Relion® 670 series

Phasor measurement unit RES670
Pre-configured
Product Guide
Contents

1. Application..................................................................... 4
2. Available functions..........................................................7
3. Wide area measurement system...................................10
4. Current protection........................................................ 11
5. Voltage protection........................................................ 12
6. Frequency protection....................................................12
7. Multipurpose protection................................................12
8. Secondary system supervision.......................................12
9. Control......................................................................... 13
10. Logic...........................................................................13
11. Monitoring...................................................................14
12. Metering.......................................................................16
13. Basic IED functions.......................................................16
14. Human machine interface.............................................16
15. Station communication ...............................................16
16. Hardware description....................................................17
17. Connection diagrams....................................................19
18. Technical data.............................................................24
19. Ordering......................................................................54

Disclaimer

The information in this document is subject to change without notice and should not be construed as a commitment by ABB. ABB assumes no responsibility for any errors that may appear in this document.

© Copyright 2012 ABB.
All rights reserved.

Trademarks

ABB and Relion are registered trademarks of the ABB Group. All other brand or product names mentioned in this document may be trademarks or registered trademarks of their respective holders.
RES 670 is a Phasor Measurement Unit that provides power system AC voltages and currents as phasors, that is as real and imaginary parts or as magnitude and phase angle. The reference for the phase angle is the NavStar Global Positioning System – GPS that also supplies highly accurate time and date. The accurate time tagging of measurements taken at different geographical locations make it possible to derive the phasor quantities. Based on phasors a number of power system applications are available.

Phasor Measurement Units (PMUs) have so far been mainly used for recording and on-line supervision of Wide Area Measurement System (WAMS) applications. In a typical setup, 10-20 PMUs at different locations in a synchronized power network, streams phasor data together with power flow data and frequency, to a data concentrator.

The data concentrator is usually a mass storage with capacity for about one week of data in a FIFO buffer. In case of any disturbance it should be very easy to access the data recorded to support the disturbance analysis process. The phasor data is normally sent from the PMU to the data concentrator at a speed of 25/30 or 50/60 samples per channel and second. The number of sampled channels is typically 10-20. Phasor data is normally understood as the magnitude and phase angle of the positive sequence voltage or current. The common reference for the angle measurement is the GPS system, which provides precise time reference. Since every measurement sent to the data concentrator is time tagged, any angle difference between power system AC quantities can be derived.

**Description of A20 configuration**
RES670 A20 configuration is applicable for a typical single busbar single breaker arrangement monitoring up to three bays on the busbar. RES670 A20 is delivered in 1/1 and 1/2 of 19” case size. Thus only 12 analog inputs are available. As shown in figure 2, RES670 A20 configuration as a PMU is capable of reporting 4 synchronized phasors; that is, one 3-phase voltage of the busbar and three 3-phase currents of bays 1 to 3. In addition, there are Binary Inputs and
protection function triggers which are reported through PMU. This configuration also includes general back-up protection functions which are mainly intended for alarm purposes.

Available functions on A20 are Over Voltage, Under Voltage, Over Frequency, Under Frequency, and Rate of Change of Frequency.

RES670 A20 function library includes additional functions, which are not configured, such as additional Overcurrent protection functions, additional Multipurpose protection function, and so on. Note that RES670 A20 must be re-configured if any additional functions are used.

Description of configuration B20
RES670 B20 configuration is applicable for a typical double busbar single breaker arrangement monitoring up to six bays on the busbar. RES670 B20 is always delivered in 1/1 of 19" case size. Thus 24 analog inputs are available. As shown in figure 3, RES670 B20 configuration as a PMU is capable of reporting 8 synchronized phasors; that is, two 3-phase voltages from busbar 1 and 2 as well as six 3-phase currents from bays 1 to 6. In addition, there are Binary Inputs and protection function triggers which are reported through PMU. This configuration also includes general back-up protection functions which are mainly intended for alarm purposes. Available functions on B20 are Over Voltage, Under Voltage, Over Frequency, Under Frequency, and Rate of Change of Frequency.

Note:
This is a default pre-configuration provided according to a typical single busbar arrangement with three bays.

Figure 2. Typical PMU application for single busbar single breaker arrangement monitoring up to three bays, including synchronized phasor reporting and back-up protection, using 12 analog input transformers in full 19" case size.
Figure 3. Typical PMU application for double busbar single breaker arrangement monitoring up to 6 bays, including synchronized phasor reporting and back-up protection, using 24 Analog Input transformers in full 19" case size.

As shown in figure 3, in order to provide proper busbar voltage for ServiceValues (CV MMXN Blocks), the Busbar Voltage Selection logic has been implemented in RES670 B20.

RES670 B20 function library includes additional functions, which are not configured, such as additional Overcurrent protection functions, additional Multipurpose protection function, and so on. Note that RES670 B20 must be re-configured if any additional functions are used.
### Available functions

#### Wide area measurement functions

<table>
<thead>
<tr>
<th>IEC 61850</th>
<th>ANSI</th>
<th>Function description</th>
<th>Phasor measurement unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>RES670 (A20)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>RES670 (B20)</td>
</tr>
<tr>
<td>PMUCONF</td>
<td></td>
<td>Configuration parameters for IEEE1344 and C37.118 protocol</td>
<td>1</td>
</tr>
<tr>
<td>PMUREPORT</td>
<td></td>
<td>Protocol reporting via IEEE1344 and C37.118</td>
<td>1</td>
</tr>
</tbody>
</table>

