr>
<td>48/60 V</td>
<td>max. 0.1 W/input</td>
<td></td>
</tr>
<tr>
<td>110/125 V</td>
<td>max. 0.2 W/input</td>
<td></td>
</tr>
<tr>
<td>220/250 V</td>
<td>max. 0.4 W/input</td>
<td></td>
</tr>
<tr>
<td>Counter input frequency</td>
<td>10 pulses/s max</td>
<td></td>
</tr>
<tr>
<td>Balanced counter input frequency</td>
<td>40 pulses/s max</td>
<td></td>
</tr>
<tr>
<td>Oscillating signal discriminator</td>
<td>Blocking settable 1–40 Hz</td>
<td>release settable 1–30 Hz</td>
</tr>
<tr>
<td>* Debounce filter</td>
<td>Settable 1–20 ms</td>
<td></td>
</tr>
<tr>
<td>Binary input operate time (Debounce filter set to 0 ms)</td>
<td>3 ms</td>
<td>-</td>
</tr>
</tbody>
</table>

* Note: For compliance with surge immunity a debounce filter time setting of 5 ms is required.
Maximum 176 binary input channels may be activated simultaneously with influencing factors within nominal range.

The stated operate time for functions include the operating time for the binary inputs and outputs.

Table 14. IOM - Binary input/output module

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Rated value</th>
<th>Nominal range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binary inputs</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>DC voltage, RL</td>
<td>24/30 V</td>
<td>RL ±20%</td>
</tr>
<tr>
<td></td>
<td>48/60 V</td>
<td>RL ±20%</td>
</tr>
<tr>
<td></td>
<td>110/125 V</td>
<td>RL ±20%</td>
</tr>
<tr>
<td></td>
<td>220/250 V</td>
<td>RL ±20%</td>
</tr>
<tr>
<td>Power consumption</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>24/30 V, 50 mA</td>
<td>max. 0.05 W/input</td>
<td>-</td>
</tr>
<tr>
<td>48/60 V, 50 mA</td>
<td>max. 0.1 W/input</td>
<td>-</td>
</tr>
<tr>
<td>110/125 V, 50 mA</td>
<td>max. 0.2 W/input</td>
<td>-</td>
</tr>
<tr>
<td>220/250 V, 50 mA</td>
<td>max. 0.4 W/input</td>
<td>-</td>
</tr>
<tr>
<td>220/250 V, 110 mA</td>
<td>max. 0.5 W/input</td>
<td>-</td>
</tr>
<tr>
<td>Counter input frequency</td>
<td>10 pulses/s max</td>
<td>-</td>
</tr>
<tr>
<td>Oscillating signal discriminator</td>
<td>Blocking settable 1-40 Hz</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Release settable 1-30 Hz</td>
<td>-</td>
</tr>
<tr>
<td>Debounce filter</td>
<td>Settable 1-20 ms</td>
<td>-</td>
</tr>
<tr>
<td>Binary input operate time</td>
<td>3 ms</td>
<td>-</td>
</tr>
</tbody>
</table>
Maximum 176 binary input channels may be activated simultaneously with influencing factors within nominal range.

The stated operate time for functions include the operating time for the binary inputs and outputs.

Table 15. IOM - Binary input/output module contact data (reference standard: IEC 61810-2)

<table>
<thead>
<tr>
<th>Function or quantity</th>
<th>Trip and signal relays</th>
<th>Fast signal relays (parallel reed relay)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binary outputs</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Max system voltage</td>
<td>250 V AC, DC</td>
<td>250 V DC</td>
</tr>
<tr>
<td>Min load voltage</td>
<td>24VDC</td>
<td>—</td>
</tr>
<tr>
<td>Test voltage across open contact, 1 min</td>
<td>1000 V rms</td>
<td>800 V DC</td>
</tr>
<tr>
<td>Current carrying capacity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per relay, continuous</td>
<td>8 A</td>
<td>8 A</td>
</tr>
<tr>
<td>Per relay, 1 s</td>
<td>10 A</td>
<td>10 A</td>
</tr>
<tr>
<td>Per process connector pin, continuous</td>
<td>12 A</td>
<td>12 A</td>
</tr>
<tr>
<td>Making capacity at inductive load with L/R &gt; 10 ms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.2 s</td>
<td>30 A</td>
<td>0.4 A</td>
</tr>
<tr>
<td>1.0 s</td>
<td>10 A</td>
<td>0.4 A</td>
</tr>
<tr>
<td>Making capacity at resistive load</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.2 s</td>
<td>30 A</td>
<td>220–250 V/0.4 A</td>
</tr>
<tr>
<td>1.0 s</td>
<td>10 A</td>
<td>110–125 V/0.4 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>48–60 V/0.2 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24–30 V/0.1 A</td>
</tr>
<tr>
<td>Breaking capacity for AC, cos φ &gt; 0.4</td>
<td>250 V/8.0 A</td>
<td>250 V/8.0 A</td>
</tr>
<tr>
<td>Breaking capacity for DC with L/R &lt; 40 ms</td>
<td>48 V/1 A</td>
<td>48 V/1 A</td>
</tr>
<tr>
<td></td>
<td>110 V/0.4 A</td>
<td>110 V/0.4 A</td>
</tr>
<tr>
<td></td>
<td>125 V/0.35 A</td>
<td>125 V/0.35 A</td>
</tr>
<tr>
<td></td>
<td>220 V/0.2 A</td>
<td>220 V/0.2 A</td>
</tr>
<tr>
<td></td>
<td>250 V/0.15 A</td>
<td>250 V/0.15 A</td>
</tr>
<tr>
<td>Maximum capacitive load</td>
<td>-</td>
<td>10 nF</td>
</tr>
<tr>
<td>Max operations with load</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>Max operations with no load</td>
<td>10000</td>
<td></td>
</tr>
<tr>
<td>Operating time</td>
<td>&lt; 6 ms</td>
<td>&lt;= 1 ms</td>
</tr>
</tbody>
</table>
Maximum 72 outputs may be activated simultaneously with influencing factors within nominal range. After 6 ms an additional 24 outputs may be activated. The activation time for the 96 outputs must not exceed 200 ms. 48 outputs can be activated during 1 s. Continued activation is possible with respect to current consumption but after 5 minutes the temperature rise will adversely affect the hardware life. Maximum two relays per BOM/IOM/SOM should be activated continuously due to power dissipation.

The stated operate time for functions include the operating time for the binary inputs and outputs.

Table 16. IOM with MOV and IOM 220/250 V, 110mA - contact data (reference standard: IEC 61810-2)

<table>
<thead>
<tr>
<th>Function or quantity</th>
<th>Trip and Signal relays</th>
<th>Fast signal relays (parallel reed relay)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binary outputs</td>
<td>IOM: 10</td>
<td>IOM: 2</td>
</tr>
<tr>
<td>Max system voltage</td>
<td>250 V AC, DC</td>
<td>250 V DC</td>
</tr>
<tr>
<td>Min load voltage</td>
<td>24VDC</td>
<td>-</td>
</tr>
<tr>
<td>Test voltage across open contact, 1 min</td>
<td>250 V rms</td>
<td>250 V rms</td>
</tr>
<tr>
<td>Current carrying capacity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per relay, continuous</td>
<td>8 A</td>
<td>8 A</td>
</tr>
<tr>
<td>Per relay, 1 s</td>
<td>10 A</td>
<td>10 A</td>
</tr>
<tr>
<td>Per process connector pin, continuous</td>
<td>12 A</td>
<td>12 A</td>
</tr>
<tr>
<td>Making capacity at inductive load</td>
<td></td>
<td></td>
</tr>
<tr>
<td>with L/R &gt; 10 ms</td>
<td>30 A</td>
<td>0.4 A</td>
</tr>
<tr>
<td>0.2 s</td>
<td>10 A</td>
<td>0.4 A</td>
</tr>
<tr>
<td>1.0 s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Making capacity at resistive load</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.2 s</td>
<td>30 A</td>
<td>220–250 V/0.4 A</td>
</tr>
<tr>
<td>1.0 s</td>
<td>10 A</td>
<td>110–125 V/0.4 A</td>
</tr>
<tr>
<td>Breaking capacity for AC, cos ψ &gt; 0.4</td>
<td>250 V/8.0 A</td>
<td>48 V/1 A</td>
</tr>
<tr>
<td>Breaking capacity for DC with</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L/R &lt; 40 ms</td>
<td>48 V/1 A</td>
<td>48 V/1 A</td>
</tr>
<tr>
<td></td>
<td>110 V/0.4 A</td>
<td>110 V/0.4 A</td>
</tr>
<tr>
<td></td>
<td>220 V/0.2 A</td>
<td>220 V/0.2 A</td>
</tr>
<tr>
<td></td>
<td>250 V/0.15 A</td>
<td>250 V/0.15 A</td>
</tr>
<tr>
<td>Maximum capacitive load</td>
<td>-</td>
<td>10 nF</td>
</tr>
<tr>
<td>Max operations with load</td>
<td>1000</td>
<td>-</td>
</tr>
<tr>
<td>Max operations with no load</td>
<td>10000</td>
<td>-</td>
</tr>
<tr>
<td>Operating time</td>
<td>&lt; 6 ms</td>
<td>&lt;= 1 ms</td>
</tr>
</tbody>
</table>
Maximum 72 outputs may be activated simultaneously with influencing factors within nominal range. After 6 ms an additional 24 outputs may be activated. The activation time for the 96 outputs must not exceed 200 ms. 48 outputs can be activated during 1 s. Continued activation is possible with respect to current consumption but after 5 minutes the temperature rise will adversely affect the hardware life. Maximum two relays per BOM/IOM/SOM should be activated continuously due to power dissipation.

The stated operate time for functions include the operating time for the binary inputs and outputs.

Table 17. SOM - Static Output Module (reference standard: IEC 61810-2): Static binary outputs

<table>
<thead>
<tr>
<th>Function of quantity</th>
<th>Static binary output trip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage</td>
<td>48-60 VDC</td>
</tr>
<tr>
<td></td>
<td>110-250 VDC</td>
</tr>
<tr>
<td>Number of outputs</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Impedance open state</td>
<td>~300 kΩ</td>
</tr>
<tr>
<td></td>
<td>~810 kΩ</td>
</tr>
<tr>
<td>Test voltage across open contact, 1 min</td>
<td>No galvanic separation</td>
</tr>
<tr>
<td></td>
<td>No galvanic separation</td>
</tr>
<tr>
<td>Current carrying capacity:</td>
<td></td>
</tr>
<tr>
<td>Continuous</td>
<td>5 A</td>
</tr>
<tr>
<td></td>
<td>5 A</td>
</tr>
<tr>
<td>1.0 s</td>
<td>10 A</td>
</tr>
<tr>
<td></td>
<td>10 A</td>
</tr>
<tr>
<td>Making capacity at capacitive load with the maximum capacitance of 0.2 μF:</td>
<td></td>
</tr>
<tr>
<td>0.2 s</td>
<td>30 A</td>
</tr>
<tr>
<td></td>
<td>30 A</td>
</tr>
<tr>
<td>1.0 s</td>
<td>10 A</td>
</tr>
<tr>
<td></td>
<td>10 A</td>
</tr>
<tr>
<td>Breaking capacity for DC with L/R ≤ 40 ms</td>
<td>48 V/1 A</td>
</tr>
<tr>
<td></td>
<td>110 V/0.4 A</td>
</tr>
<tr>
<td></td>
<td>125 V/0.35 A</td>
</tr>
<tr>
<td></td>
<td>220 V/0.2 A</td>
</tr>
<tr>
<td></td>
<td>250 V/0.15 A</td>
</tr>
<tr>
<td>60 V/0.75 A</td>
<td></td>
</tr>
<tr>
<td>Operating time</td>
<td>&lt; 1 ms</td>
</tr>
<tr>
<td></td>
<td>&lt; 1 ms</td>
</tr>
<tr>
<td>Function of quantity</td>
<td>Trip and signal relays</td>
</tr>
<tr>
<td>-----------------------------------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Max system voltage</td>
<td>250 V AC/DC</td>
</tr>
<tr>
<td>Min load voltage</td>
<td>24VDC</td>
</tr>
<tr>
<td>Number of outputs</td>
<td>6</td>
</tr>
<tr>
<td>Test voltage across open contact, 1 min</td>
<td>1000 V rms</td>
</tr>
<tr>
<td>Current carrying capacity:</td>
<td></td>
</tr>
<tr>
<td>Continuous</td>
<td>8 A</td>
</tr>
<tr>
<td>1.0 s</td>
<td>10 A</td>
</tr>
<tr>
<td>Max operations with load</td>
<td>1000</td>
</tr>
<tr>
<td>Max operations with no load</td>
<td>10000</td>
</tr>
<tr>
<td>Making capacity at capacitive load with the maximum capacitance of 0.2 μF:</td>
<td></td>
</tr>
<tr>
<td>0.2 s</td>
<td>30 A</td>
</tr>
<tr>
<td>1.0 s</td>
<td>10 A</td>
</tr>
<tr>
<td>Breaking capacity for DC with L/R ≤ 40 ms</td>
<td></td>
</tr>
<tr>
<td>48 V/1 A</td>
<td></td>
</tr>
<tr>
<td>110 V/0.4 A</td>
<td></td>
</tr>
<tr>
<td>125 V/0.35 A</td>
<td></td>
</tr>
<tr>
<td>220 V/0.2 A</td>
<td></td>
</tr>
<tr>
<td>250 V/0.15 A</td>
<td></td>
</tr>
<tr>
<td>Operating time</td>
<td>&lt; 6 ms</td>
</tr>
</tbody>
</table>
The stated operate time for functions include the operating time for the binary inputs and outputs.

Table 19. BOM - Binary output module contact data (reference standard: IEC 61810-2)

<table>
<thead>
<tr>
<th>Function or quantity</th>
<th>Trip and Signal relays</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binary outputs</td>
<td>24</td>
</tr>
<tr>
<td>Max system voltage</td>
<td>250 V AC, DC</td>
</tr>
<tr>
<td>Min load voltage</td>
<td>24VDC</td>
</tr>
<tr>
<td>Test voltage across open contact, 1 min</td>
<td>1000 V rms</td>
</tr>
<tr>
<td>Current carrying capacity</td>
<td></td>
</tr>
<tr>
<td>Per relay, continuous</td>
<td>8 A</td>
</tr>
<tr>
<td>Per relay, 1 s</td>
<td>10 A</td>
</tr>
<tr>
<td>Per process connector pin, continuous</td>
<td>12 A</td>
</tr>
<tr>
<td>Max operations with load</td>
<td>1000</td>
</tr>
<tr>
<td>Max operations with no load</td>
<td>10000</td>
</tr>
<tr>
<td>Making capacity at inductive load with L/R &gt; 10 ms</td>
<td></td>
</tr>
<tr>
<td>0.2 s</td>
<td>30 A</td>
</tr>
<tr>
<td>1.0 s</td>
<td>10 A</td>
</tr>
<tr>
<td>Breaking capacity for AC, cos φ &gt; 0.4</td>
<td>250 V/8.0 A</td>
</tr>
<tr>
<td>Breaking capacity for DC with L/R &lt; 40 ms</td>
<td></td>
</tr>
<tr>
<td>48 V/1 A</td>
<td></td>
</tr>
<tr>
<td>110 V/0.4 A</td>
<td></td>
</tr>
<tr>
<td>125 V/0.35 A</td>
<td></td>
</tr>
<tr>
<td>220 V/0.2 A</td>
<td></td>
</tr>
<tr>
<td>250 V/0.15 A</td>
<td></td>
</tr>
<tr>
<td>Operating time</td>
<td>&lt; 6 ms</td>
</tr>
</tbody>
</table>

The stated operate time for functions include the operating time for the binary inputs and outputs.

Influencing factors

Table 20. Temperature and humidity influence

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Reference value</th>
<th>Nominal range</th>
<th>Influence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient temperature, operate value</td>
<td>+20°C</td>
<td>-25°C to +55°C</td>
<td>0.02%/°C</td>
</tr>
<tr>
<td>Relative humidity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operative range</td>
<td>10-90%</td>
<td>10-90%</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>0-95%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-</td>
<td>-40°C to +70°C</td>
<td>-</td>
</tr>
</tbody>
</table>
### Table 21. Auxiliary DC supply voltage influence on functionality during operation

<table>
<thead>
<tr>
<th>Dependence on</th>
<th>Reference value</th>
<th>Within nominal range</th>
<th>Influence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ripple, in DC auxiliary voltage</td>
<td>max. 2%</td>
<td>15% of EL</td>
<td>0.01%/%</td>
</tr>
<tr>
<td>Operative range</td>
<td>Full wave rectified</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auxiliary voltage dependence,</td>
<td>±20% of EL</td>
<td></td>
<td>0.01%/%</td>
</tr>
<tr>
<td>operate value</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interrupted auxiliary DC voltage</td>
<td>24-60 V DC ± 20%</td>
<td>100-250 V DC ±20%</td>
<td>No restart</td>
</tr>
<tr>
<td>Interruption interval</td>
<td></td>
<td></td>
<td>Correct behaviour at power down</td>
</tr>
<tr>
<td>0–50 ms</td>
<td></td>
<td></td>
<td>&lt; 300 s</td>
</tr>
<tr>
<td>Restart time</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 22. Frequency influence (reference standard: IEC 60255–1)

<table>
<thead>
<tr>
<th>Dependence on</th>
<th>Reference value</th>
<th>Influence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency dependence, operate value</td>
<td>f, ±2.5 Hz for 50 Hz</td>
<td>±1.0%/Hz</td>
</tr>
<tr>
<td></td>
<td>f, ±3.0 Hz for 60 Hz</td>
<td></td>
</tr>
<tr>
<td>Harmonic frequency dependence (20% content)</td>
<td>2nd, 3rd and 5th harmonic of f,</td>
<td>±2.0%</td>
</tr>
<tr>
<td>Harmonic frequency dependence for high impedance differential protection (10% content)</td>
<td>2nd, 3rd and 5th harmonic of f,</td>
<td>±10.0%</td>
</tr>
<tr>
<td>Harmonic frequency dependence for overcurrent protection</td>
<td>2nd, 3rd and 5th harmonic of f,</td>
<td>±3.0%</td>
</tr>
</tbody>
</table>

### Type tests according to standards
Table 23. Electromagnetic compatibility

<table>
<thead>
<tr>
<th>Test</th>
<th>Type test values</th>
<th>Reference standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 MHz burst disturbance</td>
<td>2.5 kV</td>
<td>IEC 60255-26</td>
</tr>
<tr>
<td>100 kHz slow damped oscillatory wave immunity test</td>
<td>2.5 kV</td>
<td>IEC 61000-4-18, Class III</td>
</tr>
<tr>
<td>Ring wave immunity test, 100 kHz</td>
<td>2-4 kV</td>
<td>IEC 61000-4-12, Class IV</td>
</tr>
<tr>
<td>Surge withstand capability test</td>
<td>2.5 kV, oscillatory 4.0 kV, fast transient</td>
<td>IEEE/ANSI C37.90.1</td>
</tr>
<tr>
<td>Electrostatic discharge</td>
<td>15 kV air discharge 8 kV contact discharge 8 kV contact discharge</td>
<td>IEC 60255-26</td>
</tr>
<tr>
<td>Direct application</td>
<td></td>
<td>IEC 61000-4-2, Class IV</td>
</tr>
<tr>
<td>Indirect application</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrostatic discharge</td>
<td>15 kV air discharge 8 kV contact discharge 8 kV contact discharge</td>
<td>IEEE/ANSI C37.90.1</td>
</tr>
<tr>
<td>Direct application</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indirect application</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fast transient disturbance</td>
<td>4 kV 2 kV, MIM mA-inputs</td>
<td>IEC 60255-26, Zone A  IEC 60255-26, Zone B</td>
</tr>
<tr>
<td>Surge immunity test</td>
<td>2-4 kV, 1.2/50μs high energy 1-2 kV BOM and IRF outputs</td>
<td>IEC 60255-26, Zone A  IEC 60255-26, Zone B</td>
</tr>
<tr>
<td>Power frequency immunity test</td>
<td>150-300 V, 50 Hz</td>
<td>IEC 60255-26</td>
</tr>
<tr>
<td>Conducted common mode immunity test</td>
<td>15 Hz-150 kHz</td>
<td>IEC 61000-4-16, Class IV</td>
</tr>
<tr>
<td>Power frequency magnetic field test</td>
<td>1000 A/m, 3 s 100 A/m, cont.</td>
<td>IEC 61000-4-8, Class V</td>
</tr>
<tr>
<td>Pulse magnetic field immunity test</td>
<td>1000 A/m</td>
<td>IEC 61000-4-9, Class V</td>
</tr>
<tr>
<td>Damped oscillatory magnetic field test</td>
<td>100 A/m</td>
<td>IEC 61000-4-10, Class V</td>
</tr>
<tr>
<td>Radiated electromagnetic field disturbance</td>
<td>20 V/m, 80-1000 MHz 1.4-2.7 GHz</td>
<td>IEC 60255-26</td>
</tr>
<tr>
<td>Radiated electromagnetic field disturbance</td>
<td>20 V/m 80-1000 MHz 10 V/m, 5.1-6.0 GHz</td>
<td>IEEE/ANSI C37.90.2  EN 50121-5</td>
</tr>
<tr>
<td>Conducted electromagnetic field disturbance</td>
<td>10 V, 0.15-80 MHz</td>
<td>IEC 60255-26</td>
</tr>
<tr>
<td>Radiated emission</td>
<td>30-5000 MHz</td>
<td>IEC 60255-26</td>
</tr>
<tr>
<td>Radiated emission</td>
<td>30-5000 MHz</td>
<td>IEEE/ANSI C63.4, FCC</td>
</tr>
<tr>
<td>Conducted emission</td>
<td>0.15-30 MHz</td>
<td>IEC 60255-26</td>
</tr>
</tbody>
</table>

Table 24. Insulation

<table>
<thead>
<tr>
<th>Test</th>
<th>Type test values</th>
<th>Reference standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dielectric test</td>
<td>2.0 kV AC, 1 min. 1.0 kVrms, 1 min.)</td>
<td>IEC 60255-27  ANSI C37.90</td>
</tr>
<tr>
<td>Impulse voltage test</td>
<td>5 kV, 1.2/50μs, 0.5 J 1 kV, 1.2/50 μs 0.5 J</td>
<td>IEEE 802.3-2015, Environment A</td>
</tr>
<tr>
<td>Insulation resistance</td>
<td>&gt; 100 MΩ at 500 VDC</td>
<td></td>
</tr>
</tbody>
</table>
### Table 25. Environmental tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Type test value</th>
<th>Reference standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold operation test</td>
<td>Test Ad for 16 h at -25°C</td>
<td>IEC 60068-2-1</td>
</tr>
<tr>
<td>Cold storage test</td>
<td>Test Ab for 16 h at -40°C</td>
<td>IEC 60068-2-1</td>
</tr>
<tr>
<td>Dry heat operation test</td>
<td>Test Bd for 16 h at +70°C</td>
<td>IEC 60068-2-2</td>
</tr>
<tr>
<td>Dry heat storage test</td>
<td>Test Bb for 16 h at +85°C</td>
<td>IEC 60068-2-2</td>
</tr>
<tr>
<td>Change of temperature test</td>
<td>Test Nb for 5 cycles at -25°C to +70°C</td>
<td>IEC 60068-2-14</td>
</tr>
<tr>
<td>Damp heat test, steady state</td>
<td>Test Ca for 10 days at +40°C and humidity 93%</td>
<td>IEC 60068-2-78</td>
</tr>
<tr>
<td>Damp heat test, cyclic</td>
<td>Test Db for 6 cycles at +25 to +55°C and humidity 93 to 95% (1 cycle = 24 hours)</td>
<td>IEC 60068-2-30</td>
</tr>
</tbody>
</table>

### Table 26. CE compliance

<table>
<thead>
<tr>
<th>Test</th>
<th>According to</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immunity</td>
<td>EN 60255–26</td>
</tr>
<tr>
<td>Emissivity</td>
<td>EN 60255–26</td>
</tr>
<tr>
<td>Low voltage directive</td>
<td>EN 60255–27</td>
</tr>
</tbody>
</table>