#### Back-up protection functions

<table>
<thead>
<tr>
<th>IEC 61850</th>
<th>ANSI</th>
<th>Function description</th>
<th>Phasor measurement unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>RES670 (A20)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>RES670 (B20)</td>
</tr>
<tr>
<td><strong>Current protection</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OC4PTOC</td>
<td>51_67</td>
<td>Four step phase overcurrent protection</td>
<td>2</td>
</tr>
<tr>
<td>EF4PTOC</td>
<td>51N,67</td>
<td>Four step residual overcurrent protection</td>
<td>2–C25</td>
</tr>
<tr>
<td>NS4PTOC</td>
<td>46I2</td>
<td>Four step directional negative phase sequence overcurrent protection</td>
<td>1–C25</td>
</tr>
<tr>
<td>SDEPSDE</td>
<td>67N</td>
<td>Sensitive directional residual overcurrent and power protection</td>
<td>1–C25</td>
</tr>
<tr>
<td>LPPTR</td>
<td>26</td>
<td>Thermal overload protection, one time constant</td>
<td>1–C25</td>
</tr>
<tr>
<td><strong>Voltage protection</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UV2PTUV</td>
<td>27</td>
<td>Two step undervoltage protection</td>
<td>1</td>
</tr>
<tr>
<td>OV2PTOV</td>
<td>59</td>
<td>Two step overvoltage protection</td>
<td>1</td>
</tr>
<tr>
<td><strong>Frequency protection</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAPTUF</td>
<td>81</td>
<td>Underfrequency protection</td>
<td>1</td>
</tr>
<tr>
<td>SAPTOF</td>
<td>81</td>
<td>Overfrequency protection</td>
<td>1</td>
</tr>
<tr>
<td>SAPFRC</td>
<td>81</td>
<td>Rate-of-change frequency protection</td>
<td>1</td>
</tr>
<tr>
<td><strong>Multipurpose protection</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CVGAPC</td>
<td></td>
<td>General current and voltage protection</td>
<td>8–F03</td>
</tr>
</tbody>
</table>
### Control and monitoring functions

<table>
<thead>
<tr>
<th>IEC 61850</th>
<th>ANSI</th>
<th>Function description</th>
<th>Phasor measurement unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>RES670 (A20)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>RES670 (B20)</td>
</tr>
<tr>
<td><strong>Control</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QCBAY</td>
<td></td>
<td>Apparatus control</td>
<td>1</td>
</tr>
<tr>
<td>LOCREM</td>
<td></td>
<td>Handling of LRs with switch positions</td>
<td>1</td>
</tr>
<tr>
<td>LOCREMCTR</td>
<td></td>
<td>LHCI control of PSTO</td>
<td>1</td>
</tr>
<tr>
<td>SLGGIO</td>
<td></td>
<td>Logic rotating switch for function selection and LHMI presentation</td>
<td>15</td>
</tr>
<tr>
<td>VSGGIO</td>
<td></td>
<td>Selector mini switch</td>
<td>20</td>
</tr>
<tr>
<td>DPGGIO</td>
<td></td>
<td>IEC61850 generic communication I/O functions</td>
<td>16</td>
</tr>
<tr>
<td>SPC6GGGIO</td>
<td></td>
<td>Single pole generic control 8 signals</td>
<td>5</td>
</tr>
<tr>
<td>AutomationBits</td>
<td>3</td>
<td>AutomationBits, command function for DNP3.0</td>
<td>3</td>
</tr>
<tr>
<td>SingleComma nd16Signals</td>
<td>15</td>
<td>Single command, 16 signals</td>
<td>15</td>
</tr>
<tr>
<td><strong>Secondary system supervision</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCSRDIF</td>
<td>87</td>
<td>Current circuit supervision</td>
<td>3–G01</td>
</tr>
<tr>
<td>SDDRUF</td>
<td></td>
<td>Fuse failure supervision</td>
<td>1–G01</td>
</tr>
<tr>
<td><strong>Logic</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMPPTRC</td>
<td>94</td>
<td>Tripping logic</td>
<td>1</td>
</tr>
<tr>
<td>TMAGGIO</td>
<td></td>
<td>Trip matrix logic</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Configuration logic blocks</td>
<td>40–280</td>
</tr>
<tr>
<td>B16I</td>
<td></td>
<td>Boolean 16 to Integer conversion</td>
<td>16</td>
</tr>
<tr>
<td>B16IFCVI</td>
<td></td>
<td>Boolean 16 to Integer conversion with Logic Node representation</td>
<td>16</td>
</tr>
<tr>
<td>IB16</td>
<td></td>
<td>Integer to Boolean 16 conversion</td>
<td>16</td>
</tr>
<tr>
<td><strong>Monitoring</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CVMMXN</td>
<td></td>
<td>Measurements</td>
<td>6</td>
</tr>
<tr>
<td>EVENT</td>
<td></td>
<td>Event function</td>
<td>20</td>
</tr>
<tr>
<td>DRPRORE</td>
<td></td>
<td>Disturbance report</td>
<td>1</td>
</tr>
<tr>
<td>SPGGGIO</td>
<td></td>
<td>IEC61850 generic communication I/O functions</td>
<td>64</td>
</tr>
<tr>
<td>SP16GGGIO</td>
<td></td>
<td>IEC61850 generic communication I/O functions 16 inputs</td>
<td>16</td>
</tr>
<tr>
<td>MVGGGIO</td>
<td></td>
<td>IEC61850 generic communication I/O functions</td>
<td>24</td>
</tr>
<tr>
<td>BSStatReport</td>
<td>3</td>
<td>Logical signal status report</td>
<td>3</td>
</tr>
<tr>
<td>RANGE_XP</td>
<td></td>
<td>Measured value expander block</td>
<td>66</td>
</tr>
</tbody>
</table>
Phasor measurement unit RES670

Pre-configured
Product version: 1.2

<table>
<thead>
<tr>
<th>IEC 61850</th>
<th>ANSI</th>
<th>Function description</th>
<th>Phasor measurement unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>RES670 (A20)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>RES670 (B20)</td>
</tr>
</tbody>
</table>