### Table 27. Mechanical tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Type test values</th>
<th>Reference standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibration response test</td>
<td>Class II</td>
<td>IEC 60255-21-1</td>
</tr>
<tr>
<td>Vibration endurance test</td>
<td>Class I</td>
<td>IEC 60255-21-1</td>
</tr>
<tr>
<td>Shock response test</td>
<td>Class I</td>
<td>IEC 60255-21-2</td>
</tr>
<tr>
<td>Shock withstand test</td>
<td>Class I</td>
<td>IEC 60255-21-2</td>
</tr>
<tr>
<td>Bump test</td>
<td>Class I</td>
<td>IEC 60255-21-2</td>
</tr>
<tr>
<td>Seismic test</td>
<td>Class II</td>
<td>IEC 60255-21-3</td>
</tr>
</tbody>
</table>
## Differential protection

Table 28. High impedance differential protection, single phase HZPDIF

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate voltage</td>
<td>(10-900) V</td>
<td>±1.0% of ( I_r ) at ( I \leq I_r ) [1]</td>
</tr>
<tr>
<td>Reset ratio</td>
<td>&gt;95% at (30-900) V</td>
<td>-</td>
</tr>
<tr>
<td>Maximum continuous power</td>
<td>( U &gt; \text{Trip}^2 / \text{SeriesResistor} \leq 200 \text{ W} )</td>
<td>-</td>
</tr>
<tr>
<td>Operate time at 0 to 10 ( U_d )</td>
<td>Min. = 5 ms</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Max. = 15 ms</td>
<td></td>
</tr>
<tr>
<td>Reset time at 10 ( U_d ) to 0</td>
<td>Min. = 75 ms</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Max. = 95 ms</td>
<td></td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>2 ms typically at 0 to 10 ( U_d )</td>
<td>-</td>
</tr>
<tr>
<td>Operate time at 0 to 2 ( U_d )</td>
<td>Min. = 25 ms</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Max. = 35 ms</td>
<td></td>
</tr>
<tr>
<td>Reset time at 2 ( U_d ) to 0</td>
<td>Min. = 50 ms</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Max. = 70 ms</td>
<td></td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>15 ms typically at 0 to 2 ( U_d )</td>
<td>-</td>
</tr>
</tbody>
</table>
## Current protection

Table 29. Instantaneous phase overcurrent protection PHPIOC

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate current</td>
<td>(5-2500)% of lBase</td>
<td>±1.0% of ( I_r ) at ( l \leq I_r )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±1.0% of ( I ) at ( I &gt; I_r )</td>
</tr>
<tr>
<td>Reset ratio</td>
<td>&gt; 95% at (50–2500)% of lBase</td>
<td>-</td>
</tr>
<tr>
<td>Operate time at 0 to 2 x ( I_{set} )</td>
<td>Min. = 15 ms</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Max. = 25 ms</td>
<td></td>
</tr>
<tr>
<td>Reset time at 2 to 0 x ( I_{set} )</td>
<td>Min. = 15 ms</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Max. = 25 ms</td>
<td></td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>10 ms typically at 0 to 2 x ( I_{set} )</td>
<td>-</td>
</tr>
<tr>
<td>Operate time at 0 to 10 x ( I_{set} )</td>
<td>Min. = 5ms</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Max. = 15ms</td>
<td></td>
</tr>
<tr>
<td>Reset time at 10 to 0 x ( I_{set} )</td>
<td>Min. = 25ms</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Max. = 40ms</td>
<td></td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>2 ms typically at 0 to 10 x ( I_{set} )</td>
<td>-</td>
</tr>
<tr>
<td>Dynamic overreach</td>
<td>&lt; 5% at ( t = 100 ) ms</td>
<td>-</td>
</tr>
</tbody>
</table>
### Table 30. Directional phase overcurrent protection, four steps OC4PTOC

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate current, step 1-4</td>
<td>(5-2500)% of /Base</td>
<td>±1.0% of /I at /I ≤ /I,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±1.0% of /I at /I &gt; /I.</td>
</tr>
<tr>
<td>Reset ratio</td>
<td>&gt; 95% at (50–2500)% of /Base</td>
<td>-</td>
</tr>
<tr>
<td>Minimum operate current, step 1-4</td>
<td>(1-10000)% of /Base</td>
<td>±1.0% of /I at /I ≤ /I,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±1.0% of /I at /I &gt; /I.</td>
</tr>
<tr>
<td>Relay characteristic angle (RCA)</td>
<td>(40.0–65.0) degrees</td>
<td>±2.0 degrees</td>
</tr>
<tr>
<td>Relay operating angle (ROA)</td>
<td>(40.0–89.0) degrees</td>
<td>±2.0 degrees</td>
</tr>
<tr>
<td>Second harmonic blocking</td>
<td>(5–100)% of fundamental</td>
<td>±2.0% of /I</td>
</tr>
<tr>
<td>Independent time delay at 0 to 2 x /I&lt;sub&gt;set&lt;/I&gt;, step 1-4</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±35 ms whichever is greater</td>
</tr>
<tr>
<td>Minimum operate time for inverse curves , step 1-4</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±35 ms whichever is greater</td>
</tr>
<tr>
<td>Inverse time characteristics, see table 142, table 143 and table 144</td>
<td>16 curve types</td>
<td>See table 142, table 143 and table 144</td>
</tr>
<tr>
<td>Operate time, start non-directional at 0 to 2 x /I&lt;sub&gt;set&lt;/I&gt;</td>
<td>Min. = 15 ms</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Max. = 30 ms</td>
<td></td>
</tr>
<tr>
<td>Reset time, start non-directional at 2 x /I&lt;sub&gt;set&lt;/I&gt; to 0</td>
<td>Min. = 15 ms</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Max. = 30 ms</td>
<td></td>
</tr>
<tr>
<td>Operate time, start non-directional at 0 to 10 x /I&lt;sub&gt;set&lt;/I&gt;</td>
<td>Min. = 5 ms</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Max. = 20 ms</td>
<td></td>
</tr>
<tr>
<td>Reset time, start non-directional at 10 x /I&lt;sub&gt;set&lt;/I&gt; to 0</td>
<td>Min. = 20 ms</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Max. = 35 ms</td>
<td></td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>10 ms typically at 0 to 2 x /I&lt;sub&gt;set&lt;/I&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Impulse margin time</td>
<td>15 ms typically</td>
<td>-</td>
</tr>
<tr>
<td>Operate frequency, directional overcurrent</td>
<td>38-83 Hz</td>
<td>-</td>
</tr>
<tr>
<td>Operate frequency, non-directional overcurrent</td>
<td>10-90 Hz</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 31. Instantaneous residual overcurrent protection EFPIOC

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate current</td>
<td>(5-2500)% of IBase</td>
<td>±1.0% of I at I ≤ I_r</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±1.0% of I at I &gt; I_r</td>
</tr>
<tr>
<td>Reset ratio</td>
<td>&gt; 95% at (50–2500)% of IBase</td>
<td>-</td>
</tr>
<tr>
<td>Operate time at 0 to 2 x (I_{set})</td>
<td>Min. = 15 ms</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Max. = 25 ms</td>
<td>-</td>
</tr>
<tr>
<td>Reset time at 2 to 0 x (I_{set})</td>
<td>Min. = 15 ms</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Max. = 25 ms</td>
<td>-</td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>10 ms typically at 0 to 2 x (I_{set})</td>
<td>-</td>
</tr>
<tr>
<td>Operate time at 0 to 10 x (I_{set})</td>
<td>Min. = 5 ms</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Max. = 15 ms</td>
<td>-</td>
</tr>
<tr>
<td>Reset time at 10 to 0 x (I_{set})</td>
<td>Min. = 25 ms</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Max. = 35 ms</td>
<td>-</td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>2 ms typically at 0 to 10 x (I_{set})</td>
<td>-</td>
</tr>
<tr>
<td>Dynamic overreach</td>
<td>&lt; 5% at (t = 100) ms</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 32. Directional residual overcurrent protection, four steps EF4PTOC

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate current, step 1-4</td>
<td>(1-2500)% of IBase</td>
<td>±1.0% of I at I ≤ I,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±1.0% of I at I &gt; I,</td>
</tr>
<tr>
<td>Reset ratio</td>
<td>&gt; 95% at (10-2500)% of IBase</td>
<td>-</td>
</tr>
<tr>
<td>Relay characteristic angle (RCA)</td>
<td>(-180 to 180) degrees</td>
<td>±2.0 degrees</td>
</tr>
<tr>
<td>Operate current for directional release</td>
<td>(1-100)% of IBase</td>
<td>For RCA ±60 degrees:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±2.5% of I at I ≤ I,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±2.5% of I at I &gt; I,</td>
</tr>
<tr>
<td>Independent time delay at 0 to 2 x Iset, step 1-4</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±35 ms whichever is greater</td>
</tr>
<tr>
<td>Minimum operate time for inverse curves, step 1-4</td>
<td>(0.000 - 60.000) s</td>
<td>±0.2% or ±35 ms whichever is greater</td>
</tr>
<tr>
<td>Inverse time characteristics, see Table 142, Table 143 and Table 144</td>
<td>16 curve types</td>
<td>See Table 142, Table 143 and Table 144</td>
</tr>
<tr>
<td>Second harmonic blocking</td>
<td>(5-100)% of fundamental</td>
<td>±2.0% of I</td>
</tr>
<tr>
<td>Minimum polarizing voltage</td>
<td>(1-100)% of UBase</td>
<td>±0.5% of U</td>
</tr>
<tr>
<td>Minimum polarizing current</td>
<td>(2-100)% of IBase</td>
<td>±1.0% of I</td>
</tr>
<tr>
<td>Real part of source Z used for current polarization</td>
<td>(0.50-1000.00) Ω/phase</td>
<td>-</td>
</tr>
<tr>
<td>Imaginary part of source Z used for current polarization</td>
<td>(0.50–3000.00) Ω/phase</td>
<td>-</td>
</tr>
<tr>
<td>*Operate time, start non-directional at 0 to 2 x Iset</td>
<td>Min. = 15 ms Max. = 30 ms</td>
<td>-</td>
</tr>
<tr>
<td>*Reset time, start non-directional at 2 x Iset to 0</td>
<td>Min. = 15 ms Max. = 30 ms</td>
<td>-</td>
</tr>
<tr>
<td>*Operate time, start non-directional at 0 to 10 x Iset</td>
<td>Min. = 5 ms Max. = 20 ms</td>
<td>-</td>
</tr>
<tr>
<td>*Reset time, start non-directional at 10 x Iset to 0</td>
<td>Min. = 20 ms Max. = 35 ms</td>
<td>-</td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>10 ms typically at 0 to 2 x Iset</td>
<td>-</td>
</tr>
<tr>
<td>Impulse margin time</td>
<td>15 ms typically</td>
<td>-</td>
</tr>
</tbody>
</table>

*Note: Operate time and reset time are only valid if harmonic blocking is turned off for a step.
Table 33. Four step negative sequence overcurrent protection NS4PTOC

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate current, step 1 - 4</td>
<td>(1-2500)% of I&lt;sub&gt;Base&lt;/sub&gt;</td>
<td>±1.0% of I&lt;sub&gt;r&lt;/sub&gt; at I ≤ I&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Reset ratio</td>
<td>&gt; 95% at (10-2500)% of I&lt;sub&gt;Base&lt;/sub&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Independent time delay at 0 (0.000-60.000) s</td>
<td></td>
<td>±0.2% or ±35 ms whichever is greater</td>
</tr>
<tr>
<td>Minimum operate time for inverse curves, step 1 - 4</td>
<td>(0.000 - 60.000) s</td>
<td>±0.2% or ±35 ms whichever is greater</td>
</tr>
<tr>
<td>Inverse time characteristics, see table 142, table 143 and table 144</td>
<td>16 curve types</td>
<td>See table 142, table 143 and table 144</td>
</tr>
<tr>
<td>Minimum operate current, step 1 - 4</td>
<td>(1.00 - 10000.00)% of I&lt;sub&gt;Base&lt;/sub&gt;</td>
<td>±1.0% of I&lt;sub&gt;r&lt;/sub&gt; at I ≤ I&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Relay characteristic angle (RCA)</td>
<td>(-180 to 180) degrees</td>
<td>±2.0 degrees</td>
</tr>
<tr>
<td>Operate current for directional release</td>
<td>(1–100)% of I&lt;sub&gt;Base&lt;/sub&gt;</td>
<td>For RCA ±60 degrees: ±2.5% of I&lt;sub&gt;r&lt;/sub&gt; at I ≤ I&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Minimum polarizing voltage</td>
<td>(1–100)% of U&lt;sub&gt;Base&lt;/sub&gt;</td>
<td>±0.5% of U&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Minimum polarizing current</td>
<td>(2–100)% of I&lt;sub&gt;Base&lt;/sub&gt;</td>
<td>±1.0% of I&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Real part of negative sequence source impedance used for current polarization</td>
<td>(0.50-1000.00) Ω/phase</td>
<td>-</td>
</tr>
<tr>
<td>Imaginary part of negative sequence source impedance used for current polarization</td>
<td>(0.50–3000.00) Ω/phase</td>
<td>-</td>
</tr>
<tr>
<td>Operate time, start non-directional at 0 to 2 x I&lt;sub&gt;set&lt;/sub&gt;</td>
<td>Min. = 15 ms Max. = 30 ms</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, start non-directional at 2 to 0 x I&lt;sub&gt;set&lt;/sub&gt;</td>
<td>Min. = 15 ms Max. = 30 ms</td>
<td>-</td>
</tr>
<tr>
<td>Operate time, start non-directional at 0 to 10 x I&lt;sub&gt;set&lt;/sub&gt;</td>
<td>Min. = 5 ms Max. = 20 ms</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, start non-directional at 10 to 0 x I&lt;sub&gt;set&lt;/sub&gt;</td>
<td>Min. = 20 ms Max. = 35 ms</td>
<td>-</td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>10 ms typically at 0 to 2 x I&lt;sub&gt;set&lt;/sub&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Impulse margin time</td>
<td>15 ms typically</td>
<td>-</td>
</tr>
<tr>
<td>Transient overreach</td>
<td>&lt;10% at τ = 100 ms</td>
<td>-</td>
</tr>
</tbody>
</table>
### Table 34. Sensitive directional residual overcurrent and power protection SDEPSDE

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate level for $3I_0 \cos \phi$ directional residual overcurrent</td>
<td>$(0.25-200.00)%$ of $I_{Base}$</td>
<td>$\pm 1.0%$ of $I_r$ at $I \leq I_r$ $\pm 1.0%$ of $I$ at $I &gt; I_r$</td>
</tr>
<tr>
<td>Operate level for $-3I_0 \cdot 3U_0 \cos \phi$ directional residual power</td>
<td>$(0.25-200.00)%$ of $S_{Base}$</td>
<td>$\pm 1.0%$ of $S_r$ at $S \leq S_r$ $\pm 1.0%$ of $S$ at $S &gt; S_r$</td>
</tr>
<tr>
<td>Operate level for $3I_0$ and $\phi$ residual overcurrent</td>
<td>$(0.25-200.00)%$ of $I_{Base}$</td>
<td>$\pm 1.0%$ of $I_r$ at $I \leq I_r$ $\pm 1.0%$ of $I$ at $I &gt; I_r$</td>
</tr>
<tr>
<td>Operate level for non-directional overcurrent</td>
<td>$(1.00-400.00)%$ of $I_{Base}$</td>
<td>$\pm 1.0%$ of $I_r$ at $I \leq I_r$ $\pm 1.0%$ of $I$ at $I &gt; I_r$</td>
</tr>
<tr>
<td>Operate level for non-directional residual overvoltage</td>
<td>$(1.00-200.00)%$ of $U_{Base}$</td>
<td>$\pm 0.5%$ of $U_r$ at $U \leq U_r$ $\pm 0.5%$ of $U$ at $U &gt; U_r$</td>
</tr>
<tr>
<td>Residual release current for all directional modes</td>
<td>$(0.25-200.00)%$ of $I_{Base}$</td>
<td>$\pm 1.0%$ of $I_r$ at $I \leq I_r$ $\pm 1.0%$ of $I$ at $I &gt; I_r$</td>
</tr>
<tr>
<td>Residual release voltage for all directional modes</td>
<td>$(1.00-300.00)%$ of $U_{Base}$</td>
<td>$\pm 0.5%$ of $U_r$ at $U \leq U_r$ $\pm 0.5%$ of $U$ at $U &gt; U_r$</td>
</tr>
<tr>
<td>Operate time for non-directional residual overcurrent at 0 to 2 x Iset</td>
<td>Min. = 40 ms Max. = 65 ms</td>
<td></td>
</tr>
<tr>
<td>Reset time for non-directional residual overcurrent at 2 to 0 x Iset</td>
<td>Min. = 40 ms Max. = 65 ms</td>
<td></td>
</tr>
<tr>
<td>Operate time for directional residual overcurrent at 0 to 2 x Iset</td>
<td>Min. = 110 ms Max. = 160 ms</td>
<td></td>
</tr>
<tr>
<td>Reset time for directional residual overcurrent at 2 to 0 x Iset</td>
<td>Min. = 20 ms Max. = 60 ms</td>
<td></td>
</tr>
<tr>
<td>Independent time delay for non-directional residual overvoltage at 0.8 to 1.2 x Uset</td>
<td>$(0.000 - 60.000)$ s</td>
<td>$\pm 0.2%$ or $\pm 75$ ms whichever is greater</td>
</tr>
<tr>
<td>Independent time delay for non-directional residual overcurrent at 0 to 2 x Iset</td>
<td>$(0.000 - 60.000)$ s</td>
<td>$\pm 0.2%$ or $\pm 75$ ms whichever is greater</td>
</tr>
<tr>
<td>Independent time delay for directional residual overcurrent at 0 to 2 x Iset</td>
<td>$(0.000 - 60.000)$ s</td>
<td>$\pm 0.2%$ or $\pm 170$ ms whichever is greater</td>
</tr>
<tr>
<td>Inverse characteristics, see table 1, table 2 and table 3</td>
<td>16 curve types</td>
<td>See table 1, table 2 and table 3</td>
</tr>
<tr>
<td>Relay characteristic angle (RCADir)</td>
<td>(-179 to 180) degrees</td>
<td>$\pm 2.0$ degrees</td>
</tr>
<tr>
<td>Relay operate angle (ROADir)</td>
<td>(0 to 90) degrees</td>
<td>$\pm 2.0$ degrees</td>
</tr>
</tbody>
</table>
Table 35. Thermal overload protection, one time constant LCPTTR/LFPTTR

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference current</td>
<td>(2-400)% of IBase</td>
<td>±1.0% of I&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Reference temperature</td>
<td>(0-300)°C, (0 - 600)°F</td>
<td>±1.0°C, ±2.0°F</td>
</tr>
<tr>
<td>Operate time:</td>
<td>Time constant τ = (1-1000) minutes</td>
<td>IEC 60255-149, ±5.0% or ±200 ms whichever is greater</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Equation 1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[ t = \tau \ln \left( \frac{I^2 - I_{ref}^2}{I_{ref}^2 - I_{ref}^2} \right) ]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T&lt;sub&gt;Trip&lt;/sub&gt; = set operate temperature</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T&lt;sub&gt;Amb&lt;/sub&gt; = ambient temperature</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T&lt;sub&gt;ref&lt;/sub&gt; = temperature rise above ambient at I&lt;sub&gt;ref&lt;/sub&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I&lt;sub&gt;ref&lt;/sub&gt; = reference load current</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I = actual measured current</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I&lt;sub&gt;p&lt;/sub&gt; = load current before overload occurs</td>
</tr>
<tr>
<td>Alarm temperature</td>
<td>(0-200)°C, (0-400)°F</td>
<td>±2.0°C, ±4.0°F</td>
</tr>
<tr>
<td>Operate temperature</td>
<td>(0-300)°C, (0-600)°F</td>
<td>±2.0°C, ±4.0°F</td>
</tr>
<tr>
<td>Reset level temperature</td>
<td>(0-300)°C, (0-600)°F</td>
<td>±2.0°C, ±4.0°F</td>
</tr>
</tbody>
</table>

Table 36. Thermal overload protection, two time constants TRPTTR

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base current 1 and 2</td>
<td>(30–250)% of IBase</td>
<td>±1.0% of I&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Operate time:</td>
<td>Time constant τ = (0.10–500.00) minutes</td>
<td>±5.0% or ±200 ms whichever is greater</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Equation 2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[ t = \tau \ln \left( \frac{I^2 - I_{p}^2}{I_{ Trip}^2 - I_{ Trip}^2} \right) ]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I = actual measured current</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I&lt;sub&gt;p&lt;/sub&gt; = load current before overload occurs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I&lt;sub&gt;Trip&lt;/sub&gt; = steady state operate current level in % of I&lt;sub&gt;Base&lt;/sub&gt;</td>
</tr>
<tr>
<td>Alarm level 1 and 2</td>
<td>(50–99)% of heat content operate value</td>
<td>±2.0% of heat content trip</td>
</tr>
<tr>
<td>Operate current</td>
<td>(50–250)% of IBase</td>
<td>±1.0% of I&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Reset level temperature</td>
<td>(10–95)% of heat content trip</td>
<td>±2.0% of heat content trip</td>
</tr>
</tbody>
</table>
### Table 37. Breaker failure protection CCRBRF

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate phase current</td>
<td>(5-200)% of I&lt;sub&gt;Base&lt;/sub&gt;</td>
<td>±1.0% of I&lt;sub&gt;r&lt;/sub&gt; at I ≤ I&lt;sub&gt;r&lt;/sub&gt;, ±1.0% of I&lt;sub&gt;r&lt;/sub&gt; at I &gt; I&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Reset ratio, phase current</td>
<td>&gt; 95%</td>
<td>-</td>
</tr>
<tr>
<td>Operate residual current</td>
<td>(2-200)% of I&lt;sub&gt;Base&lt;/sub&gt;</td>
<td>±1.0% of I&lt;sub&gt;r&lt;/sub&gt; at I ≤ I&lt;sub&gt;r&lt;/sub&gt;, ±1.0% of I&lt;sub&gt;r&lt;/sub&gt; at I &gt; I&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Reset ratio, residual current</td>
<td>&gt; 95%</td>
<td>-</td>
</tr>
<tr>
<td>Phase current level for blocking of contact function</td>
<td>(5-200)% of I&lt;sub&gt;Base&lt;/sub&gt;</td>
<td>±1.0% of I&lt;sub&gt;r&lt;/sub&gt; at I ≤ I&lt;sub&gt;r&lt;/sub&gt;, ±1.0% of I&lt;sub&gt;r&lt;/sub&gt; at I &gt; I&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Reset ratio</td>
<td>&gt; 95%</td>
<td>-</td>
</tr>
<tr>
<td>Operate time for current detection</td>
<td>10 ms typically</td>
<td>-</td>
</tr>
<tr>
<td>Reset time for current detection</td>
<td>15 ms maximum</td>
<td>-</td>
</tr>
<tr>
<td>Time delay for re-trip at 0 to 2 x I&lt;sub&gt;set&lt;/sub&gt;</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±15 ms whichever is greater</td>
</tr>
<tr>
<td>Time delay for back-up trip at 0 to 2 x I&lt;sub&gt;set&lt;/sub&gt;</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±15 ms whichever is greater</td>
</tr>
<tr>
<td>Time delay for back-up trip at multi-phase start at 0 to 2 x I&lt;sub&gt;set&lt;/sub&gt;</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±20 ms whichever is greater</td>
</tr>
<tr>
<td>Additional time delay for a second back-up trip at 0 to 2 x I&lt;sub&gt;set&lt;/sub&gt;</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±15 ms whichever is greater</td>
</tr>
<tr>
<td>Time delay for alarm for faulty circuit breaker</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±15 ms whichever is greater</td>
</tr>
</tbody>
</table>

### Table 38. Stub protection STBPTOC

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating current</td>
<td>(5-2500)% of I&lt;sub&gt;Base&lt;/sub&gt;</td>
<td>±1.0% of I&lt;sub&gt;r&lt;/sub&gt; at I ≤ I&lt;sub&gt;r&lt;/sub&gt;, ±1.0% of I&lt;sub&gt;r&lt;/sub&gt; at I &gt; I&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Reset ratio</td>
<td>&gt; 95% at (50-2500)% of I&lt;sub&gt;Base&lt;/sub&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Independent time delay at 0 to 2 x I&lt;sub&gt;set&lt;/sub&gt;</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±30 ms whichever is greater</td>
</tr>
<tr>
<td>Operate time, start at 0 to 2 x I&lt;sub&gt;set&lt;/sub&gt;</td>
<td>Min. = 10 ms Max. = 20 ms</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, start at 2 to 0 x I&lt;sub&gt;set&lt;/sub&gt;</td>
<td>Min. = 10 ms Max. = 20 ms</td>
<td>-</td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>10 ms typically at 0 to 2 x I&lt;sub&gt;set&lt;/sub&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Impulse margin time</td>
<td>15 ms typically</td>
<td>-</td>
</tr>
</tbody>
</table>

### Table 39. Pole discordance protection CCPDSC

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate current</td>
<td>(0-100)% of I&lt;sub&gt;Base&lt;/sub&gt;</td>
<td>±1.0% of I&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Independent time delay between trip condition and trip signal</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±25 ms whichever is greater</td>
</tr>
</tbody>
</table>
### Table 40. Directional underpower protection GUPPDUP

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power level for Step 1 and Step 2</td>
<td>(0.0–500.0)% of SBase</td>
<td>±1.0% of S, at S ≤ S_r</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±1.0% of S, at S &gt; S_r</td>
</tr>
<tr>
<td></td>
<td></td>
<td>where S_r = 1.732 · U_r · I_r</td>
</tr>
<tr>
<td>Characteristic angle for Step 1 and Step 2</td>
<td>(-180.0–180.0) degrees</td>
<td>±2.0 degrees</td>
</tr>
<tr>
<td>Independent time delay to operate for Step 1 and</td>
<td>(0.01–6000.00) s</td>
<td>±0.2% or ±40 ms whichever is greater</td>
</tr>
<tr>
<td>Step 2 at 2 to 0.5 x S_r and k=0.000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 41. Directional overpower protection GOPPDOP

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power level for Step 1 and Step 2</td>
<td>(0.0–500.0)% of SBase</td>
<td>±1.0% of S, at S ≤ S_r</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±1.0% of S, at S &gt; S_r</td>
</tr>
<tr>
<td>Characteristic angle for Step 1 and Step 2</td>
<td>(-180.0–180.0) degrees</td>
<td>±2.0 degrees</td>
</tr>
<tr>
<td>Operate time, start at 0.5 to 2 x S_r and k=0.000</td>
<td>Min. = 10 ms</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Max. = 25 ms</td>
<td></td>
</tr>
<tr>
<td>Reset time, start at 2 to 0.5 x S_r and k=0.000</td>
<td>Min. = 35 ms</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Max. = 55 ms</td>
<td></td>
</tr>
<tr>
<td>Independent time delay to operate for Step 1 and</td>
<td>(0.01–6000.00) s</td>
<td>±0.2% or ±40 ms whichever is greater</td>
</tr>
<tr>
<td>Step 2 at 2 to 0.5 x S_r, k=0.000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 42. Broken conductor check BRCPTOC

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum phase current for operation</td>
<td>(5–100)% of IBase</td>
<td>±1.0% of I_r</td>
</tr>
<tr>
<td>Unbalance current operation</td>
<td>(50–90)% of maximum current</td>
<td>±1.0% of I_r</td>
</tr>
<tr>
<td>Independent operate time delay</td>
<td>(0.000–60.000) s</td>
<td>±0.2% or ±45 ms whichever is greater</td>
</tr>
<tr>
<td>Independent reset time delay</td>
<td>(0.010–60.000) s</td>
<td>±0.2% or ±30 ms whichever is greater</td>
</tr>
<tr>
<td>Start time at current change from I_r to 0</td>
<td>Min. = 25 ms</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Max. = 35 ms</td>
<td>-</td>
</tr>
<tr>
<td>Reset time at current change from 0 to I_r</td>
<td>Min. = 5 ms</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Max. = 20 ms</td>
<td>-</td>
</tr>
</tbody>
</table>
## Table 43. Capacitor bank protection CBPGAPC

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate value, overcurrent</td>
<td>(10-900)% of I&lt;sub&gt;base&lt;/sub&gt;</td>
<td>±2.0% of I&lt;sub&gt;r&lt;/sub&gt; at I ≤ I&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Reset ratio, overcurrent</td>
<td>&gt;95% at (100-900)% of I&lt;sub&gt;base&lt;/sub&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Start time, overcurrent, at 0.5 to 2 x I&lt;sub&gt;set&lt;/sub&gt;</td>
<td>Min. = 5 ms Max. = 20 ms</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, overcurrent, at 2 x I&lt;sub&gt;set&lt;/sub&gt; to 0.5</td>
<td>Min. = 25 ms Max. = 40 ms</td>
<td>-</td>
</tr>
<tr>
<td>Critical impulse time, overcurrent protection start</td>
<td>2 ms typically at 0.5 to 2 x I&lt;sub&gt;set&lt;/sub&gt; 1 ms typically at 0.5 to 10 x I&lt;sub&gt;set&lt;/sub&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Impulse margin time, overcurrent protection start</td>
<td>10 ms typically</td>
<td>-</td>
</tr>
<tr>
<td>Operate value, undercurrent</td>
<td>(5-100)% of I&lt;sub&gt;base&lt;/sub&gt;</td>
<td>±2.0% of I&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Reset ratio, undercurrent</td>
<td>&lt;105% at (30-100)% of I&lt;sub&gt;base&lt;/sub&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Operate value, reconnection inhibit function</td>
<td>(4-1000)% of I&lt;sub&gt;base&lt;/sub&gt;</td>
<td>±1.0% of I&lt;sub&gt;r&lt;/sub&gt; at I ≤ I&lt;sub&gt;r&lt;/sub&gt; ±1.0% of I at I &gt; I&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Operate value, reactive power overload function</td>
<td>(10-900)%</td>
<td>±1.0% of S&lt;sub&gt;r&lt;/sub&gt; at S ≤ S&lt;sub&gt;r&lt;/sub&gt; ±0.5% of U&lt;sub&gt;r&lt;/sub&gt; at U ≤ U&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Operate value, voltage protection function for harmonic overload (Definite time)</td>
<td>(10-500)%</td>
<td>±0.5% of U&lt;sub&gt;r&lt;/sub&gt; at U ≤ U&lt;sub&gt;r&lt;/sub&gt; ±0.5% of U at U &gt; U&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Operate value, voltage protection function for harmonic overload (Inverse time)</td>
<td>(80-200)%</td>
<td>±0.5% of U&lt;sub&gt;r&lt;/sub&gt; at U ≤ U&lt;sub&gt;r&lt;/sub&gt; ±0.5% of U at U &gt; U&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Inverse time characteristic</td>
<td>According to IEC 60871-1 (2005) and IEEE/ANSI C37.99 (2000)</td>
<td>±20% or ±200 ms whichever is greater</td>
</tr>
<tr>
<td>Maximum trip delay, harmonic overload IDMT</td>
<td>(0.05-6000.00) s</td>
<td>±20% or ±200 ms whichever is greater</td>
</tr>
<tr>
<td>Minimum trip delay, harmonic overload IDMT</td>
<td>(0.05-60.00) s</td>
<td>±20% or ±200 ms whichever is greater</td>
</tr>
<tr>
<td>Independent time delay, overcurrent at 0 to 2 x I&lt;sub&gt;set&lt;/sub&gt;</td>
<td>(0.00-6000.00) s</td>
<td>±0.2% or ±130 ms whichever is greater</td>
</tr>
<tr>
<td>Independent time delay, undercurrent at 2 x I&lt;sub&gt;set&lt;/sub&gt; to 0</td>
<td>(0.00-6000.00) s</td>
<td>±0.2% or ±160 ms whichever is greater</td>
</tr>
<tr>
<td>Independent time delay, reactive power overload function at 0 to 2 x QOL&gt;</td>
<td>(1.00-6000.00) s</td>
<td>±0.2% or ±100 ms whichever is greater</td>
</tr>
<tr>
<td>Independent time delay, harmonic overload at 0 to 2 x HOL&gt;</td>
<td>(0.00-6000.00) s</td>
<td>±0.2% or ±135 ms whichever is greater</td>
</tr>
</tbody>
</table>
## Voltage protection

Table 44. Two step undervoltage protection UV2PTUV

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate voltage, low and high step</td>
<td>(1.0–100.0)% of Ubase</td>
<td>±0.5% of U&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Absolute hysteresis</td>
<td>(0.0–50.0)% of Ubase</td>
<td>±0.5% of U&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Internal blocking level, step 1 and step 2</td>
<td>(1–50)% of UBase</td>
<td>±0.5% of U&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Inverse time characteristics for step 1 and step 2</td>
<td>-</td>
<td>See table 146</td>
</tr>
<tr>
<td>Definite time delay, step 1 at 1.2 to 0 x U&lt;sub&gt;set&lt;/sub&gt;</td>
<td>(0.00–6000.00) s</td>
<td>±0.2% or ±40ms whichever is greater</td>
</tr>
<tr>
<td>Definite time delay, step 2 at 1.2 to 0 x U&lt;sub&gt;set&lt;/sub&gt;</td>
<td>(0.000–60.000) s</td>
<td>±0.2% or ±40ms whichever is greater</td>
</tr>
<tr>
<td>Minimum operate time, inverse characteristics</td>
<td>(0.000–60.000) s</td>
<td>±0.5% or ±40ms whichever is greater</td>
</tr>
<tr>
<td>Operate time, start at 2 to 0 x U&lt;sub&gt;set&lt;/sub&gt;</td>
<td>Min. = 15 ms</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Max. = 30 ms</td>
<td></td>
</tr>
<tr>
<td>Reset time, start at 0 to 2 x U&lt;sub&gt;set&lt;/sub&gt;</td>
<td>Min. = 15 ms</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Max. = 30 ms</td>
<td></td>
</tr>
<tr>
<td>Operate time, start at 1.2 to 0 x U&lt;sub&gt;set&lt;/sub&gt;</td>
<td>Min. = 5 ms</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Max. = 25 ms</td>
<td></td>
</tr>
<tr>
<td>Reset time, start at 0 to 1.2 x U&lt;sub&gt;set&lt;/sub&gt;</td>
<td>Min. = 15 ms</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Max. = 35 ms</td>
<td></td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>5 ms typically at 1.2 to 0 x U&lt;sub&gt;set&lt;/sub&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Impulse margin time</td>
<td>15 ms typically</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 45. Two step overvoltage protection OV2PTOV

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate voltage, step 1 and 2</td>
<td>(1.0-200.0)% of U_{Base}</td>
<td>±0.5% of U_i at U ≤ U_i, ±0.5% of U at U &gt; U_i</td>
</tr>
<tr>
<td>Absolute hysteresis</td>
<td>(0.0–50.0)% of U_{Base}</td>
<td>±0.5% of U_i at U ≤ U_i, ±0.5% of U at U &gt; U_i</td>
</tr>
<tr>
<td>Inverse time characteristics for steps 1 and 2, see table 145</td>
<td>-</td>
<td>See table 145</td>
</tr>
<tr>
<td>Definite time delay, low step (step 1) at 0 to 1.2 x U_{set}</td>
<td>(0.00 - 6000.00) s</td>
<td>±0.2% or ±45 ms whichever is greater</td>
</tr>
<tr>
<td>Definite time delay, high step (step 2) at 0 to 1.2 x U_{set}</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±45 ms whichever is greater</td>
</tr>
<tr>
<td>Minimum operate time, Inverse characteristics</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±45 ms whichever is greater</td>
</tr>
<tr>
<td>Operate time, start at 0 to 2 x U_{set}</td>
<td>Min. = 15 ms Max. = 30 ms</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, start at 2 to 0 x U_{set}</td>
<td>Min. = 15 ms Max. = 30 ms</td>
<td>-</td>
</tr>
<tr>
<td>Operate time, start at 0 to 1.2 x U_{set}</td>
<td>Min. = 20 ms Max. = 35 ms</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, start at 1.2 to 0 x U_{set}</td>
<td>Min. = 5 ms Max. = 25 ms</td>
<td>-</td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>10 ms typically at 0 to 2 x U_{set}</td>
<td>-</td>
</tr>
<tr>
<td>Impulse margin time</td>
<td>15 ms typically</td>
<td>-</td>
</tr>
</tbody>
</table>
### Table 46. Two step residual overvoltage protection ROV2PTOV

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate voltage, step 1 and step 2</td>
<td>(1.0–200.0)% of $U_{base}$</td>
<td>± 0.5% of $U_r$ at $U \leq U_r$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>± 0.5% of $U$ at $U &gt; U_r$</td>
</tr>
<tr>
<td>Absolute hysteresis</td>
<td>(0.0–50.0)% of $U_{base}$</td>
<td>± 0.5% of $U_r$ at $U \leq U_r$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>± 0.5% of $U$ at $U &gt; U_r$</td>
</tr>
<tr>
<td>Inverse time characteristics for low and high step, see table 147</td>
<td>-</td>
<td>See table 147</td>
</tr>
<tr>
<td>Definite time delay low step (step 1) at 0 to 1.2 $U_{set}$</td>
<td>(0.00–6000.00) s</td>
<td>± 0.2% or ± 45 ms whichever is greater</td>
</tr>
<tr>
<td>Definite time delay high step (step 2) at 0 to 1.2 $U_{set}$</td>
<td>(0.000–60.000) s</td>
<td>± 0.2% or ± 45 ms whichever is greater</td>
</tr>
<tr>
<td>Minimum operate time</td>
<td>(0.000–60.000) s</td>
<td>± 0.2% or ± 45 ms whichever is greater</td>
</tr>
<tr>
<td>Operate time, start at 0 to 2 $U_{set}$</td>
<td>Min. = 15 ms, Max. = 30 ms</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, start at 2 to 0 $U_{set}$</td>
<td>Min. = 15 ms, Max. = 30 ms</td>
<td>-</td>
</tr>
<tr>
<td>Operate time, start at 0 to 1.2 $U_{set}$</td>
<td>Min. = 20 ms, Max. = 35 ms</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, start at 1.2 to 0 $U_{set}$</td>
<td>Min. = 5 ms, Max. = 25 ms</td>
<td>-</td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>10 ms typically at 0 to 2 $U_{set}$</td>
<td>-</td>
</tr>
<tr>
<td>Impulse margin time</td>
<td>15 ms typically</td>
<td>-</td>
</tr>
</tbody>
</table>

### Table 47. Voltage differential protection VDCPTOV

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage difference for alarm and trip</td>
<td>(2.0–100.0)% of $U_{base}$</td>
<td>± 0.5% of $U_r$</td>
</tr>
<tr>
<td>Under voltage level</td>
<td>(1.0–100.0)% of $U_{base}$</td>
<td>± 0.5% of $U_r$</td>
</tr>
<tr>
<td>Independent time delay for voltage differential alarm at 0.8 to 1.2 $U_{alarm}$</td>
<td>(0.000–60.000) s</td>
<td>± 0.2% or ± 40 ms whichever is greater</td>
</tr>
<tr>
<td>Independent time delay for voltage differential trip at 0.8 to 1.2 $U_{trip}$</td>
<td>(0.000–60.000) s</td>
<td>± 0.2% or ± 40 ms whichever is greater</td>
</tr>
<tr>
<td>Independent time delay for voltage differential reset at 1.2 to 0.8 $U_{trip}$</td>
<td>(0.000–60.000) s</td>
<td>± 0.2% or ± 40 ms whichever is greater</td>
</tr>
</tbody>
</table>
## Table 48. Loss of voltage check LOVPTUV

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate voltage</td>
<td>(1–100)% of UBase</td>
<td>±0.5% of $U_r$</td>
</tr>
<tr>
<td>Pulse timer when disconnecting all three phases</td>
<td>(0.050–60.000) s</td>
<td>±0.2% or ±15 ms whichever is greater</td>
</tr>
<tr>
<td>Time delay for enabling the functions after restoration</td>
<td>(0.000–60.000) s</td>
<td>±0.2% or ±35 ms whichever is greater</td>
</tr>
<tr>
<td>Operate time delay when disconnecting all three phases</td>
<td>(0.000–60.000) s</td>
<td>±0.2% or ±35 ms whichever is greater</td>
</tr>
<tr>
<td>Time delay to block when all three phase voltages are not low</td>
<td>(0.000–60.000) s</td>
<td>±0.2% or ±35 ms whichever is greater</td>
</tr>
</tbody>
</table>
## Frequency protection

### Table 49. Underfrequency protection SAPTUF

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate value, start function, at symmetrical three phase voltage</td>
<td>(35.00-75.00) Hz</td>
<td>±2.0 mHz</td>
</tr>
<tr>
<td>Operate time, start at ( f_{set} + 0.02 ) Hz to ( f_{set} - 0.02 ) Hz</td>
<td>( fn = 50 ) Hz</td>
<td>Min. = 80 ms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max. = 95 ms</td>
</tr>
<tr>
<td></td>
<td>( fn = 60 ) Hz</td>
<td>Min. = 65 ms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max. = 80 ms</td>
</tr>
<tr>
<td>Reset time, start at ( f_{set} - 0.02 ) Hz to ( f_{set} + 0.02 ) Hz</td>
<td>Min. = 15 ms</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Max. = 30 ms</td>
<td></td>
</tr>
<tr>
<td>Operate time, definite time function at ( f_{set} + 0.02 ) Hz to ( f_{set} - 0.02 ) Hz</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±100 ms whichever is greater</td>
</tr>
<tr>
<td>Reset time, definite time function at ( f_{set} - 0.02 ) Hz to ( f_{set} + 0.02 ) Hz</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±120 ms whichever is greater</td>
</tr>
<tr>
<td>Voltage dependent time delay</td>
<td>Settings:</td>
<td>±1.0% or ±120 ms whichever is greater</td>
</tr>
<tr>
<td></td>
<td>( UNom=(50-150)% ) of ( U_{base} )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( UMin=(50-150)% ) of ( U_{base} )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exponent=0.0-5.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( tMax=(0.010-60.000) ) s</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( tMin=(0.010-60.000) ) s</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( t = \left( \frac{U-U_{Min}}{UNom-U_{Min}} \right)^{Exp} \times (tMax-tMin)+tMin )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( U=U_{measured} )</td>
<td></td>
</tr>
</tbody>
</table>

(Equation 3)

### Table 50. Overfrequency protection SAPTOF

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate value, start function at symmetrical three-phase voltage</td>
<td>(35.00-90.00) Hz</td>
<td>±2.0 mHz</td>
</tr>
<tr>
<td>Operate time, start at ( f_{set} -0.02 ) Hz to ( f_{set} +0.02 ) Hz</td>
<td>( fn = 50) Hz</td>
<td>Min. = 80 ms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max. = 95 ms</td>
</tr>
<tr>
<td></td>
<td>( fn = 60) Hz</td>
<td>Min. = 65 ms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max. = 80 ms</td>
</tr>
<tr>
<td>Reset time, start at ( f_{set} +0.02 ) Hz to ( f_{set} -0.02 ) Hz</td>
<td>Min. = 15 ms</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Max. = 30 ms</td>
<td></td>
</tr>
<tr>
<td>Operate time, definite time function at ( f_{set} -0.02 ) Hz to ( f_{set} +0.02 ) Hz</td>
<td>(0.000-60.000) s</td>
<td>±0.2% ±100 ms whichever is greater</td>
</tr>
<tr>
<td>Reset time, definite time function at ( f_{set} +0.02 ) Hz to ( f_{set} -0.02 ) Hz</td>
<td>(0.000-60.000) s</td>
<td>±0.2% ±120 ms whichever is greater</td>
</tr>
</tbody>
</table>
## Table 51. Rate-of-change of frequency protection SAPFRC

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate value, start function</td>
<td>(-10.00-10.00) Hz/s</td>
<td>±10.0 mHz/s</td>
</tr>
<tr>
<td>Operate value, restore enable frequency</td>
<td>(45.00-65.00) Hz</td>
<td>±2.0 mHz</td>
</tr>
<tr>
<td>Definite restore time delay</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±100 ms whichever is greater</td>
</tr>
<tr>
<td>Definite time delay for frequency gradient trip</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±120 ms whichever is greater</td>
</tr>
<tr>
<td>Definite reset time delay</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±250 ms whichever is greater</td>
</tr>
</tbody>
</table>

## Table 52. Frequency accumulation protection FTAQFVR

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate value, frequency high limit level at symmetrical three phase voltage</td>
<td>(35.00 – 90.00) Hz</td>
<td>±2.0 mHz</td>
</tr>
<tr>
<td>Operate value, frequency low limit level at symmetrical three phase voltage</td>
<td>(30.00 – 85.00) Hz</td>
<td>±2.0 mHz</td>
</tr>
<tr>
<td>Operate value, voltage high and low limit for voltage band limit check</td>
<td>(0.0 – 200.0)% of UBase</td>
<td>±0.5% of U at U ≤ U_r</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.5% of U at U &gt; U_r</td>
</tr>
<tr>
<td>Operate value, current start level</td>
<td>(5.0 – 100.0)% of IBase</td>
<td>±1.0% of I_r or 0.01 A at I_sI</td>
</tr>
<tr>
<td>Independent time delay for the continuous time limit at f_set+0.02 Hz to f_set-0.02 Hz</td>
<td>(0.0 – 6000.0) s</td>
<td>±0.2% or ±200 ms whichever is greater</td>
</tr>
<tr>
<td>Independent time delay for the accumulation time limit at f_set+0.02 Hz to f_set-0.02 Hz</td>
<td>(10.0 – 90000.0) s</td>
<td>±0.2% or ±200 ms whichever is greater</td>
</tr>
</tbody>
</table>
## Multipurpose protection