### Metering

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
<th>16</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCGGIO</td>
<td>Pulse-counter logic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ETPMMTR</td>
<td>Function for energy calculation and demand handling</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Designed to communicate

<table>
<thead>
<tr>
<th>IEC 61850</th>
<th>ANSI</th>
<th>Function description</th>
<th>Phasor measurement unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>RES670 (A20)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>RES670 (B20)</td>
</tr>
</tbody>
</table>

#### Station communication

- SPA communication protocol
- LON communication protocol
- IEC60870-5-103 communication protocol
- Operation selection between SPA and IEC60870-5-103 for SLM
- DNP3.0 for TCP/IP and EIA-485 communication protocol | 1 | 1 |
- DNP3.0 fault records for TCP/IP and EIA-485 communication protocol | 1 | 1 |
- Parameter setting function for IEC61850 | 1 | 1 |
- Goose binary receive | 10 | 10 |
- Multiple command and transmit | 60/10 | 60/10 |
- Ethernet configuration of links | 1 | 1 |

#### DUODRV

- Duo driver configuration
- IEC 62439-3 Edition 2 parallel redundancy protocol
Basic IED functions

<table>
<thead>
<tr>
<th>IEC 61850</th>
<th>Function description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic functions included in all products</td>
<td></td>
</tr>
<tr>
<td>IntErrorSig</td>
<td>Self supervision with internal event list 1</td>
</tr>
<tr>
<td>TIME</td>
<td>Time and synchronization error 1</td>
</tr>
<tr>
<td>TimeSynch</td>
<td>Time synchronization 1</td>
</tr>
<tr>
<td>ActiveGroup</td>
<td>Parameter setting groups 1</td>
</tr>
<tr>
<td>Test</td>
<td>Test mode functionality 1</td>
</tr>
<tr>
<td>ChangeLock</td>
<td>Change lock function 1</td>
</tr>
<tr>
<td>TerminalID</td>
<td>IED identifiers 1</td>
</tr>
<tr>
<td>Productinfo</td>
<td>Product information 1</td>
</tr>
<tr>
<td>MiscBaseCommon</td>
<td>Misc Base Common 1</td>
</tr>
<tr>
<td>IEDRuntimeComp</td>
<td>IED Runtime Comp 1</td>
</tr>
<tr>
<td>RatedFreq</td>
<td>Rated system frequency 1</td>
</tr>
<tr>
<td>SMBI</td>
<td>Signal Matrix for binary inputs 40</td>
</tr>
<tr>
<td>SMBO</td>
<td>Signal Matrix for binary outputs 40</td>
</tr>
<tr>
<td>SMMI</td>
<td>Signal Matrix for mA inputs 4</td>
</tr>
<tr>
<td>SMAI</td>
<td>Signal Matrix for analog inputs 36</td>
</tr>
<tr>
<td>Sum3Ph</td>
<td>Summation block 3 phase 18</td>
</tr>
<tr>
<td>LocalHMI</td>
<td>Parameter setting function for HMI in PCM600 1</td>
</tr>
<tr>
<td>LocalHMI</td>
<td>Local HMI signals 1</td>
</tr>
<tr>
<td>AuthStatus</td>
<td>Authority status 1</td>
</tr>
<tr>
<td>AuthorityCheck</td>
<td>Authority check 1</td>
</tr>
<tr>
<td>AccessFTP</td>
<td>FTP access with password 1</td>
</tr>
<tr>
<td>SPACommMap</td>
<td>SPA communication mapping 1</td>
</tr>
<tr>
<td>DOSFRNT</td>
<td>Denial of service, frame rate control for front port 1</td>
</tr>
<tr>
<td>DOSOEMAB</td>
<td>Denial of service, frame rate control for OEM port AB 1</td>
</tr>
<tr>
<td>DOSOEMCD</td>
<td>Denial of service, frame rate control for OEM port CD 1</td>
</tr>
</tbody>
</table>

3. Wide area measurement system

Configuration parameters for IEEE1344 and C37.118 protocol PMUCONF

The Configuration parameters for IEEE 1344 and C37.118 protocol PMUCONF protocol contains:
- Data about the particular RES670 IED in the PMU synchrophasor streaming network. For example, IP address, id, communication port.
- Format of the data streamed through the protocol. For example, polar, rectangular, float or integer.

Protocol reporting via IEEE 1344 and C37.118 PMUREPORT

The phasor measurement reporting block moves the phasor calculations into a C37.118 frame which contains data about PMU configuration, analog values, binary signal indications and information about time synchronization quality.

The message generated by the PMUREPORT function block is set in accordance with the standard IEEE 1344 protocol for further process.

The phasor measurement reporting block has settings that allows the user to use one phasor to report the voltage or a
current phasor. There are also settings for positive or negative sequence phasors, reporting rate and phasor representation (polar or rectangular).

Phasor data can be reported to up to 8 phasor data concentrators over TCP. It is also possible to use UDP for multicast transmission of phasor data.

4. Current protection

Four step phase overcurrent protection OC4PTOC
The four step phase overcurrent protection function OC4PTOC has an inverse or definite time delay independent for step 1 and 4 separately. Step 2 and 3 are always definite time delayed.

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

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

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

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 separately.

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

The directional function is voltage polarized or dual polarized. EF4PTOC can be set directional or non-directional independently for each of the steps.

EF4PTOC can be used as main protection for unsymmetrical fault; phase-phase short circuits, phase-phase-earth short circuits and single phase earth faults.

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 $3U_0 \cdot 3I_0 \cdot \cos \phi$, 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 LPTTR
The increasing utilizing of the power system closer to the thermal limits has generated a need of a thermal overload protection also 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..
An alarm level gives early warning to allow operators to take action well before the line is tripped.

5. 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.

Two step overvoltage protection OV2PTOV
Overvoltages may occur in the power system during abnormal conditions such as sudden power loss, tap changer regulating failures, open line ends on long lines etc.

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

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

6. Frequency protection

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

Underfrequency protection SAPTUF is used for load shedding systems, remedial action schemes, gas turbine startup and so on.

SAPTUF is also 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 is provided with an undervoltage blocking.

Current circuit supervision CCSRDIF
Phasor measurement unit RES670

Pre-configured
Product version: 1.2

SAPOF 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
Rate-of-change frequency protection function (SAPFRC) gives an early indication of a main disturbance in the system.

SAPFRC can be used for generation shedding, load shedding and remedial action schemes. SAPFRC can discriminate between positive or negative change of frequency.

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.

7. 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.

8. Secondary system supervision

Current circuit supervision CCSRDIF

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.

It must be remembered that a blocking of protection functions at an occurrence of open CT circuit will mean that the situation will remain and extremely high voltages will stress the secondary circuit.

Current circuit supervision (CCSRDIF) 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 unwanted tripping.

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

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

The negative sequence detection algorithm is recommended for IEDs used in isolated or high-impedance earthed networks. It is based on the negative-sequence measuring quantities, a high value of voltage $3U_2$ without the presence of the negative-sequence current $3I_2$.

The zero sequence detection algorithm is recommended for IEDs used in directly or low impedance earthed networks. It is based on the zero sequence measuring quantities, a high value of voltage $3U_0$ without the presence of the residual current $3I_0$.

For better adaptation to system requirements, an operation mode setting has been introduced which makes it possible to select the operating conditions for negative sequence and zero sequence based function. The selection of different operation modes makes it possible to choose different interaction possibilities between the negative sequence and zero sequence based algorithm.

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.

**9. Control**

**Logic rotating switch for function selection and LHMI presentation SLGGIO**
The logic rotating switch for function selection and LHMI presentation (SLGGIO) (or the selector switch function block) is used to get a selector switch functionality similar 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 logic selector switches eliminate all these problems.

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

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

**IEC 61850 generic communication I/O functions DPGGIO**
The IEC 61850 generic communication I/O functions (DPGGIO) function block is used to send double indications to other systems or equipment in the substation. It is especially used in the interlocking and reservation station-wide logics.

**Single point generic control 8 signals SPC8GGIO**
The Single point generic control 8 signals (SPC8GGIO) 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 SPGGIO function blocks. The commands can be pulsed or steady.

**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.

**10. Logic**

**Tripping logic SMPPTRC**
A function block for protection tripping is provided 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 TMAGGIO**
Trip matrix logic TMAGGIO function is used to route trip signals and other logical output signals to different output contacts on the IED.
TMAGGIO output signals and the physical outputs allows the user to adapt the signals to the physical tripping outputs according to the specific application needs.

Configurable logic blocks
A number of logic blocks and timers are available for the user to adapt the configuration to the specific application needs.

- OR function block.
- INVERTER function blocks that inverts the input signal.
- PULSETIMER function block can be used, for example, for pulse extensions or limiting of operation of outputs, settable pulse time.
- GATE function block is used for whether or not a signal should be able to pass from the input to the output.
- XOR function block.
- LOOPDELAY function block used to delay the output signal one execution cycle.
- TIMERSET function has pick-up and drop-out delayed outputs related to the input signal. The timer has a settable time delay.
- AND function block.
- 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 the block’s output should reset or return to the state it was, after a power interruption. Set input has priority.
- 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 the block’s output should reset or return to the state it was, after a power interruption. RESET input has priority.

Fixed signal function block
The Fixed signals function (FXDSIGN) generates a number of 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.

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.

Event counter CNTGGIO
Event counter (CNTGGIO) has six counters which are used for storing the number of times each counter input has been activated.

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.

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 AxRADR or BxRBDR function blocks, which are set to trigger the disturbance recorder. All signals from start of pre-fault time to the end of post-fault time will be included in the recording.

11. Monitoring
Measurements CVMMXN, CMMXU, VNMMXU, VMXU, 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
- primary and secondary phasors
- positive, negative and zero sequence currents and voltages
- mA, input currents
- pulse counters

Disturbance report , 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 96 binary signals.
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 report 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 report function (triggered).

The Indication list function shows all selected binary input signals connected to the Disturbance report 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 report 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 report 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 report function (maximum 40 analog and 96 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.

**IEC61850 generic communication I/O function SPGGIO**
IEC61850 generic communication I/O functions (SPGGIO) is used to send one single logical signal to other systems or equipment in the substation.

**IEC61850 generic communication I/O functions MVGGIO**
IEC61850 generic communication I/O functions (MVGGIO) 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, VMXXU and VNMMXU), current and voltage sequence measurement functions (CMSQI and VMSQI) and IEC 61850 generic communication I/O functions (MVGGIO) 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-high limit or above high limit. The output signals can be used as conditions in the configurable logic or for alarming purpose.

12. Metering

Pulse counter logic PCGGIO
Pulse counter (PCGGIO) 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 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
Outputs from the Measurements (CVMMXN) function can be used to calculate energy consumption. Active as well as reactive values are calculated in import and export direction. Values can be read or generated as pulses. Maximum demand power values are also calculated by the function.

13. Basic IED functions

Time synchronization
The time synchronization source selector is used to select a common source of absolute time for the IED when it is a part of a protection system. This makes it possible to compare event and disturbance data between all IEDs in a station automation system.

Only GPS and IRIG-B time synchronization sources are acceptable for phasor measurement from the accuracy point of view, and RES670 supports both.