Table 53. General current and voltage protection CVGAPC

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring current input</td>
<td>phase1, phase2, phase3, PosSeq, -NegSeq, -3*ZeroSeq, MaxPh, MinPh, UnbalancePh, phase1-phase2, phase2-phase3, phase3-phase1, MaxPh-Ph, MinPh-Ph, UnbalancePh-Ph</td>
<td>-</td>
</tr>
<tr>
<td>Measuring voltage input</td>
<td>phase1, phase2, phase3, PosSeq, -NegSeq, -3*ZeroSeq, MaxPh, MinPh, UnbalancePh, phase1-phase2, phase2-phase3, phase3-phase1, MaxPh-Ph, MinPh-Ph, UnbalancePh-Ph</td>
<td>-</td>
</tr>
<tr>
<td>Start overcurrent, step 1 - 2</td>
<td>(2 - 5000)% of IBase</td>
<td>±1.0% of I at I ≤ I_r, ±1.0% of I at I &gt; I_r</td>
</tr>
<tr>
<td>Start undercurrent, step 1 - 2</td>
<td>(2 - 150)% of IBase</td>
<td>±1.0% of I at I ≤ I_r, ±1.0% of I at I &gt; I_r</td>
</tr>
<tr>
<td>Independent time delay, overcurrent at 0 to 2 x I_set, step 1 - 2</td>
<td>(0.00 - 6000.00) s</td>
<td>±0.2% or ±35 ms whichever is greater</td>
</tr>
<tr>
<td>Independent time delay, undercurrent at 2 to 0 x I_set, step 1 - 2</td>
<td>(0.00 - 6000.00) s</td>
<td>±0.2% or ±35 ms whichever is greater</td>
</tr>
<tr>
<td>Overcurrent (non-directional):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Start time at 0 to 2 x I_set</td>
<td>Min. = 15 ms Max. = 30 ms</td>
<td>-</td>
</tr>
<tr>
<td>Reset time at 2 to 0 x I_set</td>
<td>Min. = 15 ms Max. = 30 ms</td>
<td>-</td>
</tr>
<tr>
<td>Start time at 0 to 10 x I_set</td>
<td>Min. = 5 ms Max. = 20 ms</td>
<td>-</td>
</tr>
<tr>
<td>Reset time at 10 to 0 x I_set</td>
<td>Min. = 20 ms Max. = 35 ms</td>
<td>-</td>
</tr>
<tr>
<td>Undercurrent:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Start time at 2 to 0 x I_set</td>
<td>Min. = 15 ms Max. = 30 ms</td>
<td>-</td>
</tr>
<tr>
<td>Reset time at 0 to 2 x I_set</td>
<td>Min. = 15 ms Max. = 30 ms</td>
<td>-</td>
</tr>
<tr>
<td>Overcurrent:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inverse time characteristics, see table 142, 143 and table 144</td>
<td>16 curve types</td>
<td>See table 142, 143 and table 144</td>
</tr>
<tr>
<td>Overcurrent:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum operate time for inverse curves, step 1 - 2</td>
<td>(0.00 - 6000.00) s</td>
<td>±0.2% or ±35 ms whichever is greater</td>
</tr>
<tr>
<td>Voltage level where voltage memory takes over</td>
<td>(0.0 - 5.0)% of UBase</td>
<td>±0.5% of U_r</td>
</tr>
<tr>
<td>Start overvoltage, step 1 - 2</td>
<td>(2.0 - 200.0)% of UBase</td>
<td>±0.5% of U at U ≤ U_r, ±0.5% of U at U &gt; U_r</td>
</tr>
<tr>
<td>Start undervoltage, step 1 - 2</td>
<td>(2.0 - 150.0)% of UBase</td>
<td>±0.5% of U at U ≤ U_r, ±0.5% of U at U &gt; U_r</td>
</tr>
<tr>
<td>Function</td>
<td>Range or value</td>
<td>Accuracy</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>---------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Independent time delay, overvoltage at 0.8 to 1.2 x U&lt;sub&gt;set&lt;/sub&gt;, step 1 - 2</td>
<td>(0.00 - 6000.00) s</td>
<td>±0.2% or ±35 ms whichever is greater</td>
</tr>
<tr>
<td>Independent time delay, undervoltage at 1.2 to 0.8 x U&lt;sub&gt;set&lt;/sub&gt;, step 1 - 2</td>
<td>(0.00 - 6000.00) s</td>
<td>±0.2% or ±35 ms whichever is greater</td>
</tr>
<tr>
<td>Overvoltage:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Start time at 0.8 to 1.2 x U&lt;sub&gt;set&lt;/sub&gt;</td>
<td>Min. = 15 ms Max. = 30 ms</td>
<td>-</td>
</tr>
<tr>
<td>Reset time at 1.2 to 0.8 x U&lt;sub&gt;set&lt;/sub&gt;</td>
<td>Min. = 15 ms Max. = 30 ms</td>
<td>-</td>
</tr>
<tr>
<td>Undervoltage:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Start time at 1.2 to 0.8 x U&lt;sub&gt;set&lt;/sub&gt;</td>
<td>Min. = 15 ms Max. = 30 ms</td>
<td>-</td>
</tr>
<tr>
<td>Reset time at 1.2 to 0.8 x U&lt;sub&gt;set&lt;/sub&gt;</td>
<td>Min. = 15 ms Max. = 30 ms</td>
<td>-</td>
</tr>
<tr>
<td>Overvoltage:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inverse time characteristics, see table 145</td>
<td>4 curve types</td>
<td>See table 145</td>
</tr>
<tr>
<td>Undervoltage:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inverse time characteristics, see table 146</td>
<td>3 curve types</td>
<td>See table 146</td>
</tr>
<tr>
<td>High and low voltage limit, voltage dependent operation, step 1 - 2</td>
<td>(1.0 - 200.0)% of UBase</td>
<td>±1.0% of U&lt;sub&gt;r&lt;/sub&gt; at U ≤ U&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±1.0% of U at U &gt; U&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Directional function</td>
<td>Settable: NonDir, forward and reverse</td>
<td></td>
</tr>
<tr>
<td>Relay characteristic angle</td>
<td>(-180 to +180) degrees</td>
<td>±2.0 degrees</td>
</tr>
<tr>
<td>Relay operate angle</td>
<td>(1 to 90) degrees</td>
<td>±2.0 degrees</td>
</tr>
<tr>
<td>Reset ratio, overcurrent</td>
<td>&gt; 95%</td>
<td>-</td>
</tr>
<tr>
<td>Reset ratio, undercurrent</td>
<td>&lt; 105%</td>
<td>-</td>
</tr>
<tr>
<td>Reset ratio, overvoltage</td>
<td>&gt; 95%</td>
<td>-</td>
</tr>
<tr>
<td>Reset ratio, undervoltage</td>
<td>&lt; 105%</td>
<td>-</td>
</tr>
<tr>
<td>Overcurrent:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>10 ms typically at 0 to 2 x I&lt;sub&gt;set&lt;/sub&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Impulse margin time</td>
<td>15 ms typically</td>
<td>-</td>
</tr>
<tr>
<td>Undercurrent:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>10 ms typically at 2 to 0 x I&lt;sub&gt;set&lt;/sub&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Impulse margin time</td>
<td>15 ms typically</td>
<td>-</td>
</tr>
<tr>
<td>Overvoltage:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>10 ms typically at 0.8 to 1.2 x U&lt;sub&gt;set&lt;/sub&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Impulse margin time</td>
<td>15 ms typically</td>
<td>-</td>
</tr>
<tr>
<td>Undervoltage:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>10 ms typically at 1.2 to 0.8 x U&lt;sub&gt;set&lt;/sub&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Impulse margin time</td>
<td>15 ms typically</td>
<td>-</td>
</tr>
</tbody>
</table>
### Table 54. Voltage-restrained time overcurrent protection VRPVOC

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
</table>
| Start overcurrent                             | (2.0 - 5000.0)% of IBase                | ±1.0% of I, at I ≤ I<sub>r</sub>  
±1.0% of I, at I > I<sub>r</sub> |
| Reset ratio, overcurrent                      | > 95%                                   | -                                            |
| Operate time, start overcurrent at 0 to 2 x I<sub>set</sub> | Min. = 15 ms                           | -                                            |
|                                               | Max. = 30 ms                           | -                                            |
| Reset time, start overcurrent at 2 to 0 x I<sub>set</sub> | Min. = 15 ms                           | -                                            |
|                                               | Max. = 30 ms                           | -                                            |
| Operate time, start overcurrent at 0 to 10 x I<sub>set</sub> | Min. = 5 ms                            | -                                            |
|                                               | Max. = 20 ms                           | -                                            |
| Reset time, start overcurrent at 10 to 0 x I<sub>set</sub> | Min. = 20 ms                           | -                                            |
|                                               | Max. = 35 ms                           | -                                            |
| Independent time delay to operate at 0 to 2 x I<sub>set</sub> | (0.00 - 6000.00) s                | ±0.2% or ±35 ms whichever is greater         |
| Inverse time characteristics, see tables 142 and 143 | 13 curve types                          | See tables 142 and 143                       |
| Minimum operate time for inverse time characteristics | (0.00 - 60.00) s                | ±0.2% or ±35 ms whichever is greater         |
| High voltage limit, voltage dependent operation | (30.0 - 100.0)% of UBase               | ±1.0% of U<sub>r</sub>                      |
| Start undervoltage                            | (2.0 - 100.0)% of UBase                | ±0.5% of U<sub>r</sub>                      |
| Reset ratio, undervoltage                     | < 105%                                 | -                                            |
| Operate time start undervoltage at 2 to 0 x U<sub>set</sub> | Min. = 15 ms                           | -                                            |
|                                               | Max. = 30 ms                           | -                                            |
| Reset time start undervoltage at 0 to 2 x U<sub>set</sub> | Min. = 15 ms                           | -                                            |
|                                               | Max. = 30 ms                           | -                                            |
| Independent time delay to operate, undervoltage at 0 to 2 x U<sub>set</sub> | (0.00 - 6000.00) s                | ±0.2% or ±35 ms whichever is greater         |
| Internal low voltage blocking                 | (0.0 - 5.0)% of UBase                  | ±0.25% of U<sub>r</sub>                     |
| Overcurrent:                                  | Critical impulse time                  | -                                            |
|                                               | Impulse margin time                    | -                                            |
| Undervoltage:                                 | Critical impulse time                  | -                                            |
|                                               | Impulse margin time                    | -                                            |

1MRK 511 361-BEN D  
Bay control REC670 2.1 IEC  
ABB
### Secondary system supervision

#### Table 55. Current circuit supervision CCSSPVC

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate current</td>
<td>(10-200)% of IBase</td>
<td>±10.0% of I, at I ≤ I,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±10.0% of I, at I &gt; I,</td>
</tr>
<tr>
<td>Reset ratio, Operate current</td>
<td>&gt;90%</td>
<td></td>
</tr>
<tr>
<td>Block current</td>
<td>(20-500)% of IBase</td>
<td>±5.0% of I, at I ≤ I,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±5.0% of I, at I &gt; I,</td>
</tr>
<tr>
<td>Reset ratio, Block current</td>
<td>&gt;90% at (50-500)% of IBase</td>
<td></td>
</tr>
</tbody>
</table>

#### Table 56. Fuse failure supervision FUFSFPCV

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate voltage, zero sequence</td>
<td>(1-100)% of UBase</td>
<td>±0.5% of U</td>
</tr>
<tr>
<td>Operate current, zero sequence</td>
<td>(1–100)% of IBase</td>
<td>±0.5% of I</td>
</tr>
<tr>
<td>Operate voltage, negative sequence</td>
<td>(1-100)% of UBase</td>
<td>±0.5% of U</td>
</tr>
<tr>
<td>Operate current, negative sequence</td>
<td>(1–100)% of IBase</td>
<td>±0.5% of I</td>
</tr>
<tr>
<td>Operate voltage change level</td>
<td>(1-100)% of UBase</td>
<td>±10.0% of U</td>
</tr>
<tr>
<td>Operate current change level</td>
<td>(1–100)% of IBase</td>
<td>±10.0% of I</td>
</tr>
<tr>
<td>Operate phase voltage</td>
<td>(1-100)% of UBase</td>
<td>±0.5% of U</td>
</tr>
<tr>
<td>Operate phase current</td>
<td>(1–100)% of IBase</td>
<td>±0.5% of I</td>
</tr>
<tr>
<td>Operate phase dead line voltage</td>
<td>(1-100)% of UBase</td>
<td>±0.5% of U</td>
</tr>
<tr>
<td>Operate phase dead line current</td>
<td>(1–100)% of IBase</td>
<td>±0.5% of I</td>
</tr>
<tr>
<td>Operate time, start, 1 ph, at 1 to 0 x U</td>
<td>Min. = 10 ms Max. = 25 ms</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, start, 1 ph, at 0 to 1 x U</td>
<td>Min. = 15 ms Max. = 30 ms</td>
<td>-</td>
</tr>
<tr>
<td>Function</td>
<td>Range or value</td>
<td>Accuracy</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>-----------------------------------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Operate value, block of main fuse failure</td>
<td>(10.0-80.0)% of UBase</td>
<td>±0.5% of Ur</td>
</tr>
<tr>
<td>Reset ratio</td>
<td>&lt;110%</td>
<td></td>
</tr>
<tr>
<td>Operate time, block of main fuse failure at 1</td>
<td>Min. = 5 ms</td>
<td>–</td>
</tr>
<tr>
<td>to 0 x U&lt;sub&gt;r&lt;/sub&gt;</td>
<td>Max. = 15 ms</td>
<td></td>
</tr>
<tr>
<td>Reset time, block of main fuse failure at 0</td>
<td>Min. = 15 ms</td>
<td>–</td>
</tr>
<tr>
<td>to 1 x U&lt;sub&gt;r&lt;/sub&gt;</td>
<td>Max. = 30 ms</td>
<td></td>
</tr>
<tr>
<td>Operate value, alarm for pilot fuse failure</td>
<td>(10.0-80.0)% of UBase</td>
<td>±0.5% of Ur</td>
</tr>
<tr>
<td>Reset ratio</td>
<td>&lt;110%</td>
<td></td>
</tr>
<tr>
<td>Operate time, alarm for pilot fuse failure at</td>
<td>Min. = 5 ms</td>
<td>–</td>
</tr>
<tr>
<td>1 to 0 x U&lt;sub&gt;r&lt;/sub&gt;</td>
<td>Max. = 15 ms</td>
<td></td>
</tr>
<tr>
<td>Reset time, alarm for pilot fuse failure at 0</td>
<td>Min. = 15 ms</td>
<td>–</td>
</tr>
<tr>
<td>to 1 x U&lt;sub&gt;r&lt;/sub&gt;</td>
<td>Max. = 30 ms</td>
<td></td>
</tr>
</tbody>
</table>
## Control

Table 58. Synchronizing, synchrocheck and energizing check SESRSYN

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase shift, $\varphi_{\text{line}} - \varphi_{\text{bus}}$</td>
<td>(-180 to 180) degrees</td>
<td>-</td>
</tr>
<tr>
<td>Voltage high limit for synchronizing and synchrocheck</td>
<td>(50.0-120.0)% of UBase</td>
<td>±0.5% of $U_r$ at $U \leq U_r$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.5% of $U$ at $U &gt; U_r$</td>
</tr>
<tr>
<td>Reset ratio, synchrocheck</td>
<td>&gt; 95%</td>
<td>-</td>
</tr>
<tr>
<td>Frequency difference limit between bus and line for synchrocheck</td>
<td>(0.003-1.000) Hz</td>
<td>±2.5 mHz</td>
</tr>
<tr>
<td>Phase angle difference limit between bus and line for synchrocheck</td>
<td>(5.0-90.0) degrees</td>
<td>±2.0 degrees</td>
</tr>
<tr>
<td>Voltage difference limit between bus and line for synchronizing and</td>
<td>(0.02-0.5) p.u</td>
<td>±0.5% of $U_r$</td>
</tr>
<tr>
<td>synchrocheck</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time delay output for synchrocheck when angle difference between</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±35 ms whichever is greater</td>
</tr>
<tr>
<td>bus and line jumps from “PhaseDiff” + 2 degrees to “PhaseDiff” - 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>degrees</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency difference minimum limit for synchronizing</td>
<td>(0.003-0.250) Hz</td>
<td>±2.5 mHz</td>
</tr>
<tr>
<td>Frequency difference maximum limit for synchronizing</td>
<td>(0.050-0.500) Hz</td>
<td>±2.5 mHz</td>
</tr>
<tr>
<td>Breaker closing pulse duration</td>
<td>(0.050-60.000) s</td>
<td>±0.2% or ±15 ms whichever is greater</td>
</tr>
<tr>
<td>tMaxSynch, which resets synchronizing function if no close has been</td>
<td>(0.000-6000.00) s</td>
<td>±0.2% or ±35 ms whichever is greater</td>
</tr>
<tr>
<td>made before set time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum time to accept synchronizing conditions</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±35 ms whichever is greater</td>
</tr>
<tr>
<td>Voltage high limit for energizing check</td>
<td>(50.0-120.0)% of UBase</td>
<td>±0.5% of $U_r$ at $U \leq U_r$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.5% of $U$ at $U &gt; U_r$</td>
</tr>
<tr>
<td>Reset ratio, voltage high limit</td>
<td>&gt; 95%</td>
<td>-</td>
</tr>
<tr>
<td>Voltage low limit for energizing check</td>
<td>(10.0-80.0)% of UBase</td>
<td>±0.5% of $U_r$</td>
</tr>
<tr>
<td>Reset ratio, voltage low limit</td>
<td>&lt; 105%</td>
<td>-</td>
</tr>
<tr>
<td>Maximum voltage for energizing</td>
<td>(50.0-180.0)% of UBase</td>
<td>±0.5% of $U_r$ at $U \leq U_r$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.5% of $U$ at $U &gt; U_r$</td>
</tr>
<tr>
<td>Time delay for energizing check when voltage jumps from 0 to 90% of</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±100 ms whichever is greater</td>
</tr>
<tr>
<td>Urated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operate time for synchrocheck function when angle difference between</td>
<td>Min. = 15 ms</td>
<td>-</td>
</tr>
<tr>
<td>bus and line jumps from “PhaseDiff” + 2 degrees to “PhaseDiff” - 2</td>
<td>Max. = 30 ms</td>
<td></td>
</tr>
<tr>
<td>degrees</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operate time for energizing function when voltage jumps from 0 to 90%</td>
<td>Min. = 70 ms</td>
<td>-</td>
</tr>
<tr>
<td>of Urated</td>
<td>Max. = 90 ms</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Table 59. Autorecloser SMBRREC

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of autoreclosing shots</td>
<td>1 - 5</td>
<td>-</td>
</tr>
<tr>
<td>Autoreclosing open time:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>shot 1 - t1 1Ph</td>
<td>(0.000-120.000) s</td>
<td>±0.2% or ±35 ms whichever is greater</td>
</tr>
<tr>
<td>shot 1 - t1 2Ph</td>
<td></td>
<td></td>
</tr>
<tr>
<td>shot 1 - t1 3Ph HS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>shot 1 - t1 3Ph</td>
<td></td>
<td></td>
</tr>
<tr>
<td>shot 2 - t2 3Ph</td>
<td>(0.00-6000.00) s</td>
<td>±0.2% or ±35 ms whichever is greater</td>
</tr>
<tr>
<td>shot 3 - t3 3Ph</td>
<td></td>
<td></td>
</tr>
<tr>
<td>shot 4 - t4 3Ph</td>
<td></td>
<td></td>
</tr>
<tr>
<td>shot 5 - t5 3Ph</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extended autorecloser open time</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±35 ms whichever is greater</td>
</tr>
<tr>
<td>Minimum time CB must be closed before AR becomes ready for autoreclosing cycle</td>
<td>(0.00-6000.00) s</td>
<td>±0.2% or ±35 ms whichever is greater</td>
</tr>
<tr>
<td>Maximum operate pulse duration</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±15 ms whichever is greater</td>
</tr>
<tr>
<td>Reclaim time</td>
<td>(0.00-6000.00) s</td>
<td>±0.2% or ±15 ms whichever is greater</td>
</tr>
<tr>
<td>Circuit breaker closing pulse length</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±15 ms whichever is greater</td>
</tr>
<tr>
<td>Wait for master release</td>
<td>(0.00-6000.00) s</td>
<td>±0.2% or ±15 ms whichever is greater</td>
</tr>
<tr>
<td>Inhibit reset time</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±45 ms whichever is greater</td>
</tr>
<tr>
<td>Autorecloser maximum wait time for sync</td>
<td>(0.00-6000.00) s</td>
<td>±0.2% or ±45 ms whichever is greater</td>
</tr>
<tr>
<td>CB check time before unsuccessful</td>
<td>(0.00-6000.00) s</td>
<td>±0.2% or ±45 ms whichever is greater</td>
</tr>
<tr>
<td>Wait time after close command before proceeding to next shot</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±45 ms whichever is greater</td>
</tr>
</tbody>
</table>
Table 60. Voltage control TR1ATCC and TR8ATCC

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transformer reactance</td>
<td>(0.1–200.0)Ω, primary</td>
<td>-</td>
</tr>
<tr>
<td>Time delay for lower command when fast step down mode is activated</td>
<td>(1.0–100.0) s</td>
<td>-</td>
</tr>
<tr>
<td>Voltage control set voltage</td>
<td>(85.0–120.0)% of UBase</td>
<td>±0.25 % of U,</td>
</tr>
<tr>
<td>Outer voltage deadband</td>
<td>(0.2–9.0)% of UBase</td>
<td>-</td>
</tr>
<tr>
<td>Inner voltage deadband</td>
<td>(0.1–9.0)% of UBase</td>
<td>-</td>
</tr>
<tr>
<td>Upper limit of busbar voltage</td>
<td>(80–180)% of UBase</td>
<td>±0.5% of U,</td>
</tr>
<tr>
<td>Lower limit of busbar voltage</td>
<td>(70–120)% of UBase</td>
<td>±0.5% of U,</td>
</tr>
<tr>
<td>Undervoltage block level</td>
<td>(50–120)% of UBase</td>
<td>±0.5% of U,</td>
</tr>
<tr>
<td>Time delay (long) for automatic control commands</td>
<td>(3–1000) s</td>
<td>±0.2% or ±600 ms whichever is greater</td>
</tr>
<tr>
<td>Time delay (short) for automatic control commands</td>
<td>(1–1000) s</td>
<td>±0.2% or ±600 ms whichever is greater</td>
</tr>
<tr>
<td>Minimum operating time in inverse mode</td>
<td>(3–120) s</td>
<td>±0.2% or ±600 ms whichever is greater</td>
</tr>
<tr>
<td>Line resistance</td>
<td>(0.00–150.00)Ω, primary</td>
<td>-</td>
</tr>
<tr>
<td>Line reactance</td>
<td>(-150.00–150.00)Ω, primary</td>
<td>-</td>
</tr>
<tr>
<td>Load voltage adjustment constants</td>
<td>(-20.0–20.0)% of UBase</td>
<td>-</td>
</tr>
<tr>
<td>Load voltage auto correction</td>
<td>(-20.0–20.0)% of UBase</td>
<td>-</td>
</tr>
<tr>
<td>Duration time for the reverse action block signal</td>
<td>(30–6000) s</td>
<td>±0.2% or ±600 ms whichever is greater</td>
</tr>
<tr>
<td>Current limit for reverse action block</td>
<td>(0–100)% of I1Base</td>
<td>-</td>
</tr>
<tr>
<td>Overcurrent block level</td>
<td>(5–250)% of I1Base</td>
<td>±1.0% of I, at</td>
</tr>
<tr>
<td>Level for number of counted raise/lower within one hour</td>
<td>(0–30) operations/hour</td>
<td>-</td>
</tr>
<tr>
<td>Level for number of counted raise/lower within 24 hours</td>
<td>(0–100) operations/day</td>
<td>-</td>
</tr>
<tr>
<td>Time window for hunting alarm</td>
<td>(1–120) minutes</td>
<td>-</td>
</tr>
<tr>
<td>Hunting detection alarm, max operations/window</td>
<td>(3–30) operations/window</td>
<td>-</td>
</tr>
<tr>
<td>Alarm level of active power in forward and reverse direction at (10-200)% of S, and (85-120)% of UBase</td>
<td>(-9999.99–9999.99) MW</td>
<td>±1.0% of S,</td>
</tr>
<tr>
<td>Alarm level of reactive power in forward and reverse direction at (10-200)% of S, and (85-120)% of UBase</td>
<td>(-9999.99–9999.99) MVAr</td>
<td>±1.0% of S,</td>
</tr>
<tr>
<td>Time delay for alarms from power supervision</td>
<td>(1–6000) s</td>
<td>±0.2% or ±600 ms whichever is greater</td>
</tr>
<tr>
<td>Tap position for lowest and highest voltage</td>
<td>(1–63)</td>
<td>-</td>
</tr>
<tr>
<td>mA for lowest and highest voltage tap position</td>
<td>(0.000–25.000) mA</td>
<td>-</td>
</tr>
<tr>
<td>Type of code conversion</td>
<td>BIN, BCD, GRAY, SINGLE, mA</td>
<td>-</td>
</tr>
</tbody>
</table>
### Table 60. Voltage control TR1ATCC and TR8ATCC, continued

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time after position change before the value is accepted</td>
<td>(1–60) s</td>
<td>±0.2% or ±200 ms whichever is greater</td>
</tr>
<tr>
<td>Tap changer constant time-out</td>
<td>(1–120) s</td>
<td>±0.2% or ±200 ms whichever is greater</td>
</tr>
<tr>
<td>Raise/lower command output pulse duration</td>
<td>(0.5–10.0) s</td>
<td>±0.2% or ±200 ms whichever is greater</td>
</tr>
</tbody>
</table>
## Scheme communication

Table 61. Scheme communication logic for distance or overcurrent protection ZCPSCH

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheme type</td>
<td>Off</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Intertrip</td>
<td>±0.5% of ΔU</td>
</tr>
<tr>
<td></td>
<td>Permissive UR</td>
<td>±5.0% of ΔU</td>
</tr>
<tr>
<td></td>
<td>Permissive OR</td>
<td>±5.0% of ΔU</td>
</tr>
<tr>
<td></td>
<td>Blocking</td>
<td>±5.0% of ΔU</td>
</tr>
<tr>
<td></td>
<td>Delta Blocking</td>
<td>±5.0% of ΔU</td>
</tr>
<tr>
<td>Operate voltage, Delta U</td>
<td>(0–100)% of UBase</td>
<td>±5.0% of ΔU</td>
</tr>
<tr>
<td>Operate current, Delta I</td>
<td>(0–200)% of IBase</td>
<td>±5.0% of ΔI</td>
</tr>
<tr>
<td>Operate zero sequence voltage, Delta 3U₀</td>
<td>(0–100)% of UBase</td>
<td>±10.0% of Δ3U₀</td>
</tr>
<tr>
<td>Operate zero sequence current, Delta 3I₀</td>
<td>(0–200)% of IBase</td>
<td>±10.0% of Δ3I₀</td>
</tr>
<tr>
<td>Co-ordination time for blocking</td>
<td>(0.000-60.000) s</td>
<td>±0.5% ±10 ms</td>
</tr>
<tr>
<td>communication scheme</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum duration of a carrier send</td>
<td>(0.000-60.000) s</td>
<td>±0.5% ±10 ms</td>
</tr>
<tr>
<td>signal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Security timer for loss of guard</td>
<td>(0.000-60.000) s</td>
<td>±0.5% ±10 ms</td>
</tr>
<tr>
<td>signal detection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation mode of unblocking logic</td>
<td>Off</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>NoRestart</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Restart</td>
<td></td>
</tr>
</tbody>
</table>

Table 62. Current reversal and weak-end infeed logic for distance protection ZCRWPSCH