14. Human machine interface

Human machine interface
The local human machine interface is available in a medium sized model. Up to 12 single line diagram pages can be defined, depending on the product capability.

The local HMI is divided into zones with different functionality.

- Status indication LEDs.
- Alarm indication LEDs, which consist of 15 LEDs (6 red and 9 yellow) with user printable label. All LEDs are configurable from PCM600.
- Liquid crystal display (LCD).
- Keypad with push buttons for control and navigation purposes, switch for selection between local and remote control and reset.
- Isolated RJ45 communication port.

15. Station communication

IEC 61850-8-1 communication protocol
The IED is equipped with double optical Ethernet rear ports for IEC 61850-8-1 station bus communication. IEC 61850-8-1 protocol allows intelligent electrical devices (IEDs) from different vendors to exchange information and simplifies system engineering. Peer-to-peer communication according to GOOSE is part of the standard. 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 670 IED’s are used in Substation Automation systems with LON, SPA or IEC60870-5-103 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 Redundant Protocol**

Redundant station bus communication according to IEC 62439-3 Edition 1 and IEC 62439-3 Edition 2 are available as options in 670 series IEDs. IEC 62439-3 parallel redundant protocol is an optional quantity and the selection is made at ordering. Redundant station bus communication according to IEC 62439-3 uses both port AB and port CD on the OEM module.

16. 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 terminal 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.

**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 to connect an IED to the communication buses (like the station bus) that use the IEC 61850-8-1 protocol (port A, B). The module has two optical ports with ST connectors.

**Galvanic RS485 serial communication module**

The Galvanic RS485 communication module (RS485) is used for DNP3.0 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 GPS 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 synchronizing of the IED from a station clock. 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 transform 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.
### Dimensions

![Diagram of 1/1 x 19" case with rear cover](xx05000059.vsd)

**Figure 5.** 1/1 x 19" case with rear cover

<table>
<thead>
<tr>
<th>Case size</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>6U, 1/1 x 19&quot;</td>
<td>265.9</td>
<td>448.1</td>
<td>201.1</td>
<td>242.1</td>
<td>252.9</td>
<td>430.3 (mm)</td>
</tr>
</tbody>
</table>

### Mounting alternatives

- 19" rack mounting kit
- Flush mounting kit with cut-out dimensions:
  - 1/2 case size (h) 254.3 mm (w) 210.1 mm
  - 1/1 case size (h) 254.3 mm (w) 434.7 mm
- Wall mounting kit

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

Table 1. Designations for 1/1 x 19” casing with 2 TRM slots

<table>
<thead>
<tr>
<th>Module</th>
<th>Rear Positions</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSM</td>
<td>X11</td>
</tr>
<tr>
<td>BIM, BOM, SOM, IOM or MIM</td>
<td>X31 and X32 etc. to X131 and X132</td>
</tr>
<tr>
<td>SLM</td>
<td>X301:A, B, C, D</td>
</tr>
<tr>
<td>LDCM, IRIG-B or RS485</td>
<td>X302</td>
</tr>
<tr>
<td>LDCM or RS485</td>
<td>X303</td>
</tr>
<tr>
<td>OEM</td>
<td>X311:A, B, C, D</td>
</tr>
<tr>
<td>LDCM, RS485 or GTM</td>
<td>X312, X313, X322, X323</td>
</tr>
<tr>
<td>TRM 1</td>
<td>X401</td>
</tr>
<tr>
<td>TRM 2</td>
<td>X411</td>
</tr>
</tbody>
</table>

SLM and LDCM ports shall not be used in RES670.
Figure 6. Transformer input module (TRM)

- Indicates high polarity

<table>
<thead>
<tr>
<th>Current/voltage configuration</th>
<th>AI01</th>
<th>AI02</th>
<th>AI03</th>
<th>AI04</th>
<th>AI05</th>
<th>AI06</th>
<th>AI07</th>
<th>AI08</th>
<th>AI09</th>
<th>AI10</th>
<th>AI11</th>
<th>AI12</th>
</tr>
</thead>
<tbody>
<tr>
<td>9I+3U, 1A</td>
<td>1A</td>
<td>1A</td>
<td>1A</td>
<td>1A</td>
<td>1A</td>
<td>1A</td>
<td>1A</td>
<td>1A</td>
<td>1A</td>
<td>110-220V</td>
<td>110-220V</td>
<td>110-220V</td>
</tr>
<tr>
<td>9I+3U, 5A</td>
<td>5A</td>
<td>5A</td>
<td>5A</td>
<td>5A</td>
<td>5A</td>
<td>5A</td>
<td>5A</td>
<td>5A</td>
<td>5A</td>
<td>110-220V</td>
<td>110-220V</td>
<td>110-220V</td>
</tr>
<tr>
<td>5I, 1A+4I, 5A+3U</td>
<td>1A</td>
<td>1A</td>
<td>1A</td>
<td>1A</td>
<td>5A</td>
<td>5A</td>
<td>5A</td>
<td>5A</td>
<td>5A</td>
<td>110-220V</td>
<td>110-220V</td>
<td>110-220V</td>
</tr>
</tbody>
</table>

Note that internal polarity can be adjusted by setting of analog input CT neutral direction and/or on SMAI pre-processing function blocks.
Figure 7. Binary input module (BIM). Input contacts named XA corresponds to rear position X31, X41, and so on, and input contacts named XB to rear position X32, X42, and so on.