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detection level phase-to-neutral voltage</td>
<td>(10–90)% of UBase</td>
<td>±0.5% of Uᵣ</td>
</tr>
<tr>
<td>Detection level phase-to-phase voltage</td>
<td>(10–90)% of UBase</td>
<td>±0.5% of Uᵣ</td>
</tr>
<tr>
<td>Operate time for current reversal logic</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±15 ms whichever is greater</td>
</tr>
<tr>
<td>Delay time for current reversal</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±15 ms whichever is greater</td>
</tr>
<tr>
<td>Coordination time for weak-end infeed logic</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±15 ms whichever is greater</td>
</tr>
</tbody>
</table>

Table 63. Scheme communication logic for residual overcurrent protection ECPSCB

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheme type</td>
<td>Permissive Underreaching</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Permissive Overreaching</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Blocking</td>
<td></td>
</tr>
<tr>
<td>Communication scheme coordination time</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±20 ms whichever is greater</td>
</tr>
</tbody>
</table>
### Table 64. Current reversal and weak-end infeed logic for residual overcurrent protection ECRWPSCH

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate mode of WEI logic</td>
<td>Off</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Echo</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Echo &amp; Trip</td>
<td></td>
</tr>
<tr>
<td>Operate voltage 3U0 for WEI trip</td>
<td>(5-70)% of UBase</td>
<td>±0.5% of Ut</td>
</tr>
<tr>
<td>Operate time for current reversal logic</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±30 ms whichever is greater</td>
</tr>
<tr>
<td>Delay time for current reversal</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±30 ms whichever is greater</td>
</tr>
<tr>
<td>Coordination time for weak-end infeed logic</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±30 ms whichever is greater</td>
</tr>
</tbody>
</table>
## Logic

### Table 65. Tripping logic common 3-phase output SMPPTRC

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trip action</td>
<td>3-ph, 1/3-ph, 1/2/3-ph</td>
<td>-</td>
</tr>
<tr>
<td>Minimum trip pulse length</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±15 ms whichever is greater</td>
</tr>
<tr>
<td>3-pole trip delay</td>
<td>(0.020-0.500) s</td>
<td>±0.2% or ±15 ms whichever is greater</td>
</tr>
<tr>
<td>Evolving fault delay</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±15 ms whichever is greater</td>
</tr>
</tbody>
</table>

### Table 66. Number of SMPPTRC instances

<table>
<thead>
<tr>
<th>Function</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMPPTRC</td>
<td>3 ms 8 ms 100 ms</td>
</tr>
<tr>
<td></td>
<td>6</td>
</tr>
</tbody>
</table>

### Table 67. Number of TMAGAPC instances

<table>
<thead>
<tr>
<th>Function</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMAGAPC</td>
<td>3 ms 8 ms 100 ms</td>
</tr>
<tr>
<td></td>
<td>6</td>
</tr>
</tbody>
</table>

### Table 68. Number of ALMCALH instances

<table>
<thead>
<tr>
<th>Function</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALMCALH</td>
<td>3 ms 8 ms 100 ms</td>
</tr>
<tr>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>

### Table 69. Number of WRNCALH instances

<table>
<thead>
<tr>
<th>Function</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td>WRNCALH</td>
<td>3 ms 8 ms 100 ms</td>
</tr>
<tr>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>

### Table 70. Number of INDCALH instances

<table>
<thead>
<tr>
<th>Function</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td>INDCALH</td>
<td>3 ms 8 ms 100 ms</td>
</tr>
<tr>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>

### Table 71. Number of AND instances

<table>
<thead>
<tr>
<th>Logic block</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td>AND</td>
<td>3 ms 8 ms 100 ms</td>
</tr>
<tr>
<td></td>
<td>60 60 160</td>
</tr>
</tbody>
</table>
### Table 72. Number of GATE instances

<table>
<thead>
<tr>
<th>Logic block</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 ms</td>
</tr>
<tr>
<td>GATE</td>
<td>10</td>
</tr>
</tbody>
</table>

### Table 73. Number of INV instances

<table>
<thead>
<tr>
<th>Logic block</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 ms</td>
</tr>
<tr>
<td>INV</td>
<td>90</td>
</tr>
</tbody>
</table>

### Table 74. Number of LLD instances

<table>
<thead>
<tr>
<th>Logic block</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 ms</td>
</tr>
<tr>
<td>LLD</td>
<td>10</td>
</tr>
</tbody>
</table>

### Table 75. Number of OR instances

<table>
<thead>
<tr>
<th>Logic block</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 ms</td>
</tr>
<tr>
<td>OR</td>
<td>60</td>
</tr>
</tbody>
</table>

### Table 76. Number of PULSETIMER instances

<table>
<thead>
<tr>
<th>Logic block</th>
<th>Quantity with cycle time</th>
<th>Range or Value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>PULSETIMER</td>
<td>3 ms</td>
<td>8 ms</td>
<td>100 ms</td>
</tr>
</tbody>
</table>

### Table 77. Number of RSMEMORY instances

<table>
<thead>
<tr>
<th>Logic block</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 ms</td>
</tr>
<tr>
<td>RSMEMORY</td>
<td>10</td>
</tr>
</tbody>
</table>

### Table 78. Number of SRMEMORY instances

<table>
<thead>
<tr>
<th>Logic block</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 ms</td>
</tr>
<tr>
<td>SRMEMORY</td>
<td>10</td>
</tr>
</tbody>
</table>

### Table 79. Number of TIMERSET instances

<table>
<thead>
<tr>
<th>Logic block</th>
<th>Quantity with cycle time</th>
<th>Range or Value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIMERSET</td>
<td>3 ms</td>
<td>8 ms</td>
<td>100 ms</td>
</tr>
</tbody>
</table>
### Table 80. Number of XOR instances

<table>
<thead>
<tr>
<th>Logic block</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 ms</td>
</tr>
<tr>
<td>XOR</td>
<td>10</td>
</tr>
</tbody>
</table>

### Table 81. Number of ANDQT instances

<table>
<thead>
<tr>
<th>Logic block</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 ms</td>
</tr>
<tr>
<td>ANDQT</td>
<td>-</td>
</tr>
</tbody>
</table>

### Table 82. Number of INDCOMBSPQT instances

<table>
<thead>
<tr>
<th>Logic block</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td>INDCOMBSPQT</td>
<td>3 ms</td>
</tr>
<tr>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>

### Table 83. Number of INDEXTSPQT instances

<table>
<thead>
<tr>
<th>Logic block</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td>INDEXTSPQT</td>
<td>3 ms</td>
</tr>
<tr>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>

### Table 84. Number of INVALIDQT instances

<table>
<thead>
<tr>
<th>Logic block</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td>INVALIDQT</td>
<td>3 ms</td>
</tr>
<tr>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>

### Table 85. Number of INVERTERQT instances

<table>
<thead>
<tr>
<th>Logic block</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td>INVERTERQT</td>
<td>3 ms</td>
</tr>
<tr>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>

### Table 86. Number of ORQT instances

<table>
<thead>
<tr>
<th>Logic block</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORQT</td>
<td>3 ms</td>
</tr>
<tr>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>

### Table 87. Number of PULSETIMERQT instances

<table>
<thead>
<tr>
<th>Logic block</th>
<th>Range or Value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>PULSETIMERQT</td>
<td>(0.000–90000.000) s</td>
<td>±0.5% ±10 ms</td>
</tr>
</tbody>
</table>
Table 88. Number of RSMEMORYQT instances

<table>
<thead>
<tr>
<th>Logic block</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 ms</td>
</tr>
<tr>
<td>RSMEMORYQT</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 89. Number of SRMEMORYQT instances

<table>
<thead>
<tr>
<th>Logic block</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 ms</td>
</tr>
<tr>
<td>SRMEMORYQT</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 90. Number of TIMERSETQT instances

<table>
<thead>
<tr>
<th>Logic block</th>
<th>Quantity with cycle time</th>
<th>Range or Value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 ms</td>
<td>8 ms</td>
<td>100 ms</td>
</tr>
<tr>
<td>TIMERSETQT</td>
<td>-</td>
<td>10</td>
<td>30</td>
</tr>
</tbody>
</table>

Table 91. Number of XORQT instances

<table>
<thead>
<tr>
<th>Logic block</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 ms</td>
</tr>
<tr>
<td>XORQT</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 92. Number of instances in the extension logic package

<table>
<thead>
<tr>
<th>Logic block</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 ms</td>
</tr>
<tr>
<td>AND</td>
<td>40</td>
</tr>
<tr>
<td>GATE</td>
<td>-</td>
</tr>
<tr>
<td>INV</td>
<td>40</td>
</tr>
<tr>
<td>LLD</td>
<td>-</td>
</tr>
<tr>
<td>OR</td>
<td>40</td>
</tr>
<tr>
<td>PULSETIMER</td>
<td>5</td>
</tr>
<tr>
<td>SLGAPC</td>
<td>10</td>
</tr>
<tr>
<td>SRMEMORY</td>
<td>-</td>
</tr>
<tr>
<td>TIMERSET</td>
<td>-</td>
</tr>
<tr>
<td>VSGAPC</td>
<td>10</td>
</tr>
<tr>
<td>XOR</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 93. Number of B16I instances

<table>
<thead>
<tr>
<th>Function</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 ms</td>
</tr>
<tr>
<td>B16I</td>
<td>6</td>
</tr>
</tbody>
</table>
### Table 94. Number of BTIGAPC instances

<table>
<thead>
<tr>
<th>Function</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 ms</td>
</tr>
<tr>
<td>BTIGAPC</td>
<td>4</td>
</tr>
</tbody>
</table>

### Table 95. Number of IB16 instances

<table>
<thead>
<tr>
<th>Function</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 ms</td>
</tr>
<tr>
<td>IB16</td>
<td>6</td>
</tr>
</tbody>
</table>

### Table 96. Number of ITBGAPC instances

<table>
<thead>
<tr>
<th>Function</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 ms</td>
</tr>
<tr>
<td>ITBGAPC</td>
<td>4</td>
</tr>
</tbody>
</table>

### Table 97. Elapsed time integrator with limit transgression and overflow supervision TEIGAPC

<table>
<thead>
<tr>
<th>Function</th>
<th>Cycle time (ms)</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elapsed time integration</td>
<td>3</td>
<td>0 ~ 999999.9 s</td>
<td>±0.2% or ±20 ms whichever is greater</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>0 ~ 999999.9 s</td>
<td>±0.2% or ±100 ms whichever is greater</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>0 ~ 999999.9 s</td>
<td>±0.2% or ±250 ms whichever is greater</td>
</tr>
</tbody>
</table>

### Table 98. Number of TEIGAPC instances

<table>
<thead>
<tr>
<th>Function</th>
<th>Quantity with cycle time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 ms</td>
</tr>
<tr>
<td>TEIGAPC</td>
<td>4</td>
</tr>
</tbody>
</table>

### Table 99. Running hour-meter TEILGAPC

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time limit for alarm supervision</td>
<td>(0 - 99999.9) hours</td>
<td>±0.1% of set value</td>
</tr>
<tr>
<td>Time limit for warning supervision</td>
<td>(0 - 99999.9) hours</td>
<td>±0.1% of set value</td>
</tr>
<tr>
<td>Time limit for overflow supervision</td>
<td>Fixed to 99999.9 hours</td>
<td>±0.1%</td>
</tr>
</tbody>
</table>
### Monitoring

#### Table 100. Measurements CVMMXN

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>((0.95-1.05) \times f)</td>
<td>(\pm 2.0) mHz</td>
</tr>
<tr>
<td>Voltage</td>
<td>((10) to (300)) V</td>
<td>(\pm 0.3%) of (U) at (U \leq 50) V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(\pm 0.2%) of (U) at (U &gt; 50) V</td>
</tr>
<tr>
<td>Current</td>
<td>((0.1-4.0) \times I)</td>
<td>(\pm 0.8%) of (I) at (0.1 \times I &lt; I &lt; 0.2 \times I)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(\pm 0.5%) of (I) at (0.2 \times I &lt; I &lt; 0.5 \times I)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(\pm 0.2%) of (I) at (0.5 \times I &lt; I &lt; 4.0 \times I)</td>
</tr>
<tr>
<td>Active power, (P)</td>
<td>((10) to (300)) V</td>
<td>(\pm 0.5%) of (S) at (S \leq 0.5 \times S)</td>
</tr>
<tr>
<td></td>
<td>((0.1-4.0) \times I)</td>
<td>(\pm 0.5%) of (S) at (S &gt; 0.5 \times S)</td>
</tr>
<tr>
<td></td>
<td>((100) to (220)) V</td>
<td>(\pm 0.2%) of (P)</td>
</tr>
<tr>
<td></td>
<td>((0.5-2.0) \times I)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(\cos \varphi &gt; 0.7)</td>
<td></td>
</tr>
<tr>
<td>Reactive power, (Q)</td>
<td>((10) to (300)) V</td>
<td>(\pm 0.5%) of (S) at (S \leq 0.5 \times S)</td>
</tr>
<tr>
<td></td>
<td>((0.1-4.0) \times I)</td>
<td>(\pm 0.5%) of (S) at (S &gt; 0.5 \times S)</td>
</tr>
<tr>
<td></td>
<td>((100) to (220)) V</td>
<td>(\pm 0.2%) of (Q)</td>
</tr>
<tr>
<td></td>
<td>((0.5-2.0) \times I)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(\cos \varphi &lt; 0.7)</td>
<td></td>
</tr>
<tr>
<td>Apparent power, (S)</td>
<td>((10) to (300)) V</td>
<td>(\pm 0.5%) of (S) at (S \leq 0.5 \times S)</td>
</tr>
<tr>
<td></td>
<td>((0.1-4.0) \times I)</td>
<td>(\pm 0.5%) of (S) at (S &gt; 0.5 \times S)</td>
</tr>
<tr>
<td></td>
<td>((100) to (220)) V</td>
<td>(\pm 0.2%) of (S)</td>
</tr>
<tr>
<td></td>
<td>((0.5-2.0) \times I)</td>
<td></td>
</tr>
<tr>
<td>Power factor, (\cos (\varphi))</td>
<td>((10) to (300)) V</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td></td>
<td>((0.1-4.0) \times I)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>((100) to (220)) V</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>((0.5-2.0) \times I)</td>
<td></td>
</tr>
</tbody>
</table>

#### Table 101. Phase current measurement CMMXU

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current at symmetrical load</td>
<td>((0.1-4.0) \times I)</td>
<td>(\pm 0.3%) of (I) at (I \leq 0.5 \times I)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(\pm 0.3%) of (I) at (I &gt; 0.5 \times I)</td>
</tr>
<tr>
<td>Phase angle at symmetrical load</td>
<td>((0.1-4.0) \times I)</td>
<td>(\pm 1.0) degrees at (0.1 \times I &lt; I &lt; 0.5 \times I)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(\pm 0.5) degrees at (0.5 \times I, &lt; I &lt; 4.0 \times I)</td>
</tr>
</tbody>
</table>

#### Table 102. Phase-phase voltage measurement VMMXU

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>((10) to (300)) V</td>
<td>(\pm 0.5%) of (U) at (U \leq 50) V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(\pm 0.2%) of (U) at (U &gt; 50) V</td>
</tr>
<tr>
<td>Phase angle</td>
<td>((10) to (300)) V</td>
<td>(\pm 0.5) degrees at (U \leq 50) V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(\pm 0.2) degrees at (U &gt; 50) V</td>
</tr>
</tbody>
</table>
### Table 103. Phase-neutral voltage measurement VNMMXU

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>(5 to 175) V</td>
<td>±0.5% of U at U ≤ 50 V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.2% of U at U &gt; 50 V</td>
</tr>
<tr>
<td>Phase angle</td>
<td>(5 to 175) V</td>
<td>±0.5 degrees at U ≤ 50 V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.2 degrees at U &gt; 50 V</td>
</tr>
</tbody>
</table>

### Table 104. Current sequence component measurement CMSQI

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current positive sequence, I₁</td>
<td>(0.1–4.0) × Iᵢ</td>
<td>±0.3% of Iᵢ at I ≤ 0.5 × Iᵢ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.3% of I at I &gt; 0.5 × Iᵢ</td>
</tr>
<tr>
<td>Current zero sequence, I₀</td>
<td>(0.1–1.0) × Iᵢ</td>
<td>±0.3% of Iᵢ at I ≤ 0.5 × Iᵢ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.3% of I at I &gt; 0.5 × Iᵢ</td>
</tr>
<tr>
<td>Current negative sequence, I₂</td>
<td>(0.1–1.0) × Iᵢ</td>
<td>±0.3% of Iᵢ at I ≤ 0.5 × Iᵢ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.3% of I at I &gt; 0.5 × Iᵢ</td>
</tr>
<tr>
<td>Phase angle</td>
<td>(0.1–4.0) × Iᵢ</td>
<td>±1.0 degrees at 0.1 × Iᵢ &lt; I ≤ 0.5 × Iᵢ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.5 degrees at 0.5 × Iᵢ &lt; I ≤ 4.0 × Iᵢ</td>
</tr>
</tbody>
</table>

### Table 105. Voltage sequence measurement VMSQI

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage positive sequence, U₁</td>
<td>(10 to 300) V</td>
<td>±0.5% of U at U ≤ 50 V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.2% of U at U &gt; 50 V</td>
</tr>
<tr>
<td>Voltage zero sequence, U₀</td>
<td>(10 to 300) V</td>
<td>±0.5% of U at U ≤ 50 V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.2% of U at U &gt; 50 V</td>
</tr>
<tr>
<td>Voltage negative sequence, U₂</td>
<td>(10 to 300) V</td>
<td>±0.5% of U at U ≤ 50 V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.2% of U at U &gt; 50 V</td>
</tr>
<tr>
<td>Phase angle</td>
<td>(10 to 300) V</td>
<td>±0.5 degrees at U ≤ 50 V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>±0.2 degrees at U &gt; 50 V</td>
</tr>
</tbody>
</table>

### Table 106. Supervision of mA input signals

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>mA measuring function</td>
<td>±5, ±10, ±20 mA</td>
<td>±0.1 % of set value ±0.005 mA</td>
</tr>
<tr>
<td></td>
<td>0-5, 0-10, 0-20, 4-20 mA</td>
<td></td>
</tr>
<tr>
<td>Max current of transducer to input</td>
<td>(-20.00 to +20.00) mA</td>
<td></td>
</tr>
<tr>
<td>Min current of transducer to input</td>
<td>(-20.00 to +20.00) mA</td>
<td></td>
</tr>
<tr>
<td>Alarm level for input</td>
<td>(-20.00 to +20.00) mA</td>
<td></td>
</tr>
<tr>
<td>Warning level for input</td>
<td>(-20.00 to +20.00) mA</td>
<td></td>
</tr>
<tr>
<td>Alarm hysteresis for input</td>
<td>(0.0-20.0) mA</td>
<td></td>
</tr>
</tbody>
</table>
Table 107. Disturbance report DRPRDRE

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-fault time</td>
<td>(0.05–9.90) s</td>
<td>-</td>
</tr>
<tr>
<td>Post-fault time</td>
<td>(0.1–10.0) s</td>
<td>-</td>
</tr>
<tr>
<td>Limit time</td>
<td>(0.5–10.0) s</td>
<td>-</td>
</tr>
<tr>
<td>Maximum number of recordings</td>
<td>100, first in - first out</td>
<td>-</td>
</tr>
<tr>
<td>Time tagging resolution</td>
<td>1 ms</td>
<td>See table 138</td>
</tr>
<tr>
<td>Maximum number of analog inputs</td>
<td>30 + 10 (external + internally derived)</td>
<td>-</td>
</tr>
<tr>
<td>Maximum number of binary inputs</td>
<td>352</td>
<td>-</td>
</tr>
<tr>
<td>Maximum number of phasors in the Trip Value recorder per recording</td>
<td>30</td>
<td>-</td>
</tr>
<tr>
<td>Maximum number of indications in a disturbance report</td>
<td>96</td>
<td>-</td>
</tr>
<tr>
<td>Maximum number of events in the Event recording per recording</td>
<td>150</td>
<td>-</td>
</tr>
<tr>
<td>Maximum number of events in the Event list</td>
<td>1000, first in - first out</td>
<td>-</td>
</tr>
<tr>
<td>Maximum total recording time (3.4 s recording time and maximum number of channels, typical value)</td>
<td>340 seconds (100 recordings) at 50 Hz, 280 seconds (80 recordings) at 60 Hz</td>
<td>-</td>
</tr>
<tr>
<td>Sampling rate</td>
<td>1 kHz at 50 Hz</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>1.2 kHz at 60 Hz</td>
<td>-</td>
</tr>
<tr>
<td>Recording bandwidth</td>
<td>(5-300) Hz</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 108. Insulation gas monitoring function SSIMG

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure alarm level</td>
<td>1.00-100.00</td>
<td>±10.0% of set value</td>
</tr>
<tr>
<td>Pressure lockout level</td>
<td>1.00-100.00</td>
<td>±10.0% of set value</td>
</tr>
<tr>
<td>Temperature alarm level</td>
<td>-40.00-200.00</td>
<td>±2.5% of set value</td>
</tr>
<tr>
<td>Temperature lockout level</td>
<td>-40.00-200.00</td>
<td>±2.5% of set value</td>
</tr>
<tr>
<td>Time delay for pressure alarm</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±250ms whichever is greater</td>
</tr>
<tr>
<td>Reset time delay for pressure alarm</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±250ms whichever is greater</td>
</tr>
<tr>
<td>Time delay for pressure lockout</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±250ms whichever is greater</td>
</tr>
<tr>
<td>Time delay for temperature alarm</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±250ms whichever is greater</td>
</tr>
<tr>
<td>Reset time delay for temperature alarm</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±250ms whichever is greater</td>
</tr>
<tr>
<td>Time delay for temperature lockout</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±250ms whichever is greater</td>
</tr>
</tbody>
</table>
### Table 109. Insulation liquid monitoring function SSIML

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil alarm level</td>
<td>1.00-100.00</td>
<td>±10.0% of set value</td>
</tr>
<tr>
<td>Oil lockout level</td>
<td>1.00-100.00</td>
<td>±10.0% of set value</td>
</tr>
<tr>
<td>Temperature alarm level</td>
<td>-40.00-200.00</td>
<td>±2.5% of set value</td>
</tr>
<tr>
<td>Temperature lockout level</td>
<td>-40.00-200.00</td>
<td>±2.5% of set value</td>
</tr>
<tr>
<td>Time delay for oil alarm</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±250ms whichever is greater</td>
</tr>
<tr>
<td>Reset time delay for oil alarm</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±250ms whichever is greater</td>
</tr>
<tr>
<td>Time delay for oil lockout</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±250ms whichever is greater</td>
</tr>
<tr>
<td>Time delay for temperature alarm</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±250ms whichever is greater</td>
</tr>
<tr>
<td>Reset time delay for temperature alarm</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±250ms whichever is greater</td>
</tr>
<tr>
<td>Time delay for temperature lockout</td>
<td>(0.000-60.000) s</td>
<td>±0.2% or ±250ms whichever is greater</td>
</tr>
</tbody>
</table>

### Table 110. Circuit breaker condition monitoring SSCBR

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alarm level for open and close travel time</td>
<td>(0 – 200) ms</td>
<td>±3 ms</td>
</tr>
<tr>
<td>Alarm level for number of operations</td>
<td>(0 – 9999)</td>
<td></td>
</tr>
<tr>
<td>Independent time delay for spring charging time alarm</td>
<td>(0.00 – 60.00) s</td>
<td>±0.2% or ±30 ms whichever is greater</td>
</tr>
<tr>
<td>Independent time delay for gas pressure alarm</td>
<td>(0.00 – 60.00) s</td>
<td>±0.2% or ±30 ms whichever is greater</td>
</tr>
<tr>
<td>Independent time delay for gas pressure lockout</td>
<td>(0.00 – 60.00) s</td>
<td>±0.2% or ±30 ms whichever is greater</td>
</tr>
<tr>
<td>CB Contact Travel Time, opening and closing</td>
<td></td>
<td>±3 ms</td>
</tr>
<tr>
<td>Remaining Life of CB</td>
<td></td>
<td>±2 operations</td>
</tr>
<tr>
<td>Accumulated Energy</td>
<td></td>
<td>±1.0% or ±0.5 whichever is greater</td>
</tr>
</tbody>
</table>

### Table 111. Fault locator LMBRFLO

<table>
<thead>
<tr>
<th>Function</th>
<th>Value or range</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactive and resistive reach</td>
<td>(0.001-1500.000) Ω/phase</td>
<td>±2.0% static accuracy Conditions: Voltage range: (0.1-1.1) x U, Current range: (0.5-30) x I,</td>
</tr>
<tr>
<td>Phase selection</td>
<td>According to input signals</td>
<td>-</td>
</tr>
<tr>
<td>Maximum number of fault locations</td>
<td>100</td>
<td>-</td>
</tr>
</tbody>
</table>
### Table 112. Event list

<table>
<thead>
<tr>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffer capacity</td>
<td>Maximum number of events in the list</td>
</tr>
<tr>
<td>Resolution</td>
<td></td>
</tr>
<tr>
<td>Accuracy</td>
<td></td>
</tr>
</tbody>
</table>

### Table 113. Indications

<table>
<thead>
<tr>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffer capacity</td>
<td>Maximum number of indications presented for single disturbance</td>
</tr>
<tr>
<td></td>
<td>Maximum number of recorded disturbances</td>
</tr>
</tbody>
</table>

### Table 114. Event recorder

<table>
<thead>
<tr>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffer capacity</td>
<td>Maximum number of events in disturbance report</td>
</tr>
<tr>
<td></td>
<td>Maximum number of disturbance reports</td>
</tr>
<tr>
<td>Resolution</td>
<td></td>
</tr>
<tr>
<td>Accuracy</td>
<td></td>
</tr>
</tbody>
</table>

### Table 115. Trip value recorder

<table>
<thead>
<tr>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffer capacity</td>
<td>Maximum number of analog inputs</td>
</tr>
<tr>
<td></td>
<td>Maximum number of disturbance reports</td>
</tr>
</tbody>
</table>

### Table 116. Disturbance recorder

<table>
<thead>
<tr>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffer capacity</td>
<td>Maximum number of analog inputs</td>
</tr>
<tr>
<td></td>
<td>Maximum number of binary inputs</td>
</tr>
<tr>
<td></td>
<td>Maximum number of disturbance reports</td>
</tr>
<tr>
<td>Maximum total recording time (3.4 s recording time and maximum number of channels, typical value)</td>
<td>340 seconds (100 recordings) at 50 Hz</td>
</tr>
<tr>
<td></td>
<td>280 seconds (80 recordings) at 60 Hz</td>
</tr>
</tbody>
</table>

### Table 117. Limit counter L4UFCNT

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Counter value</td>
<td>0-65535</td>
<td>-</td>
</tr>
<tr>
<td>Max. count up speed</td>
<td>30 pulses/s (50% duty cycle)</td>
<td>-</td>
</tr>
</tbody>
</table>
## Metering

### Table 118. Pulse-counter logic PCFCNT

<table>
<thead>
<tr>
<th>Function</th>
<th>Setting range</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input frequency</td>
<td>See Binary Input Module (BIM)</td>
<td>-</td>
</tr>
<tr>
<td>Cycle time for report of counter value</td>
<td>(1–3600) s</td>
<td>-</td>
</tr>
</tbody>
</table>

### Table 119. Energy metering ETPMMTR

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy metering</td>
<td>kWh Export/Import, kvarh Export/Import</td>
<td>Input from MMXU. No extra error at steady load</td>
</tr>
</tbody>
</table>
### Station communication

**Table 120. Communication protocols**

<table>
<thead>
<tr>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocol</td>
<td>IEC 61850-8-1</td>
</tr>
<tr>
<td>Communication speed for the IEDs</td>
<td>100BASE-FX</td>
</tr>
<tr>
<td>Protocol</td>
<td>IEC 60870–5–103</td>
</tr>
<tr>
<td>Communication speed for the IEDs</td>
<td>9600 or 19200 Bd</td>
</tr>
<tr>
<td>Protocol</td>
<td>DNP3.0</td>
</tr>
<tr>
<td>Communication speed for the IEDs</td>
<td>300–19200 Bd</td>
</tr>
<tr>
<td>Protocol</td>
<td>TCP/IP, Ethernet</td>
</tr>
<tr>
<td>Communication speed for the IEDs</td>
<td>100 Mbit/s</td>
</tr>
</tbody>
</table>

**Table 121. IEC 61850-9-2 communication protocol**

<table>
<thead>
<tr>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocol</td>
<td>IEC 61850-9-2</td>
</tr>
<tr>
<td>Communication speed for the IEDs</td>
<td>100BASE-FX</td>
</tr>
</tbody>
</table>

**Table 122. LON communication protocol**

<table>
<thead>
<tr>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocol</td>
<td>LON</td>
</tr>
<tr>
<td>Communication speed</td>
<td>1.25 Mbit/s</td>
</tr>
</tbody>
</table>

**Table 123. SPA communication protocol**

<table>
<thead>
<tr>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocol</td>
<td>SPA</td>
</tr>
<tr>
<td>Communication speed</td>
<td>300, 1200, 2400, 4800, 9600, 19200 or 38400 Bd</td>
</tr>
<tr>
<td>Slave number</td>
<td>1 to 899</td>
</tr>
</tbody>
</table>

**Table 124. IEC 60870-5-103 communication protocol**

<table>
<thead>
<tr>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocol</td>
<td>IEC 60870-5-103</td>
</tr>
<tr>
<td>Communication speed</td>
<td>9600, 19200 Bd</td>
</tr>
</tbody>
</table>
### Table 125. SLM – LON port

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Range or value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optical connector</td>
<td>Glass fiber: type ST</td>
</tr>
<tr>
<td></td>
<td>Plastic fiber: type HFBR snap-in</td>
</tr>
<tr>
<td>Fiber, optical budget</td>
<td>Glass fiber: 11 dB (1000m/3000 ft typically *)</td>
</tr>
<tr>
<td></td>
<td>Plastic fiber: 7 dB (10m/35ft typically *)</td>
</tr>
<tr>
<td>Fiber diameter</td>
<td>Glass fiber: 62.5/125 μm</td>
</tr>
<tr>
<td></td>
<td>Plastic fiber: 1 mm</td>
</tr>
</tbody>
</table>

*) depending on optical budget calculation

### Table 126. SLM – SPA/IEC 60870-5-103/DNP3 port

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Range or value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optical connector</td>
<td>Glass fiber: type ST</td>
</tr>
<tr>
<td></td>
<td>Plastic fiber: type HFBR snap-in</td>
</tr>
<tr>
<td>Fiber, optical budget</td>
<td>Glass fiber: 11 dB (1000m/3000ft m typically *)</td>
</tr>
<tr>
<td></td>
<td>Plastic fiber: 7 dB (25m/80ft m typically *)</td>
</tr>
<tr>
<td>Fiber diameter</td>
<td>Glass fiber: 62.5/125 μm</td>
</tr>
<tr>
<td></td>
<td>Plastic fiber: 1 mm</td>
</tr>
</tbody>
</table>

*) depending on optical budget calculation

### Table 127. Galvanic X.21 line data communication module (X.21-LDCM)

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Range or value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connector, X.21</td>
<td>Micro D-sub, 15-pole male, 1.27 mm (0.050&quot;) pitch</td>
</tr>
<tr>
<td>Connector, ground selection</td>
<td>2 pole screw terminal</td>
</tr>
<tr>
<td>Standard</td>
<td>CCITT X21</td>
</tr>
<tr>
<td>Communication speed</td>
<td>64 kbit/s</td>
</tr>
<tr>
<td>Insulation</td>
<td>1 kV</td>
</tr>
<tr>
<td>Maximum cable length</td>
<td>100 m</td>
</tr>
</tbody>
</table>

### Table 128. Galvanic RS485 communication module

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Range or value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication speed</td>
<td>2400–19200 bauds</td>
</tr>
<tr>
<td>External connectors</td>
<td>RS-485 6-pole connector</td>
</tr>
<tr>
<td></td>
<td>Soft ground 2-pole connector</td>
</tr>
</tbody>
</table>

### Table 129. IEC 62439-3 Edition 1 and Edition 2 parallel redundancy protocol

<table>
<thead>
<tr>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication speed</td>
<td>100 Base-FX</td>
</tr>
</tbody>
</table>
### Remote communication

Table 130. Line data communication module

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Range or value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of LDCM</td>
<td>Short range (SR)</td>
</tr>
<tr>
<td></td>
<td>Medium range (MR)</td>
</tr>
<tr>
<td></td>
<td>Long range (LR)</td>
</tr>
<tr>
<td>Type of fiber</td>
<td>Multi-mode fiber glass 62.5/125 µm</td>
</tr>
<tr>
<td></td>
<td>Multi-mode fiber glass 50/125 µm</td>
</tr>
<tr>
<td></td>
<td>Single-mode fiber glass 9/125 µm</td>
</tr>
<tr>
<td>Peak Emission Wave length</td>
<td>Nominal</td>
</tr>
<tr>
<td></td>
<td>Maximum</td>
</tr>
<tr>
<td></td>
<td>Minimum</td>
</tr>
<tr>
<td></td>
<td>820 nm</td>
</tr>
<tr>
<td></td>
<td>865 nm</td>
</tr>
<tr>
<td></td>
<td>792 nm</td>
</tr>
<tr>
<td></td>
<td>1310 nm</td>
</tr>
<tr>
<td></td>
<td>1330 nm</td>
</tr>
<tr>
<td></td>
<td>1290 nm</td>
</tr>
<tr>
<td></td>
<td>1550 nm</td>
</tr>
<tr>
<td></td>
<td>1580 nm</td>
</tr>
<tr>
<td></td>
<td>1520 nm</td>
</tr>
<tr>
<td>Optical budget</td>
<td>Multi-mode fiber glass 62.5/125 µm</td>
</tr>
<tr>
<td></td>
<td>18.8 dB (typical distance about 3 km/2 mile *)</td>
</tr>
<tr>
<td></td>
<td>26.8 dB (typical distance 80 km/50 mile *)</td>
</tr>
<tr>
<td></td>
<td>28.7 dB (typical distance 120 km/68 mile *)</td>
</tr>
<tr>
<td></td>
<td>Multi-mode fiber glass 50/125 µm</td>
</tr>
<tr>
<td></td>
<td>11.5 dB (typical distance about 2 km/1 mile *)</td>
</tr>
<tr>
<td>Optical connector</td>
<td>Type ST</td>
</tr>
<tr>
<td>Protocol</td>
<td>Type FC/PC</td>
</tr>
<tr>
<td></td>
<td>Type FC/PC</td>
</tr>
<tr>
<td>Data transmission</td>
<td>Synchronous</td>
</tr>
<tr>
<td></td>
<td>Synchronous</td>
</tr>
<tr>
<td></td>
<td>Synchronous</td>
</tr>
<tr>
<td>Transmission rate / Data rate</td>
<td>64 kbit/s</td>
</tr>
<tr>
<td></td>
<td>64 kbit/s</td>
</tr>
<tr>
<td></td>
<td>64 kbit/s</td>
</tr>
<tr>
<td>Clock source</td>
<td>Internal or derived from received signal</td>
</tr>
<tr>
<td></td>
<td>Internal or derived from received signal</td>
</tr>
<tr>
<td></td>
<td>Internal or derived from received signal</td>
</tr>
</tbody>
</table>

*) depending on optical budget calculation

**) C37.94 originally defined just for multi-mode; using same header, configuration and data format as C37.94
## Hardware

### IED

<table>
<thead>
<tr>
<th>Table 131. Case</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Material</strong></td>
</tr>
<tr>
<td>Front plate</td>
</tr>
<tr>
<td>Surface treatment</td>
</tr>
<tr>
<td>Finish</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 132. Water and dust protection level according to IEC 60529</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front</td>
</tr>
<tr>
<td>Sides, top and bottom</td>
</tr>
<tr>
<td>Rear side</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 133. Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Case size</strong></td>
</tr>
<tr>
<td>6U, 1/2 x 19&quot;</td>
</tr>
<tr>
<td>6U, 3/4 x 19&quot;</td>
</tr>
<tr>
<td>6U, 1/1 x 19&quot;</td>
</tr>
</tbody>
</table>

### Electrical safety

<table>
<thead>
<tr>
<th>Table 134. Electrical safety according to IEC 60255-27</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Equipment class</strong></td>
</tr>
<tr>
<td><strong>Overvoltage category</strong></td>
</tr>
<tr>
<td><strong>Pollution degree</strong></td>
</tr>
</tbody>
</table>

### Connection system

<table>
<thead>
<tr>
<th>Table 135. CT and VT circuit connectors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Connector type</strong></td>
</tr>
<tr>
<td>Screw compression type</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Terminal blocks suitable for ring lug terminals</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 136. Auxiliary power supply and binary I/O connectors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Connector type</strong></td>
</tr>
<tr>
<td>Screw compression type</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Terminal blocks suitable for ring lug terminals</td>
</tr>
</tbody>
</table>
Because of limitations of space, when ring lug terminal is ordered for Binary I/O connections, one blank slot is necessary between two adjacent IO cards. Please refer to the ordering particulars for details.
Basic IED functions

Table 137. Self supervision with internal event list

<table>
<thead>
<tr>
<th>Data</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recording manner</td>
<td>Continuous, event controlled</td>
</tr>
<tr>
<td>List size</td>
<td>40 events, first in-first out</td>
</tr>
</tbody>
</table>

Table 138. Time synchronization, time tagging

<table>
<thead>
<tr>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time tagging resolution, events and sampled measurement values</td>
<td>1 ms</td>
</tr>
<tr>
<td>Time tagging error with synchronization once/min (minute pulse synchronization), events and sampled measurement values</td>
<td>± 1.0 ms typically</td>
</tr>
<tr>
<td>Time tagging error with SNTP synchronization, sampled measurement values</td>
<td>± 1.0 ms typically</td>
</tr>
</tbody>
</table>

Table 139. GPS time synchronization module (GTM)

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receiver</td>
<td>–</td>
<td>±1µs relative UTC</td>
</tr>
<tr>
<td>Time to reliable time reference with antenna in new position or after power loss longer than 1 month</td>
<td>&lt;30 minutes</td>
<td>–</td>
</tr>
<tr>
<td>Time to reliable time reference after a power loss longer than 48 hours</td>
<td>&lt;15 minutes</td>
<td>–</td>
</tr>
<tr>
<td>Time to reliable time reference after a power loss shorter than 48 hours</td>
<td>&lt;5 minutes</td>
<td>–</td>
</tr>
</tbody>
</table>

Table 140. GPS – Antenna and cable

<table>
<thead>
<tr>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max antenna cable attenuation</td>
<td>26 db @ 1.6 GHz</td>
</tr>
<tr>
<td>Antenna cable impedance</td>
<td>50 ohm</td>
</tr>
<tr>
<td>Lightning protection</td>
<td>Must be provided externally</td>
</tr>
<tr>
<td>Antenna cable connector</td>
<td>SMA in receiver end, TNC in antenna end</td>
</tr>
<tr>
<td>Accuracy</td>
<td>+/-1µs</td>
</tr>
</tbody>
</table>
Table 141. IRIG-B

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Rated value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of channels IRIG-B</td>
<td>1</td>
</tr>
<tr>
<td>Number of optical channels</td>
<td>1</td>
</tr>
<tr>
<td><strong>Electrical connector:</strong></td>
<td></td>
</tr>
<tr>
<td>Electrical connector IRIG-B</td>
<td>BNC</td>
</tr>
<tr>
<td>Pulse-width modulated</td>
<td>5 Vpp</td>
</tr>
<tr>
<td>Amplitude modulated</td>
<td></td>
</tr>
<tr>
<td>– low level</td>
<td>1-3 Vpp</td>
</tr>
<tr>
<td>– high level</td>
<td>3 x low level, max 9 Vpp</td>
</tr>
<tr>
<td>Supported formats</td>
<td>IRIG-B 00x, IRIG-B 12x</td>
</tr>
<tr>
<td>Accuracy</td>
<td>+/-10μs for IRIG-B 00x and +/-100μs for IRIG-B 12x</td>
</tr>
<tr>
<td>Input impedance</td>
<td>100 k ohm</td>
</tr>
<tr>
<td><strong>Optical connector:</strong></td>
<td></td>
</tr>
<tr>
<td>Optical connector IRIG-B</td>
<td>Type ST</td>
</tr>
<tr>
<td>Type of fiber</td>
<td>62.5/125 μm multimode fiber</td>
</tr>
<tr>
<td>Supported formats</td>
<td>IRIG-B 00x</td>
</tr>
<tr>
<td>Accuracy</td>
<td>+/-1μs</td>
</tr>
</tbody>
</table>
Inverse characteristic

Table 142. ANSI Inverse time characteristics

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating characteristic:</td>
<td>$0.05 \leq k \leq 999.00$</td>
<td>ANSI/IEEE C37.112 ,</td>
</tr>
<tr>
<td></td>
<td>$1.5 \times I_{set} \leq I \leq 20 \times I_{set}$</td>
<td>±2.0% or ±40 ms whichever is greater</td>
</tr>
<tr>
<td></td>
<td>$t = \left( \frac{A}{I'^{-1}} + B \right) \cdot k$</td>
<td></td>
</tr>
<tr>
<td>Reset characteristic:</td>
<td>$t = \frac{I_r}{(I' - 1)} \cdot k$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$I = \frac{I_{measured}}{I_{set}}$</td>
<td></td>
</tr>
<tr>
<td>ANSI Extremely Inverse</td>
<td>$A=28.2$, $B=0.1217$, $P=2.0$, $tr=29.1$</td>
<td></td>
</tr>
<tr>
<td>ANSI Very Inverse</td>
<td>$A=19.61$, $B=0.491$, $P=2.0$, $tr=21.6$</td>
<td></td>
</tr>
<tr>
<td>ANSI Normal Inverse</td>
<td>$A=0.0086$, $B=0.0185$, $P=0.02$, $tr=0.46$</td>
<td></td>
</tr>
<tr>
<td>ANSI Moderately Inverse</td>
<td>$A=0.0515$, $B=0.1140$, $P=0.02$, $tr=4.85$</td>
<td></td>
</tr>
<tr>
<td>ANSI Long Time Extremely Inverse</td>
<td>$A=64.07$, $B=0.250$, $P=2.0$, $tr=30$</td>
<td></td>
</tr>
<tr>
<td>ANSI Long Time Very Inverse</td>
<td>$A=28.55$, $B=0.712$, $P=2.0$, $tr=13.46$</td>
<td></td>
</tr>
<tr>
<td>ANSI Long Time Inverse</td>
<td>$A=0.086$, $B=0.185$, $P=0.02$, $tr=4.6$</td>
<td></td>
</tr>
</tbody>
</table>
### Table 143. IEC Inverse time characteristics

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating characteristic:</td>
<td>$t = \left( \frac{A}{(I^{P} - C)} + B \right) \cdot k$</td>
<td>IEC 60255-151, ±2.0% or ±40 ms whichever is greater</td>
</tr>
<tr>
<td></td>
<td>$I = \frac{l_{\text{measured}}}{l_{\text{set}}}$</td>
<td></td>
</tr>
<tr>
<td>IEC Normal Inverse</td>
<td>$A=0.14, P=0.02$</td>
<td></td>
</tr>
<tr>
<td>IEC Very inverse</td>
<td>$A=13.5, P=1.0$</td>
<td></td>
</tr>
<tr>
<td>IEC Inverse</td>
<td>$A=0.14, P=0.02$</td>
<td></td>
</tr>
<tr>
<td>IEC Extremely inverse</td>
<td>$A=80.0, P=2.0$</td>
<td></td>
</tr>
<tr>
<td>IEC Short time inverse</td>
<td>$A=0.05, P=0.04$</td>
<td></td>
</tr>
<tr>
<td>IEC Long time inverse</td>
<td>$A=120, P=1.0$</td>
<td></td>
</tr>
<tr>
<td>Programmable characteristic</td>
<td>$k = (0.05-999)$ in steps of 0.01</td>
<td></td>
</tr>
<tr>
<td>Operate characteristic:</td>
<td>$A=(0.005-200.000)$ in steps of 0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$B=(0.00-20.000)$ in steps of 0.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$C=(0.1-10.00)$ in steps of 0.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$P=(0.005-3.000)$ in steps of 0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$TR=(0.005-100.000)$ in steps of 0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$CR=(0.1-10.0)$ in steps of 0.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$PR=(0.005-3.000)$ in steps of 0.001</td>
<td></td>
</tr>
<tr>
<td>Reset characteristic:</td>
<td>$t = \frac{TR}{(I_{PR} - CR)} \cdot k$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$I = \frac{l_{\text{measured}}}{l_{\text{set}}}$</td>
<td></td>
</tr>
</tbody>
</table>

The parameter setting Characteristn = Reserved (where, n = 1 - 4) shall not be used, since this parameter setting is for future use and not implemented yet.
Table 144. RI and RD type inverse time characteristics

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>RI type inverse characteristic</td>
<td>$t = \frac{1}{0.339 - \frac{0.236}{I}} \cdot k$</td>
<td>$0.05 \leq k \leq 999.00$</td>
</tr>
<tr>
<td></td>
<td>$I = \frac{l_{\text{measured}}}{I_{\text{set}}}$</td>
<td>$1.5 \times I_{\text{set}} \leq l \leq 20 \times I_{\text{set}}$</td>
</tr>
<tr>
<td>RD type logarithmic inverse</td>
<td>$t = 5.8 - \left(1.35 \cdot \ln \frac{l}{k}\right)$</td>
<td></td>
</tr>
<tr>
<td>characteristic</td>
<td>$I = \frac{l_{\text{measured}}}{I_{\text{set}}}$</td>
<td></td>
</tr>
</tbody>
</table>

Table 145. Inverse time characteristics for overvoltage protection

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A curve:</td>
<td>$k = (0.05-1.10)$ in steps of 0.01</td>
<td>±5.0% or ±45 ms whichever is greater</td>
</tr>
<tr>
<td>$t = \frac{k}{(U - U_&gt;) - (U &gt;)}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$U_&gt;$ = $U_{\text{set}}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$U = l_{\text{measured}}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type B curve:</td>
<td>$k = (0.05-1.10)$ in steps of 0.01</td>
<td></td>
</tr>
<tr>
<td>$t = \frac{k \cdot 480}{\left(32 \cdot \frac{U - U_&gt;} - \frac{U_&gt;} - 0.5\right)^{0.5} + 0.035}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type C curve:</td>
<td>$k = (0.05-1.10)$ in steps of 0.01</td>
<td></td>
</tr>
<tr>
<td>$t = \frac{k \cdot 480}{\left(32 \cdot \frac{U - U_&gt;} - \frac{U_&gt;} - 0.5\right)^{0.5} + 0.035}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Programmable curve:</td>
<td>$k = (0.05-1.10)$ in steps of 0.01</td>
<td></td>
</tr>
<tr>
<td>$t = \frac{k \cdot A}{\left(B \cdot \frac{U - U_&gt;} - C\right)^{D} + D}$</td>
<td>$A = (0.005-200.000)$ in steps of 0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$B = (0.50-100.00)$ in steps of 0.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$C = (0.0-1.0)$ in steps of 0.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$D = (0.000-60.000)$ in steps of 0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$P = (0.000-3.000)$ in steps of 0.001</td>
<td></td>
</tr>
<tr>
<td>Function</td>
<td>Range or value</td>
<td>Accuracy</td>
</tr>
<tr>
<td>------------------------</td>
<td>----------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Type A curve:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[ t = \frac{k}{U_\text{set} - U_{\text{measured}}} ]</td>
<td>( k = (0.05-1.10) ) in steps of 0.01</td>
<td>±5.0% or ±45 ms whichever is greater</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type B curve:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[ t = \frac{k \cdot 480}{32 \cdot \left( \frac{U_\text{set} - U_{\text{measured}}}{U_\text{set} - 0.5} \right)^2} + 0.055 ]</td>
<td>( k = (0.05-1.10) ) in steps of 0.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Programmable curve:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[ t = \left[ \frac{k \cdot A}{B \cdot \left( \frac{U_\text{set} - U_{\text{measured}}}{U_\text{set} - C} \right)^p} \right] + D ]</td>
<td>( k = (0.05-1.10) ) in steps of 0.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>A = (0.005-200.000) in steps of 0.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B = (0.50-100.00) in steps of 0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C = (0.0-1.0) in steps of 0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D = (0.000-60.000) in steps of 0.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P = (0.000-3.000) in steps of 0.001</td>
</tr>
</tbody>
</table>
Table 147. Inverse time characteristics for residual overvoltage protection

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A curve:</td>
<td>( t = \frac{k}{U &gt; - U &gt;} ) ( U &gt; = U_{\text{set}} ) ( U = U_{\text{measured}} )</td>
<td>( k = (0.05-1.10) ) in steps of 0.01 ±5.0% or ±45 ms whichever is greater</td>
</tr>
<tr>
<td>Type B curve:</td>
<td>( t = \frac{k \cdot 480}{32 \cdot \left( \frac{U - U &gt;}{U &gt;} - 0.5 \right)^2 + 0.035} )</td>
<td>( k = (0.05-1.10) ) in steps of 0.01</td>
</tr>
<tr>
<td>Type C curve:</td>
<td>( t = \frac{k \cdot 480}{32 \cdot \left( \frac{U - U &gt;}{U &gt;} - 0.5 \right)^3 + 0.035} )</td>
<td>( k = (0.05-1.10) ) in steps of 0.01</td>
</tr>
<tr>
<td>Programmable curve:</td>
<td>( t = \frac{k \cdot A}{B \cdot \left( \frac{U - U &gt;}{U &gt;} - C \right)^p + D} )</td>
<td>( k = (0.05-1.10) ) in steps of 0.01 ( A = (0.005-200.000) ) in steps of 0.001 ( B = (0.50-100.00) ) in steps of 0.01 ( C = (0.0-1.0) ) in steps of 0.1 ( D = (0.000-60.000) ) in steps of 0.001 ( P = (0.000-3.000) ) in steps of 0.001</td>
</tr>
</tbody>
</table>
21. Ordering for customized IED

Table 148. General guidelines

Guidelines
Carefully read and follow the set of rules to ensure problem-free order management.
Please refer to the available functions table for included application functions.
PCM600 can be used to make changes and/or additions to the delivered factory configuration of the pre-configured.