Figure 8. mA input module (MIM)

Figure 9. IED with basic functionality and communication interfaces
Figure 10. Power supply module (PSM)

![Diagram of Power Supply Module (PSM)]

Figure 11. Binary output module (BOM). Output contacts named XA corresponds to rear position X31, X41, and so on, and output contacts named XB to rear position X32, X42, and so on.
Figure 12. Static output module (SOM)

Figure 13. Binary in/out module (IOM). Input contacts named XA corresponds to rear position X31, X41, and so on, and output contacts named XB to rear position X32, X42, and so on.
18. Technical data

General

Definitions

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Rated value</th>
<th>Nominal range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>( I_r = 1 \text{ or } 5 \text{ A} )</td>
<td>((0.2-40) \times I_r)</td>
</tr>
<tr>
<td>Operative range</td>
<td>((0-100) \times I_r)</td>
<td></td>
</tr>
<tr>
<td>Permissive overload</td>
<td>(4 \times I_r \text{ cont.})</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(100 \times I_r \text{ for 1 s }^\text{1)})</td>
<td></td>
</tr>
<tr>
<td>Burden</td>
<td>(&lt; 150 \text{ mVA at } I_r = 5 \text{ A})</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(&lt; 20 \text{ mVA at } I_r = 1 \text{ A})</td>
<td></td>
</tr>
<tr>
<td>Ac voltage</td>
<td>(U_r = 110 \text{ V})</td>
<td>(0.5-288 \text{ V})</td>
</tr>
<tr>
<td>Operative range</td>
<td>((0-340) \text{ V})</td>
<td></td>
</tr>
<tr>
<td>Permissive overload</td>
<td>(420 \text{ V cont.})</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(450 \text{ V 10 s})</td>
<td></td>
</tr>
<tr>
<td>Burden</td>
<td>(&lt; 20 \text{ mVA at } 110 \text{ V})</td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td>(f_r = 50/60 \text{ Hz})</td>
<td>(\pm 5%)</td>
</tr>
</tbody>
</table>

^1) max. 350 A for 1 s when COMBITEST test switch is included.
### Table 3. TRM - Energizing quantities, rated values and limits for measuring transformer modules

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Rated value</th>
<th>Nominal range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>$I_r = 1$ or $5~A$</td>
<td>$(0-1.8) \times I_r$ at $I_r = 1<del>A$ $(0-1.6) \times I_r$ at $I_r = 5</del>A$</td>
</tr>
<tr>
<td>Permissive overload</td>
<td>$1.1 \times I_r$ cont.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$1.8 \times I_r$ for 30 min at $I_r = 1~A$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$1.6 \times I_r$ for 30 min at $I_r = 5~A$</td>
<td></td>
</tr>
<tr>
<td>Burden</td>
<td>$&lt; 350<del>mVA$ at $I_r = 5</del>A$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$&lt; 200<del>mVA$ at $I_r = 1</del>A$</td>
<td></td>
</tr>
<tr>
<td>Ac voltage</td>
<td>$U_i = 110~V$</td>
<td>$(0-340)<del>V$ 0.5–288</del>V</td>
</tr>
<tr>
<td>Operative range</td>
<td>$(0-340)~V$</td>
<td></td>
</tr>
<tr>
<td>Permissive overload</td>
<td>$420~V$ cont.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$450~V$ 10 s</td>
<td></td>
</tr>
<tr>
<td>Burden</td>
<td>$&lt; 20<del>mVA$ at $110</del>V$</td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td>$f_i = 50/60~Hz$</td>
<td>± 5%</td>
</tr>
</tbody>
</table>

### Table 4. 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>$R_{in} = 194~\Omega$</td>
<td>-</td>
</tr>
<tr>
<td>Input range</td>
<td>$\pm 5$, $\pm 10$, $\pm 20mA$</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>$0-5$, $0-10$, $0-20$, $4-20mA$</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 5. OEM - Optical ethernet module

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Rated value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of channels</td>
<td>2</td>
</tr>
<tr>
<td>Standard</td>
<td>IEEE 802.3u 100BASE-FX</td>
</tr>
<tr>
<td>Type of fiber</td>
<td>62.5/125 $\mu$m multimode fibre</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 MB</td>
</tr>
</tbody>
</table>

### Auxiliary DC voltage

### Table 6. 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>$EL \pm 20%$</td>
</tr>
<tr>
<td></td>
<td>$EL = (90 - 250)~V$</td>
<td>$EL \pm 20%$</td>
</tr>
<tr>
<td>Power consumption</td>
<td>50~W typically</td>
<td>-</td>
</tr>
<tr>
<td>Auxiliary DC power in-rush</td>
<td>$&lt; 5<del>A$ during $0.1</del>s$</td>
<td>-</td>
</tr>
</tbody>
</table>
Binary inputs and outputs

Table 7. 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>24/30 V, 50mA</td>
<td>max. 0.05 W/input</td>
</tr>
<tr>
<td></td>
<td>48/60 V, 50mA</td>
<td>max. 0.1 W/input</td>
</tr>
<tr>
<td></td>
<td>110/125 V, 50mA</td>
<td>max. 0.2 W/input</td>
</tr>
<tr>
<td></td>
<td>220/250 V, 50mA</td>
<td>max. 0.4 W/input</td>
</tr>
<tr>
<td></td>
<td>220/250 V, 110mA</td>
<td>max. 0.5 W/input</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 1–20ms</td>
<td></td>
</tr>
</tbody>
</table>

Maximum 176 binary input channels may be activated simultaneously with influencing factors within nominal range.

Table 8. 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>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>24/30 V, 50mA</td>
<td>max. 0.05 W/input</td>
</tr>
<tr>
<td></td>
<td>48/60 V, 50mA</td>
<td>max. 0.1 W/input</td>
</tr>
<tr>
<td></td>
<td>110/125 V, 50mA</td>
<td>max. 0.2 W/input</td>
</tr>
<tr>
<td></td>
<td>220/250 V, 50mA</td>
<td>max. 0.4 W/input</td>
</tr>
<tr>
<td></td>
<td>220/250 V, 110mA</td>
<td>max. 0.5 W/input</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></td>
</tr>
<tr>
<td></td>
<td>Release settable 1–30 Hz</td>
<td></td>
</tr>
</tbody>
</table>

Maximum 176 binary input channels may be activated simultaneously with influencing factors within nominal range.
### Table 9. 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, 110 - 250 VDC</td>
</tr>
<tr>
<td>Number of outputs</td>
<td>6, 6</td>
</tr>
<tr>
<td>Impedance open state</td>
<td>~300 kΩ, ~810 kΩ</td>
</tr>
<tr>
<td>Test voltage across open contact, 1 min</td>
<td>No galvanic separation, No galvanic separation</td>
</tr>
<tr>
<td>Current carrying capacity:</td>
<td></td>
</tr>
<tr>
<td>Continuous</td>
<td>5A, 5A</td>
</tr>
<tr>
<td>1.0s</td>
<td>10A, 10A</td>
</tr>
<tr>
<td>Making capacity at capacitive load with the maximum capacitance of 0.2 µF :</td>
<td></td>
</tr>
<tr>
<td>0.2s</td>
<td>30A, 30A</td>
</tr>
<tr>
<td>1.0s</td>
<td>10A, 10A</td>
</tr>
<tr>
<td>Breaking capacity for DC with L/R ≤ 40ms</td>
<td>48V / 1A, 110V / 0.4A</td>
</tr>
<tr>
<td></td>
<td>60V / 0.75A, 125V / 0.35A</td>
</tr>
<tr>
<td></td>
<td>48V / 1A, 110V / 0.4A</td>
</tr>
<tr>
<td></td>
<td>60V / 0.75A, 125V / 0.35A</td>
</tr>
<tr>
<td>Operating time</td>
<td>&lt;1ms, &lt;1ms</td>
</tr>
</tbody>
</table>

### Table 10. SOM - Static Output module data (reference standard: IEC 61810-2): Electromechanical relay outputs

<table>
<thead>
<tr>
<th>Function of quantity</th>
<th>Trip and signal relays</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max system voltage</td>
<td>250V AC/DC</td>
</tr>
<tr>
<td>Number of outputs</td>
<td>6</td>
</tr>
<tr>
<td>Test voltage across open contact, 1 min</td>
<td>1000V rms</td>
</tr>
<tr>
<td>Current carrying capacity:</td>
<td></td>
</tr>
<tr>
<td>Continuous</td>
<td>8A</td>
</tr>
<tr>
<td>1.0s</td>
<td>10A</td>
</tr>
<tr>
<td>Making capacity at capacitive load with the maximum capacitance of 0.2 µF :</td>
<td></td>
</tr>
<tr>
<td>0.2s</td>
<td>30A</td>
</tr>
<tr>
<td>1.0s</td>
<td>10A</td>
</tr>
<tr>
<td>Breaking capacity for DC with L/R ≤ 40ms</td>
<td>48V / 1A, 110V / 0.4A</td>
</tr>
<tr>
<td></td>
<td>125V / 0.35A, 220V / 0.2A</td>
</tr>
<tr>
<td></td>
<td>250V / 0.15A</td>
</tr>
</tbody>
</table>
### Table 11. 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>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>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 $\phi$ &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></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>
</tbody>
</table>

### Influencing factors

### Table 12. 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>-10 °C to +55 °C</td>
<td>0.02% /°C</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>10%-90%</td>
<td>10%-90%</td>
<td>-</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-40 °C to +70 °C</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### Table 13. 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></td>
<td>Full wave rectified</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auxiliary voltage dependence, operate value</td>
<td>± 20% of EL</td>
<td></td>
<td>0.01% /%</td>
</tr>
<tr>
<td>Interrupted auxiliary DC voltage</td>
<td>24-60 V DC ± 20%</td>
<td>90-250 V DC ± 20%</td>
<td>No restart</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Correct behaviour at power down</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt;300 s</td>
</tr>
</tbody>
</table>
Table 14. Frequency influence (reference standard: IEC 60255-1)

<table>
<thead>
<tr>
<th>Dependence on</th>
<th>Within nominal range</th>
<th>Influence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency dependence, operate value</td>
<td>$f_r \pm 2.5$ Hz for 50 Hz</td>
<td>$\pm 1.0% /$ Hz</td>
</tr>
<tr>
<td></td>
<td>$f_r \pm 3.0$ Hz for 60 Hz</td>
<td></td>
</tr>
<tr>
<td>Harmonic frequency dependence (20% content)</td>
<td>2nd, 3rd and 5th harmonic of $f_r$</td>
<td>$\pm 1.0%$</td>
</tr>
</tbody>
</table>