Table 149. Example ordering code

To obtain the complete ordering code, please combine code from the selection tables, as given in the example below.
The selected qty of each table must be filled in, if no selection is possible the code is 0
Example of a complete code: REC670*2.1-F00X00 - A000000600000000 - B0000000000000000000000000000000 - C6600666666660036221300300 - D22206020 - E6662 - F3 - G642 - H26461114444 - K10101110 - L0611 - M61 - P01 - B1X0 - AC - MB - B - A3X0 - D1D1ARGN1N1XXXXXXX - AAFXXX - AX

<table>
<thead>
<tr>
<th>Product definition</th>
<th>Differential protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>REC670* 2.1</td>
<td>X00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Impedance protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Current protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>C 00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Voltage protection</th>
<th>Frequency protection</th>
<th>Multipurpose protection</th>
<th>General calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>D O 0 0</td>
<td>E</td>
<td>F</td>
<td>S</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Secondary system supervision</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>G 00</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scheme communication</th>
<th>Logic</th>
<th>Monitoring</th>
<th>Station communication</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L 0</td>
<td>L M P 0</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Casing and Mounting</th>
<th>Connectio and power</th>
<th>HMI</th>
<th>Analog input</th>
<th>Binary input/output</th>
</tr>
</thead>
<tbody>
<tr>
<td>B 1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Remote end serial communication</th>
<th>Serial communication unit for station communication</th>
</tr>
</thead>
</table>

Table 150. Product definition

<table>
<thead>
<tr>
<th>Product</th>
<th>Software version</th>
</tr>
</thead>
<tbody>
<tr>
<td>REC670*</td>
<td>2.1</td>
</tr>
</tbody>
</table>

Table 151. Product definition ordering codes

<table>
<thead>
<tr>
<th>Product</th>
<th>Software version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bay Control REC670</td>
<td>F00</td>
</tr>
<tr>
<td>Bay control REC670 61850-9-2LE</td>
<td>N00</td>
</tr>
</tbody>
</table>

Selection:

- ACT configuration
- ABB Standard configuration

X00
### Table 152. Differential protection

<table>
<thead>
<tr>
<th>Position</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

### Table 153. Differential functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Function identification</th>
<th>Ordering no</th>
<th>Position</th>
<th>Available qty</th>
<th>Selected qty</th>
<th>Notes and rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>1Ph High impedance differential protection</td>
<td>HZPDIF</td>
<td>1MRK005904-HA</td>
<td>7</td>
<td>0-6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 154. Impedance protection

| Position | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
|----------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| B        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |

### Table 155. Current protection

| Position | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
|----------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| C        | 00| 00| 00| 00| 00| 00| 00| 00| 00| 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |

### Table 156. Current functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Function identification</th>
<th>Ordering no</th>
<th>Position</th>
<th>Available qty</th>
<th>Selected qty</th>
<th>Notes and rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instantaneous phase overcurrent protection</td>
<td>PHPIOC</td>
<td>1MRK005910-AC</td>
<td>1</td>
<td>0-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Four step phase overcurrent protection</td>
<td>OC4PTOC</td>
<td>1MRK005910-BB</td>
<td>2</td>
<td>0-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instantaneous residual overcurrent protection</td>
<td>EFPIOC</td>
<td>1MRK005910-DC</td>
<td>4</td>
<td>0-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Four step residual overcurrent protection</td>
<td>EF4PTOC</td>
<td>1MRK005910-EC</td>
<td>5</td>
<td>0-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Four step directional negative phase sequence overcurrent protection</td>
<td>NS4PTOC</td>
<td>1MRK005910-FB</td>
<td>6</td>
<td>0-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitive Directional residual over current and power protection</td>
<td>SDEPSDE</td>
<td>1MRK005910-GA</td>
<td>7</td>
<td>0-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal overload protection, one time constant, Celsius</td>
<td>LCPTTR</td>
<td>1MRK005911-BA</td>
<td>8</td>
<td>0-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal overload protection, one time constant, Fahrenheit</td>
<td>LFPTTR</td>
<td>1MRK005911-AA</td>
<td>9</td>
<td>0-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal overload protection, two time constants</td>
<td>TRPTTR</td>
<td>1MRK005910-HB</td>
<td>10</td>
<td>0-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breaker failure protection</td>
<td>CCRBRF</td>
<td>1MRK005910-LA</td>
<td>11</td>
<td>0-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stub protection</td>
<td>STBPTOC</td>
<td>1MRK005910-NA</td>
<td>13</td>
<td>0-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pole discordance protection</td>
<td>CCPDSC</td>
<td>1MRK005910-PA</td>
<td>14</td>
<td>0-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Directional Underpower protection</td>
<td>GUPPDUP</td>
<td>1MRK005910-RA</td>
<td>15</td>
<td>0-2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Directional Overpower protection</td>
<td>GOPPDOP</td>
<td>1MRK005910-TA</td>
<td>16</td>
<td>0-2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broken conductor check</td>
<td>BRCPCTOC</td>
<td>1MRK005910-SA</td>
<td>17</td>
<td>0-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacitor bank protection</td>
<td>CBPGAPC</td>
<td>1MRK005910-UA</td>
<td>18</td>
<td>0-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage restrained overcurrent protection</td>
<td>VRVPOC</td>
<td>1MRK005910-XA</td>
<td>21</td>
<td>0-3</td>
<td></td>
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</table>

### Table 157. Voltage protection

<table>
<thead>
<tr>
<th>Position</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</table>

### Table 158. Voltage functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Function identification</th>
<th>Ordering no</th>
<th>Position</th>
<th>Available qty</th>
<th>Selected qty</th>
<th>Notes and rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two step undervoltage protection</td>
<td>UV2PTUV</td>
<td>1MRK005912-AA</td>
<td>1</td>
<td>0-2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two step overvoltage protection</td>
<td>OV2PTOV</td>
<td>1MRK005912-BA</td>
<td>2</td>
<td>0-2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two step residual overvoltage protection</td>
<td>ROV2PTOV</td>
<td>1MRK005912-CC</td>
<td>3</td>
<td>0-2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage differential protection</td>
<td>VDCPTOV</td>
<td>1MRK005912-EA</td>
<td>5</td>
<td>0-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loss of voltage check</td>
<td>LOVPTUV</td>
<td>1MRK005912-GA</td>
<td>7</td>
<td>0-2</td>
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</table>
Table 159. Frequency protection

<table>
<thead>
<tr>
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<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
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</table>

Table 160. Frequency functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Function identification</th>
<th>Ordering no</th>
<th>Position</th>
<th>Available qty</th>
<th>Selected qty</th>
<th>Notes and rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underfrequency protection</td>
<td>SAPTUF</td>
<td>1MRK005914-AA</td>
<td>1</td>
<td>0-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overfrequency protection</td>
<td>SAPTOF</td>
<td>1MRK005914-BA</td>
<td>2</td>
<td>0-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate-of-change frequency protection</td>
<td>SAPFRC</td>
<td>1MRK005914-CA</td>
<td>3</td>
<td>0-6</td>
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<tr>
<td>Frequency time accumulation protection</td>
<td>FTAQFVR</td>
<td>1MRK005914-DB</td>
<td>4</td>
<td>00-12</td>
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Table 161. Multipurpose protection

<table>
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Table 162. Multipurpose functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Function identification</th>
<th>Ordering no</th>
<th>Position</th>
<th>Available qty</th>
<th>Selected qty</th>
<th>Notes and rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>General current and voltage protection</td>
<td>CVGAPC</td>
<td>1MRK005915-AA</td>
<td>1</td>
<td>0-9</td>
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Table 163. General calculation

<table>
<thead>
<tr>
<th>Position</th>
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</thead>
<tbody>
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</table>

Table 164. General calculation functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Function identification</th>
<th>Ordering no</th>
<th>Position</th>
<th>Available qty</th>
<th>Selected qty</th>
<th>Notes and rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency tracking filter</td>
<td>SMAIHPAC</td>
<td>1MRK005915-KA</td>
<td>1</td>
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</table>

Table 165. Secondary system supervision

<table>
<thead>
<tr>
<th>Position</th>
<th>1</th>
<th>2</th>
<th>3</th>
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</table>

Table 166. Secondary system supervision functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Function identification</th>
<th>Ordering no</th>
<th>Position</th>
<th>Available qty</th>
<th>Selected qty</th>
<th>Notes and rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current circuit supervision</td>
<td>CCSSPVC</td>
<td>1MRK005916-AA</td>
<td>1</td>
<td>0-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuse failure supervision</td>
<td>FUFSVPC</td>
<td>1MRK005916-BA</td>
<td>2</td>
<td>0-4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuse failure supervision based on voltage difference</td>
<td>VDSPVC</td>
<td>1MRK005916-CA</td>
<td>3</td>
<td>0-2</td>
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<td></td>
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</tbody>
</table>

Table 167. Control

<table>
<thead>
<tr>
<th>Position</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
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<td></td>
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</tr>
</tbody>
</table>
### Table 168. Control functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Function identification</th>
<th>Ordering no</th>
<th>Position</th>
<th>Available qty</th>
<th>Selected Qty</th>
<th>Notes and rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synchrocheck, energizing check and synchronizing</td>
<td>SESRSYN</td>
<td>1MRK005917-AA</td>
<td>1</td>
<td>0-2</td>
<td></td>
<td>Rule: Can only be ordered with Apparatus control APC10/ APC15</td>
</tr>
<tr>
<td>Synchrocheck, energizing check and synchronizing</td>
<td>SESRSYN</td>
<td>1MRK005917-XA</td>
<td>2</td>
<td>0-6</td>
<td></td>
<td>Rule: Can only be ordered with Apparatus control APC30</td>
</tr>
<tr>
<td>Autorecloser</td>
<td>SMBRREC</td>
<td>1MRK005917-BA</td>
<td>3</td>
<td>0-4</td>
<td></td>
<td>Rule: Can only be ordered with Apparatus control APC10/ APC15</td>
</tr>
<tr>
<td>Autorecloser</td>
<td>SMBRREC</td>
<td>1MRK005917-XB</td>
<td>4</td>
<td>0-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apparatus control for single bay, max 10 app. (1CB) incl. Interlocking</td>
<td>APC10</td>
<td>1MRK005917-Ay</td>
<td>5</td>
<td>0-1</td>
<td></td>
<td>Note: One of Apparatus control APC10</td>
</tr>
<tr>
<td>Apparatus control for single bay, max 15 app. (2CBs) incl. Interlocking</td>
<td>APC15</td>
<td>1MRK005917-BY</td>
<td>6</td>
<td>0-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apparatus control for up to 6 bays, max 30 app. (6CBs) incl. Interlocking</td>
<td>APC30</td>
<td>1MRK005917-CY</td>
<td>7</td>
<td>0-1</td>
<td></td>
<td>APC15 or APC30 must be ordered.</td>
</tr>
<tr>
<td>Automatic voltage control for tapchanger, single control</td>
<td>TRIATCC</td>
<td>1MRK005917-NB</td>
<td>8</td>
<td>0-4</td>
<td></td>
<td>Note: Only one TCC may be selected. Note: If TRIATCC or TRBATCC is ordered then one of TCMYLT or TCLYLTC must be ordered.</td>
</tr>
<tr>
<td>Automatic voltage control for tapchanger, parallel control</td>
<td>TRBATCC</td>
<td>1MRK005917-PB</td>
<td>9</td>
<td>0-4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tap changer control and supervision, 6 binary inputs</td>
<td>TCMYLT C</td>
<td>1MRK005917-DB</td>
<td>10</td>
<td>0-4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tap changer control and supervision, 32 binary inputs</td>
<td>TCLYLTC</td>
<td>1MRK005917-EA</td>
<td>11</td>
<td>0-4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 169. Scheme communication

<table>
<thead>
<tr>
<th>Position</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

ABB
## Table 170. Scheme communication functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Function identification</th>
<th>Ordering no</th>
<th>Position</th>
<th>Available qty</th>
<th>Selected qty</th>
<th>Notes and rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheme communication logic for distance or Overcurrent protection</td>
<td>ZCPSCH</td>
<td>1MRK005920-AA</td>
<td>1</td>
<td>0-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current reversal and weak-end infeed logic for distance protection</td>
<td>ZCRWPSCH</td>
<td>1MRK005920-CA</td>
<td>3</td>
<td>0-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local acceleration logic</td>
<td>ZCLCPSC</td>
<td>1MRK005920-EA</td>
<td>5</td>
<td>0-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scheme communication logic for residual overcurrent protection</td>
<td>ECPSCH</td>
<td>1MRK005920-FA</td>
<td>6</td>
<td>0-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current reversal and weak-end infeed logic for residual overcurrent protection</td>
<td>ECRWPSCH</td>
<td>1MRK005920-GA</td>
<td>7</td>
<td>0-1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Table 171. Logic

<table>
<thead>
<tr>
<th>Position</th>
<th>1</th>
<th>2</th>
<th>L</th>
</tr>
</thead>
</table>

## Table 172. Logic functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Function identification</th>
<th>Ordering no</th>
<th>Position</th>
<th>Available qty</th>
<th>Selected qty</th>
<th>Notes and rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Configurable logic blocks Q/T</td>
<td>1MRK005922-MX</td>
<td>1</td>
<td>0-1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extension logic package</td>
<td>1MRK005922-AY</td>
<td>2</td>
<td>0-1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Table 173. Monitoring

<table>
<thead>
<tr>
<th>Position</th>
<th>1</th>
<th>2</th>
<th>M</th>
</tr>
</thead>
</table>

## Table 174. Monitoring functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Function identification</th>
<th>Ordering no</th>
<th>Position</th>
<th>Available qty</th>
<th>Selected qty</th>
<th>Notes and rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circuit breaker condition monitoring</td>
<td>SSCBR</td>
<td>1MRK005924-HA</td>
<td>1</td>
<td>00-18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fault locator</td>
<td>LMBRFLO</td>
<td>1MRK005925-XB</td>
<td>2</td>
<td>0-1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Table 175. Station communication

<table>
<thead>
<tr>
<th>Position</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Table 176. Station communication functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Function identification</th>
<th>Ordering no</th>
<th>Position</th>
<th>Available qty</th>
<th>Selected qty</th>
<th>Notes and rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process Bus communication IEC 61850-9-2</td>
<td>1MRK005930-TA</td>
<td>1</td>
<td>0</td>
<td>0 if F00 is selected, 6 if N00 is selected</td>
<td></td>
<td>Note: REC670 customized qty = 0, REC670 61850-9-2 qty = 6</td>
</tr>
<tr>
<td>IEC 62439-3 parallel redundancy protocol</td>
<td>PRP</td>
<td>1MRK002924-YB</td>
<td>2</td>
<td>0-1</td>
<td></td>
<td>Note: Not valid in REC670 61850-9-2LE product, Requires 2-channel OEM</td>
</tr>
</tbody>
</table>
### Table 177. Language selection

<table>
<thead>
<tr>
<th>First local HMI user dialogue language</th>
<th>Selection</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMI language, English IEC</td>
<td>B1</td>
<td></td>
</tr>
</tbody>
</table>

### Additional HMI language

<table>
<thead>
<tr>
<th>Notes and Rules</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No additional HMI language</td>
<td>X0</td>
</tr>
<tr>
<td>HMI language, English US</td>
<td>A12</td>
</tr>
</tbody>
</table>

### Table 178. Casing selection

<table>
<thead>
<tr>
<th>Casing</th>
<th>Selection</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 x 19&quot; case</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>3/4 x 19&quot; case 1 TRM slot</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>3/4 x 19&quot; case 2 TRM slots</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>1/1 x 19&quot; case 1 TRM slot</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>1/1 x 19&quot; case 2 TRM slots</td>
<td>E</td>
<td></td>
</tr>
</tbody>
</table>

### Table 179. Mounting selection

<table>
<thead>
<tr>
<th>Mounting details with IP40 of protection from the front</th>
<th>Selection</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>No mounting kit included</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>19&quot; rack mounting kit for 1/2 x 19&quot; case of 2xRHGS6 or RHGSI2</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>19&quot; rack mounting kit for 3/4 x 19&quot; case or 3xRGHS6</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>19&quot; rack mounting kit for 1/1 x 19&quot; case</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Wall mounting kit</td>
<td>D</td>
<td>Note: Wall mounting not recommended with communication modules with fiber connection (SLM, OEM, LDCM)</td>
</tr>
<tr>
<td>Flush mounting kit</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td>Flush mounting kit + IP54 mounting seal</td>
<td>F</td>
<td></td>
</tr>
</tbody>
</table>

### Table 180. Connection type

<table>
<thead>
<tr>
<th>Connection type for Power supply module</th>
<th>Selection</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compression terminals</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>Ringlug terminals</td>
<td>N</td>
<td></td>
</tr>
</tbody>
</table>

### Connection type for Input/Output modules

| Compression terminals | P         | |
|-----------------------|-----------||
| Ringlug terminals     | R         | |

### Table 181. Auxiliary power supply

| 24-60 VDC   | A         | |
|-------------|-----------||
| 90-250 VDC  | B         | |

### Table 182. Human machine interface selection

<table>
<thead>
<tr>
<th>Human machine hardware interface</th>
<th>Selection</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium size - graphic display, IEC keypad symbols</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>Medium size - graphic display, ANSI keypad symbols</td>
<td>C</td>
<td></td>
</tr>
</tbody>
</table>

1 MRK 511 361-BEN D
Table 183. Analog system selection

<table>
<thead>
<tr>
<th>Analog system</th>
<th>Selection</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>No first TRM included</td>
<td>X 0</td>
<td>Note: Only the same type of TRM (compression or ringlug) in the same terminal.</td>
</tr>
<tr>
<td>Compression terminals</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Ringlug terminals</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>First TRM 12I 1A, 50/60Hz</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>First TRM 12I 5A, 50/60Hz</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>First TRM 9I+3U 1A, 100/220V, 50/60Hz</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>First TRM 9I+3U 5A, 100/220V, 50/60Hz</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>First TRM 5I, 1A+4I, 5A+3U, 100/220V, 50/60Hz</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>First TRM 6I+6U 1A, 100/220V, 50/60Hz</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>First TRM 6I+6U 5A, 100/220V, 50/60Hz</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>First TRM 6I 1A, 50/60Hz</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>First TRM 6I 5A, 50/60Hz</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>First TRM 7I+5U 1A, 100/220V, 50/60Hz</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>First TRM 7I+5U 5A, 100/220V, 50/60Hz</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>First TRM 6I, 5A + 1I, 1A + 5U, 110/220V, 50/60Hz</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>First TRM 3I, 5A + 4I, 1A + 5U, 110/220V, 50/60Hz</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>First TRM 3I, 5A + 3I, 1A + 6U, 110/220V, 50/60Hz</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>First TRM 3IM, 1A + 4IP, 1A + 5U, 110/220V, 50/60Hz</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>First TRM 3IM, 5A + 4IP, 5A + 5U, 110/220V, 50/60Hz</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>First TRM 10I+2U, 1A, 110/220V, 50/60Hz</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>First TRM 10I+2U, 5A, 110/220V, 50/60Hz</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>No second TRM included</td>
<td>X 0</td>
<td></td>
</tr>
<tr>
<td>Compression terminals</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Ringlug terminals</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>Second TRM 12I 1A, 50/60Hz</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Second TRM 12I 5A, 50/60Hz</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Second TRM 9I+3U 1A, 100/220V, 50/60Hz</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Second TRM 9I+3U 5A, 100/220V, 50/60Hz</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Second TRM 5I, 1A+4I, 5A+3U, 100/220V, 50/60Hz</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Second TRM 6I+6U 1A, 100/220V, 50/60Hz</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Second TRM 6I+6U 5A, 100/220V, 50/60Hz</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Second TRM 6I 1A, 50/60Hz</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Second TRM 6I 5A, 50/60Hz</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Second TRM 7I+5U 1A, 100/220V, 50/60Hz</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Second TRM 7I+5U 5A, 100/220V, 50/60Hz</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Second TRM 6I, 5A + 1I, 1A + 5U, 110/220V, 50/60Hz</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Second TRM 3I, 5A + 4I, 1A + 5U, 110/220V, 50/60Hz</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Second TRM 3I, 5A + 3I, 1A + 6U, 110/220V, 50/60Hz</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Second TRM 3IM, 1A + 4IP, 1A + 5U, 110/220V, 50/60Hz</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Second TRM 3IM, 5A + 4IP, 5A + 5U, 110/220V, 50/60Hz</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Second TRM 10I+2U, 1A, 110/220V, 50/60Hz</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Second TRM 10I+2U, 5A, 110/220V, 50/60Hz</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

Selected
When ordering I/O modules, observe the maximum quantities according to the table below.

Note: Standard order of location for I/O modules is BIM-BOM-SOM-IOM-MIM from left to right as seen from the rear side of the IED, but can also be freely placed.

Note: The maximum quantity of I/O modules depends on the type of connection terminals.

### Table 184. Maximum quantity of I/O modules

<table>
<thead>
<tr>
<th>Case sizes</th>
<th>BIM</th>
<th>IOM</th>
<th>BOM/SOM</th>
<th>MIM</th>
<th>Maximum in case</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1 x 19&quot;, one (1) TRM</td>
<td>14</td>
<td>6</td>
<td>4</td>
<td>4</td>
<td>14 cards, including a combination of four cards of type BOM, SOM and MIM</td>
</tr>
<tr>
<td>1/1 x 19&quot;, two (2) TRM</td>
<td>11</td>
<td>6</td>
<td>4</td>
<td>4</td>
<td>11 cards, including a combination of four cards of type BOM, SOM and MIM</td>
</tr>
<tr>
<td>3/4 x 19&quot;, one (1) TRM</td>
<td>8</td>
<td>6</td>
<td>4</td>
<td>4</td>
<td>8 cards, including a combination of four cards of type BOM, SOM and MIM</td>
</tr>
<tr>
<td>3/4 x 19&quot;, two (2) TRM</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>5 cards, including a combination of four cards of type BOM, SOM and MIM</td>
</tr>
<tr>
<td>1/2 x 19&quot;, one (1) TRM</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3 cards</td>
</tr>
</tbody>
</table>

### Table 185. Maximum quantity of I/O modules, with ringlug terminals

Note: Only every second slot can be used.

<table>
<thead>
<tr>
<th>Case sizes</th>
<th>BIM</th>
<th>IOM</th>
<th>BOM/SOM</th>
<th>MIM</th>
<th>Maximum in case</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1 x 19&quot; rack casing, one (1) TRM</td>
<td>7</td>
<td>6</td>
<td>4</td>
<td>4</td>
<td>7 **) possible locations: P3, P5, P7, P9, P11, P13, P15</td>
</tr>
<tr>
<td>1/1 x 19&quot; rack casing, two (2) TRM</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>5 **) possible locations: P3, P5, P7, P9, P11</td>
</tr>
<tr>
<td>3/4 x 19&quot; rack casing, one (1) TRM</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4 **) possible locations: P3, P5, P7, P9</td>
</tr>
<tr>
<td>3/4 x 19&quot; rack casing, two (2) TRM</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2, possible locations: P3, P5</td>
</tr>
<tr>
<td>1/2 x 19&quot; rack casing, one (1) TRM</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1, possible location: P3</td>
</tr>
</tbody>
</table>

**) including a combination of maximum four modules of type BOM, SOM and MIM
## Table 186. Binary input/output module selection

<table>
<thead>
<tr>
<th>Binary input/output modules</th>
<th>Selection</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slot position (rear view)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/2 Case with 1 TRM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/4 Case with 1 TRM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/4 Case with 2 TRM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/1 Case with 1 TRM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/1 Case with 2 TRM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No board in slot</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Binary output module</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 output relays (BOM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIM 16 inputs, RL24-30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VDC, 50 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIM 16 inputs, RL48-60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VDC, 50 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIM 16 inputs, RL110-125</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VDC, 50 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIM 16 inputs, RL220-250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VDC, 50 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIMp 16 inputs, RL48-60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VDC, 50 mA, 30 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIMp 16 inputs, RL110-125</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VDC, 30 mA, 50 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIMp 16 inputs, RL220-250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VDC, 30 mA, 120mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IOM 8 inputs, 10+2 output</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RL24-30 VDC, 50 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IOM 8 inputs, 10+2 output</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RL48-60 VDC, 50 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IOM 8 inputs, 10+2 output</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RL110-125 VDC, 50 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IOM 8 inputs, 10+2 output</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RL220-250 VDC, 50 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IOM 8 inputs, 10+2 output</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RL220-250 VDC, 50 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IOM with MOV 8 inputs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-2 output, 24-30 VDC, 30 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IOM with MOV 8 inputs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-2 output, 48-60 VDC, 30 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IOM with MOV 8 inputs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-2 output, 110-125 VDC, 30 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IOM with MOV 8 inputs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-2 output, 220-250 VDC, 30 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mA input module MIM 6 channels</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Max 3 positions in 1/2 rack, 8 in 3/4 rack with 1 TRM, 5 in 3/4 rack with 2 TRM, 11 in 1/1 rack with 2 TRM and 14 in 1/1 rack with 1 TRM.
Note: SOM must not be placed in the following positions: 1/2 case slot X51, 3/4 case 1 TRM slot X101, 3/4 case 2 TRM slot X71, 1/1 case 1 TRM slot X161, 1/1 case 2 TRM slot X131 X51 not in B30/C30.

Table 187. Remote end serial communication selection

<table>
<thead>
<tr>
<th>Remote end communication, DNP serial comm. and time synchronization modules</th>
<th>Selection</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slot position (rear view)</td>
<td>X312</td>
<td></td>
</tr>
<tr>
<td></td>
<td>X313</td>
<td></td>
</tr>
<tr>
<td></td>
<td>X320</td>
<td></td>
</tr>
<tr>
<td></td>
<td>X323</td>
<td></td>
</tr>
<tr>
<td>Available slots in 1/2, 3/4 and 1/1 case with 1TRM</td>
<td></td>
<td>Note: Max 2 LDCM in 1/2 case</td>
</tr>
<tr>
<td>Available slots in 3/4 and 1/1 case with 2 TRM</td>
<td></td>
<td>Note: Max 2 LDCM (same or different type) can be selected</td>
</tr>
<tr>
<td>No remote communication board included</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Optical short range LDCM</td>
<td>A</td>
<td>Note: Max 2 LDCM</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>modules on the same board to support redundant communication; in P30:2 and P30:3, P31:2 and P31:3 or P32:2 and P32:3.</td>
</tr>
<tr>
<td>Optical medium range, LDCM 1310 nm</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>Optical long range, LDCM 1550 nm</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Galvanic X21 line data communication module</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E</td>
<td></td>
</tr>
<tr>
<td></td>
<td>E</td>
<td></td>
</tr>
<tr>
<td>IRIG-B Time synchronization module</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td></td>
<td>F</td>
<td></td>
</tr>
<tr>
<td></td>
<td>F</td>
<td></td>
</tr>
<tr>
<td></td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>Galvanic RS485 communication module</td>
<td>G</td>
<td></td>
</tr>
<tr>
<td></td>
<td>G</td>
<td></td>
</tr>
<tr>
<td></td>
<td>G</td>
<td></td>
</tr>
<tr>
<td></td>
<td>G</td>
<td></td>
</tr>
<tr>
<td>GPS time synchronization module</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td></td>
<td>S</td>
<td></td>
</tr>
<tr>
<td></td>
<td>S</td>
<td></td>
</tr>
</tbody>
</table>

Selected.

Table 188. Serial communication unit for station communication selection

<table>
<thead>
<tr>
<th>Serial communication unit for station communication</th>
<th>Selection</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slot position (rear view)</td>
<td>X312</td>
<td></td>
</tr>
<tr>
<td>No communication board included</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Serial SPA/LON/DNP/IEC 60870-5-103 plastic interface</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Serial SPA/LON/DNP/IEC 60870-5-103 plastic/glass interface</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>Serial SPA/LON/DNP/IEC 60870-5-103 glass interface</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Optical ethernet module, 1 channel glass</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Optical ethernet module, 2 channel glass</td>
<td>E</td>
<td></td>
</tr>
</tbody>
</table>

Selected.
22. Ordering for pre-configured IED

Guidelines
Carefully read and follow the set of rules to ensure problem-free order management.
Please refer to the available functions table for included application functions.
PCM600 can be used to make changes and/or additions to the delivered factory configuration of the pre-configured.

To obtain the complete ordering code, please combine code from the tables, as given in the example below.
Example code: REC670 *2.1-A30X00- A02H02-B1A3-AC-MB-B-A3X0-DB81RG111XXXXXX-XFXXXX-AX. Using the code of each position #1-13 specified as

<table>
<thead>
<tr>
<th>Position</th>
<th>#1</th>
<th>Software</th>
<th>Version number</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>2.1</td>
<td></td>
</tr>
</tbody>
</table>

Selection for position #1.

<table>
<thead>
<tr>
<th>Configuration alternatives</th>
<th>#2</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single breaker</td>
<td>A30</td>
<td></td>
</tr>
<tr>
<td>Bus coupler for double busbar</td>
<td>A31</td>
<td></td>
</tr>
<tr>
<td>Double breaker</td>
<td>B30</td>
<td></td>
</tr>
<tr>
<td>1 1/2 breaker diameter</td>
<td>C30</td>
<td></td>
</tr>
<tr>
<td>ACT configuration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ABB standard configuration</td>
<td>X00</td>
<td></td>
</tr>
</tbody>
</table>

Selection for position #2.
<table>
<thead>
<tr>
<th>Software options</th>
<th>#3</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>No option</td>
<td>X 0 0</td>
<td>All fields in the ordering form do not need to be filled in</td>
</tr>
<tr>
<td>High impedance differential protections - 3 blocks</td>
<td>A 02</td>
<td>Note: A02 only in A30/A31/B30, A07 only in C30</td>
</tr>
<tr>
<td>High impedance differential protections - 6 blocks</td>
<td>A 07</td>
<td></td>
</tr>
<tr>
<td>Sensitive directional residual overcurrent and power protection</td>
<td>C1 6</td>
<td></td>
</tr>
<tr>
<td>Directional power protection</td>
<td>C1 7</td>
<td></td>
</tr>
<tr>
<td>Current and breaker failure protections - 1 circuit breaker</td>
<td>C 51</td>
<td></td>
</tr>
<tr>
<td>Current and breaker failure protections - 2 circuit breaker</td>
<td>C 52</td>
<td></td>
</tr>
<tr>
<td>Current and breaker failure protections - 1 1/2 circuit breaker</td>
<td>C 53</td>
<td></td>
</tr>
<tr>
<td>Voltage protection</td>
<td>D 02</td>
<td></td>
</tr>
<tr>
<td>Frequency protections - station</td>
<td>E 01</td>
<td></td>
</tr>
<tr>
<td>General current and voltage protection</td>
<td>F 01</td>
<td></td>
</tr>
<tr>
<td>Fuse failure supervision based on voltage difference</td>
<td>G 03</td>
<td></td>
</tr>
<tr>
<td>Autorecloser, 1 circuit breaker</td>
<td>H 0 4</td>
<td></td>
</tr>
<tr>
<td>Autorecloser, 2 circuit breakers</td>
<td>H 0 5</td>
<td></td>
</tr>
<tr>
<td>Autorecloser, 1 1/2 circuit breakers</td>
<td>H 0 6</td>
<td></td>
</tr>
<tr>
<td>Voltage control, single transformer, 1 objects</td>
<td>H 11</td>
<td></td>
</tr>
<tr>
<td>Voltage control, eight parallel transformers, 1 objects</td>
<td>H 15</td>
<td></td>
</tr>
<tr>
<td>Voltage control, single transformer, 1 objects, 2 control blocks</td>
<td>H 16</td>
<td></td>
</tr>
<tr>
<td>Voltage control, eight parallel transformers, 1 objects, 2 control blocks</td>
<td>H 18</td>
<td></td>
</tr>
<tr>
<td>Scheme communication</td>
<td>K 01</td>
<td></td>
</tr>
<tr>
<td>Fault locator</td>
<td>M 01</td>
<td></td>
</tr>
<tr>
<td>Circuit breaker condition monitoring - 3 CB</td>
<td>M 13</td>
<td></td>
</tr>
<tr>
<td>Circuit breaker condition monitoring - 6 CB</td>
<td>M 15</td>
<td></td>
</tr>
<tr>
<td>Circuit breaker condition monitoring - 9 CB</td>
<td>M 17</td>
<td></td>
</tr>
<tr>
<td>IEC 62439-3 parallel redundancy protocol</td>
<td>P 03</td>
<td>Note: P03 requires a 2-channel OEM.</td>
</tr>
</tbody>
</table>

**Selection for position #3**

<table>
<thead>
<tr>
<th>First local HMI user dialogue language</th>
<th>#4</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMI language, English IEC</td>
<td>B1</td>
<td></td>
</tr>
<tr>
<td>Additional local HMI user dialogue language</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No additional HMI language</td>
<td>X0</td>
<td></td>
</tr>
<tr>
<td>HMI language, English US</td>
<td>A12</td>
<td></td>
</tr>
</tbody>
</table>

**Selection for position #4.**
## Casing

<table>
<thead>
<tr>
<th>Case Description</th>
<th>Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 x 19&quot; case</td>
<td>A</td>
</tr>
<tr>
<td>3/4 x 19&quot; case 1 TRM slot</td>
<td>B</td>
</tr>
<tr>
<td>3/4 x 19&quot; case 2 TRM slots</td>
<td>C</td>
</tr>
<tr>
<td>1/1 x 19&quot; case 1 TRM slots</td>
<td>D</td>
</tr>
<tr>
<td>1/1 x 19&quot; case 2 TRM slots</td>
<td>E</td>
</tr>
</tbody>
</table>

**Selection for position #5.**

## Mounting details with IP40 of protection from the front

<table>
<thead>
<tr>
<th>Mounting Kit Description</th>
<th>Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>No mounting kit included</td>
<td>X</td>
</tr>
<tr>
<td>19&quot; rack mounting kit for 1/2 x 19&quot; case of 2xRHGS6 or RHGS12</td>
<td>A</td>
</tr>
<tr>
<td>19&quot; rack mounting kit for 3/4 x 19&quot; case or 3xRGHS6</td>
<td>B</td>
</tr>
<tr>
<td>19&quot; rack mounting kit for 1/1 x 19&quot; case</td>
<td>C</td>
</tr>
</tbody>
</table>

**Selection for position #6.**

### Connection type

- **Connection type for Power supply module**
  - Compression terminals: M
  - Ringlug terminals: N

**Selection for position #7.**

### Auxiliary power supply

- 24-60 VDC: A
- 90-250 VDC: B

**Selection for position #8.**

### Human machine hardware interface

- Medium size - graphic display, IEC keypad symbols: B
- Medium size - graphic display, ANSI keypad symbols: C

**Selection for position #9.**

### Analog input system

<table>
<thead>
<tr>
<th>TRM Configuration</th>
<th>Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>No first TRM included</td>
<td>X0</td>
</tr>
<tr>
<td>Compression terminals</td>
<td>A</td>
</tr>
<tr>
<td>Ringlug terminals</td>
<td>B</td>
</tr>
<tr>
<td>First TRM, 6I+6U 1A, 100/220V</td>
<td>6</td>
</tr>
<tr>
<td>First TRM, 6I+6U 5A, 100/220V</td>
<td>7</td>
</tr>
<tr>
<td>No second TRM included</td>
<td>X0</td>
</tr>
<tr>
<td>Compression terminals</td>
<td>A</td>
</tr>
<tr>
<td>Ringlug terminals</td>
<td>B</td>
</tr>
<tr>
<td>Second TRM, 9I+3U 1A, 110/220V</td>
<td>3</td>
</tr>
<tr>
<td>Second TRM, 9I+3U 5A, 110/220V</td>
<td>4</td>
</tr>
<tr>
<td>Second TRM, 5I, 1A+4I, 5A+3U, 110/220V</td>
<td>5</td>
</tr>
<tr>
<td>Second TRM, 6I+6U 1A, 110/220V</td>
<td>6</td>
</tr>
<tr>
<td>Second TRM, 6I+6U 5A, 110/220V</td>
<td>7</td>
</tr>
<tr>
<td>Second TRM, 6I, 1A, 110/220V</td>
<td>8</td>
</tr>
<tr>
<td>Second TRM, 6I, 5A, 5A, 110/220V</td>
<td>9</td>
</tr>
<tr>
<td>Second TRM, 7I+5U 1A, 110/220V</td>
<td>12</td>
</tr>
<tr>
<td>Second TRM, 7I+5U 5A, 110/220V</td>
<td>13</td>
</tr>
</tbody>
</table>

**Selection for position #10.**
## Bay control REC670 2.1 IEC

### Binary input/output module, mA and time synchronizing boards.

For pulse counting, for example kWh metering, the BIM with enhanced pulse counting capabilities must be used. Note: 1BIM and 1 BOM included in A20 and A31. 2 BIM and 1 BOM included in B30 and C30.

<table>
<thead>
<tr>
<th>Slot position (rear view)</th>
<th>#11</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 Case with 1 TRM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/4 Case with 1 TRM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/4 Case with 2 TRM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/1 Case with 1 TRM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/1 Case with 2 TRM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No board in slot</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Binary output module 24 output relays (BOM)

### mA input module MIM 6 channels

### SOM Static output module, 12 outputs, 48-60 VDC

### SOM Static outputs module, 12 outputs, 110-250 VDC

| Selection for position #11 | |

---

Note: Maximum 4 (BOM+SOM+MIM) boards. X51 not in B30/C30.
Remote end communication, DNP serial comm. and time synchronization modules

<table>
<thead>
<tr>
<th>Slot position (rear view)</th>
<th>#12</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available slots in 1/2 case with 1 TRM</td>
<td>X</td>
<td>Note: Max 2 LDCM in 1/2 case</td>
</tr>
<tr>
<td>Available slots in 3/4 and 1/1 case with 1 TRM</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Available slots in 3/4 and 1/1 case with 2 TRM slots</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>No remote communication board included</td>
<td>X</td>
<td>Note: The maximum number and type of LDCM modules supported depend on the total amount of modules (BIM, BOM, LDCM, OEM, GTM, SLM, RS485, IRIG-B) in the IED.</td>
</tr>
<tr>
<td>Optical short range LDCM</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Optical medium range, LDCM 1310 nm</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>IRIG-B Time synchronization module, with PPS</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>Galvanic RS485 communication module</td>
<td>G</td>
<td></td>
</tr>
<tr>
<td>GPS Time Module, GTM</td>
<td>S</td>
<td></td>
</tr>
</tbody>
</table>

Selection for position #12.

Serial communication unit for station communication

<table>
<thead>
<tr>
<th>Slot position (rear view)</th>
<th>#13</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>No first communication board included</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>No second communication board included</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Serial and LON communication module (plastic)</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Serial (plastic) and LON (glass) communication module</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>Serial and LON communication module (glass)</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Optical ethernet module, 1 channel glass</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Optical ethernet module, 2 channel glass</td>
<td>E</td>
<td></td>
</tr>
</tbody>
</table>

Selection for position #13.
23. Ordering for Accessories

Accessories

GPS antenna and mounting details

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Quantity</th>
<th>Order Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPS antenna, including mounting kits</td>
<td></td>
<td>1MRK 001 640-AA</td>
</tr>
<tr>
<td>Cable for antenna, 20 m (Appx. 65 ft)</td>
<td></td>
<td>1MRK 001 665-AA</td>
</tr>
<tr>
<td>Cable for antenna, 40 m (Appx. 131 ft)</td>
<td></td>
<td>1MRK 001 665-BA</td>
</tr>
</tbody>
</table>

Interface converter (for remote end data communication)

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Quantity</th>
<th>Order Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>External interface converter from C37.94 to G703</td>
<td>1</td>
<td>1MRK 002 245-AA</td>
</tr>
<tr>
<td>External interface converter from C37.94 to G703.E1</td>
<td>1</td>
<td>1MRK 002 245-BA</td>
</tr>
</tbody>
</table>

Test switch

The test system COMBITEST intended for use with the IEDs is described in 1MRK 512 001-BEN and 1MRK 001024-CA. Please refer to the website: www.abb.com/substationautomation for detailed information.

Due to the high flexibility of our product and the wide variety of applications possible the test switches needs to be selected for each specific application.

Select your suitable test switch base on the available contacts arrangements shown in the reference documentation.

However our proposals for suitable variants are;

Single breaker/Single or Three Phase trip with internal neutral on current circuits (ordering number RK926 315-AK).

Single breaker/Single or Three Phase trip with external neutral on current circuits (ordering number RK926 315-AC).

Multi-breaker/Single or Three Phase trip with internal neutral on current circuits (ordering number RK926 315-BE).

Multi-breaker/Single or Three Phase trip with external neutral on current circuit (ordering number RK926 315-BV).

The normally open "In test mode" contact 29-30 on the RTXP test switches should be connected to the input of the test function block to allow activation of functions individually during testing.

Test switches type RTXP 24 is ordered separately. Please refer to Section Related documents for references to corresponding documents.

RHGS 6 Case or RHGS 12 Case with mounted RTXP 24 and the on/off switch for dc-supply are ordered separately. Please refer to Section Related documents for references to corresponding documents.
## Protection cover

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Ordering number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protective cover for rear side of RHG56, 6U, 1/4 x 19”</td>
<td></td>
<td>1MRK 002 420-AE</td>
</tr>
<tr>
<td>Protective cover for rear side of terminal, 6U, 1/2 x 19”</td>
<td></td>
<td>1MRK 002 420-AC</td>
</tr>
<tr>
<td>Protective cover for rear side of terminal, 6U, 3/4 x 19”</td>
<td></td>
<td>1MRK 002 420-AB</td>
</tr>
<tr>
<td>Protective cover for rear side of terminal, 6U, 1/1 x 19”</td>
<td></td>
<td>1MRK 002 420-AA</td>
</tr>
</tbody>
</table>

## External resistor unit

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Ordering number</th>
</tr>
</thead>
<tbody>
<tr>
<td>High impedance resistor unit 1-ph with resistor and voltage dependent resistor for 20-100V operating voltage</td>
<td>1</td>
<td>RK 795 101-MA</td>
</tr>
<tr>
<td>High impedance resistor unit 3-ph with resistor and voltage dependent resistor for 20-100V operating voltage</td>
<td></td>
<td>RK 795 101-MB</td>
</tr>
<tr>
<td>High impedance resistor unit 1-ph with resistor and voltage dependent resistor for 100-400V operating voltage</td>
<td>1</td>
<td>RK 795 101-CB</td>
</tr>
<tr>
<td>High impedance resistor unit 3-ph with resistor and voltage dependent resistor for 100-400V operating voltage</td>
<td></td>
<td>RK 795 101-DC</td>
</tr>
</tbody>
</table>

## CombiFlex

### Key switch for settings

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Ordering number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key switch for lock-out of settings via LCD-HMI</td>
<td></td>
<td>1MRK 000 611-A</td>
</tr>
</tbody>
</table>

*Note: To connect the key switch, leads with 10 A CombiFlex socket on one end must be used.*

### Mounting kit

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Ordering number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Side-by-side mounting kit</td>
<td></td>
<td>1MRK 002 420-Z</td>
</tr>
</tbody>
</table>

## Configuration and monitoring tools

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Ordering number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front connection cable between LCD-HMI and PC</td>
<td></td>
<td>1MRK 001 665-CA</td>
</tr>
<tr>
<td>LED Label special paper A4, 1 pc</td>
<td></td>
<td>1MRK 002 038-CA</td>
</tr>
<tr>
<td>LED Label special paper Letter, 1 pc</td>
<td></td>
<td>1MRK 002 038-DA</td>
</tr>
</tbody>
</table>

## Manuals

*Note: One (1) IED Connect CD containing user documentation (Operation manual, Technical manual, Installation manual, Commissioning manual, Application manual and Getting started guide), Connectivity packages and LED label template is always included for each IED.*
Bay control REC670 2.1 IEC

Rule: Specify additional quantity of IED Connect CD requested.

Quantity: 1MRK 002 290-AD
User documentation

*Rule: Specify the number of printed manuals requested*

<table>
<thead>
<tr>
<th>Manual Type</th>
<th>IEC Quantity</th>
<th>ANSI Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application manual</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical manual</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commissioning manual</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication protocol manual, IEC 61850 Edition 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication protocol manual, IEC 61850 Edition 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication protocol manual, IEC 60870-5-103</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication protocol manual, LON</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication protocol manual, SPA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication protocol manual, DNP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Point list manual, DNP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation manual</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installation manual</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX

Reference information

For our reference and statistics we would be pleased to be provided with the following application data:

- **Country:**
- **End user:**
- **Station name:**
- **Voltage level:** kV

### Related documents

<table>
<thead>
<tr>
<th>Documents related to REC670</th>
<th>Document numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>670 series manuals</strong></td>
<td></td>
</tr>
<tr>
<td>Operation manual</td>
<td>IEC:1MRK 500 123-UEN ANSI:1MRK 500 123-UUS</td>
</tr>
<tr>
<td>Engineering manual</td>
<td>IEC:1MRK 511 355-UEN ANSI:1MRK 511 355-UUS</td>
</tr>
<tr>
<td>Installation manual</td>
<td>IEC:1MRK 514 024-UEN ANSI:1MRK 514 024-UUS</td>
</tr>
<tr>
<td>Communication protocol manual, DNP3</td>
<td>1MRK 511 348-UUS</td>
</tr>
<tr>
<td>Communication protocol manual, IEC 60870-5-103</td>
<td>1MRK 511 351-UEN</td>
</tr>
<tr>
<td>Communication protocol manual, IEC 61850 Edition 1</td>
<td>1MRK 511 349-UEN</td>
</tr>
<tr>
<td>Communication protocol manual, IEC 61850 Edition 2</td>
<td>1MRK 511 350-UEN</td>
</tr>
<tr>
<td>Communication protocol manual, LON</td>
<td>1MRK 511 352-UEN</td>
</tr>
<tr>
<td>Communication protocol manual, SPA</td>
<td>1MRK 511 353-UEN</td>
</tr>
<tr>
<td>Point list manual, DNP3</td>
<td>1MRK 511 354-UUS</td>
</tr>
<tr>
<td>Accessories guide</td>
<td>IEC:1MRK 514 012-BEN ANSI:1MRK 514 012-BUS</td>
</tr>
<tr>
<td>Cyber security deployment guideline</td>
<td>1MRK 511 356-UEN</td>
</tr>
<tr>
<td>Connection and Installation components</td>
<td>1MRK 513 003-BEN</td>
</tr>
<tr>
<td>Test system, COMBITEST</td>
<td>1MRK 512 001-BEN</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Documents related to REC670</th>
<th>Document numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1MRK 511 361-BEN D</strong></td>
<td></td>
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<tr>
<td>Operation manual</td>
<td></td>
</tr>
<tr>
<td>Engineering manual</td>
<td></td>
</tr>
<tr>
<td>Installation manual</td>
<td></td>
</tr>
<tr>
<td>Communication protocol manual, DNP3</td>
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<tr>
<td>Communication protocol manual, IEC 60870-5-103</td>
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<tr>
<td>Communication protocol manual, IEC 61850 Edition 1</td>
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<tr>
<td>Accessories guide</td>
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<tr>
<td>Cyber security deployment guideline</td>
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<tr>
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