Type tests according to standards

Table 15. 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 60255-22-1</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></td>
<td></td>
</tr>
<tr>
<td>Direct application</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indirect application</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 kV air discharge</td>
<td></td>
<td>IEC 60255-22-2, Class IV</td>
</tr>
<tr>
<td>8 kV contact discharge</td>
<td></td>
<td>IEC 61000-4-2, Class IV</td>
</tr>
<tr>
<td>8 kV contact discharge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrostatic discharge</td>
<td></td>
<td>IEC 60255-22-2, Class IV</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>15 kV air discharge</td>
<td></td>
<td>IEC 60255-22-2, Class IV</td>
</tr>
<tr>
<td>8 kV contact discharge</td>
<td></td>
<td>IEC 61000-4-2, Class IV</td>
</tr>
<tr>
<td>8 kV contact discharge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fast transient disturbance</td>
<td>4 kV</td>
<td>IEC 60255-22-4, Class A</td>
</tr>
<tr>
<td>Surge immunity test</td>
<td>1-2 kV, 1.2/50 $\mu$s high energy</td>
<td>IEC 60255-22-5</td>
</tr>
<tr>
<td>Power frequency immunity test</td>
<td>150-300 V, 50 Hz</td>
<td>IEC 60255-22-7, Class A</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</td>
<td>IEC 61000-4-8, Class V</td>
</tr>
<tr>
<td></td>
<td>100 A/m, cont.</td>
<td></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</td>
<td>IEC 60255-22-3</td>
</tr>
<tr>
<td></td>
<td>1.4-2.7 GHz</td>
<td></td>
</tr>
<tr>
<td>Radiated electromagnetic field disturbance</td>
<td>35 V/m</td>
<td>IEEE/ANSI C37.90.2</td>
</tr>
<tr>
<td></td>
<td>26-1000 MHz</td>
<td></td>
</tr>
<tr>
<td>Conducted electromagnetic field disturbance</td>
<td>10 V, 0.15-80 MHz</td>
<td>IEC 60255-22-6</td>
</tr>
<tr>
<td>Radiated emission</td>
<td>30-1000 MHz</td>
<td>IEC 60255-25</td>
</tr>
<tr>
<td>Conducted emission</td>
<td>0.15-30 MHz</td>
<td>IEC 60255-25</td>
</tr>
</tbody>
</table>

Table 16. 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.</td>
<td>IEC 60255-5</td>
</tr>
<tr>
<td>Impulse voltage test</td>
<td>5 kV, 1.2/50 $\mu$s, 0.5 J</td>
<td></td>
</tr>
<tr>
<td>Insulation resistance</td>
<td>&gt;100 M$\Omega$ at 500 VDC</td>
<td></td>
</tr>
</tbody>
</table>
### Table 17. Environmental tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Type test value</th>
<th>Reference standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold test</td>
<td>Test Ad for 16 h at -25°C</td>
<td>IEC 60068-2-1</td>
</tr>
<tr>
<td>Storage test</td>
<td>Test Ad for 16 h at -40°C</td>
<td>IEC 60068-2-1</td>
</tr>
<tr>
<td>Dry heat test</td>
<td>Test Bd for 16 h at +70°C</td>
<td>IEC 60068-2-2</td>
</tr>
<tr>
<td>Damp heat test, steady state</td>
<td>Test Ca for 4 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 18. CE compliance

<table>
<thead>
<tr>
<th>Test</th>
<th>According to</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immunity</td>
<td>EN 50263</td>
</tr>
<tr>
<td>Emissivity</td>
<td>EN 50263</td>
</tr>
<tr>
<td>Low voltage directive</td>
<td>EN 50178</td>
</tr>
</tbody>
</table>

### Table 19. 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 II</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>
Wide area measurement system

Table 20. Protocol reporting via IEEE 1344 and C37.118 PMUREPORT

<table>
<thead>
<tr>
<th>Influencing quantity</th>
<th>Range</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal frequency</td>
<td>± 0.1 x f&lt;sub&gt;r&lt;/sub&gt;</td>
<td>≤ 1.0% TVE</td>
</tr>
<tr>
<td>Signal magnitude:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage phasor</td>
<td>(0.1–1.2) x U&lt;sub&gt;r&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td>Current phasor</td>
<td>(0.5–2.0) x I&lt;sub&gt;r&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td>Phase angle</td>
<td>± 180°</td>
<td></td>
</tr>
<tr>
<td>Harmonic distortion</td>
<td>10% from 2nd – 50th</td>
<td></td>
</tr>
<tr>
<td>Interfering signal:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnitude</td>
<td>10% of fundamental signal</td>
<td></td>
</tr>
<tr>
<td>Minimum frequency</td>
<td>0.1 x f&lt;sub&gt;r&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td>Maximum frequency</td>
<td>1000 Hz</td>
<td></td>
</tr>
</tbody>
</table>
## Current protection

### Table 21. OC4PTOC

<table>
<thead>
<tr>
<th>Function</th>
<th>Setting range</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate current</td>
<td></td>
<td>± 1.0% of ( I_r ) at ( I \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></td>
<td>-</td>
</tr>
<tr>
<td>Min. operating current</td>
<td>((1-10000)% ) of ( I_{\text{Base}} )</td>
<td>± 1.0% of ( I_r ) at ( I \leq I_r )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>± 1.0% of ( I ) at ( I &gt; I_r )</td>
</tr>
<tr>
<td>Relay characteristic angle (RCA)</td>
<td></td>
<td>± 2.0 degrees</td>
</tr>
<tr>
<td>2nd harmonic blocking</td>
<td>((5–100)% ) of fundamental</td>
<td>± 2.0% of ( I_r )</td>
</tr>
<tr>
<td>Independent time delay at 0 to 2 x ( I_{\text{set}} ) &lt; I</td>
<td>((0.000-60.000)) s</td>
<td>-</td>
</tr>
<tr>
<td>Minimum operate time</td>
<td>((0.000-60.000)) s</td>
<td>-</td>
</tr>
<tr>
<td>Inverse characteristics, see</td>
<td>curve types</td>
<td>-</td>
</tr>
<tr>
<td>table 64, table 65 and table 66</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Operate time, start non-directional at 0 to 2 x ( I_{\text{set}} ) &lt; I</td>
<td>Min. = 15 ms</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max. = 30 ms</td>
</tr>
<tr>
<td>Reset time, start non-directional at 2 to 0 x ( I_{\text{set}} ) &lt; I</td>
<td>Min. = 15 ms</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max. = 30 ms</td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>10 ms typically at 0 to 2 x ( I_{\text{set}} )</td>
<td>-</td>
</tr>
<tr>
<td>Impulse margin time</td>
<td>15 ms typically</td>
<td>-</td>
</tr>
</tbody>
</table>

### Table 22. Four step residual overcurrent protection EF4PTOC

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate current</td>
<td>((1-2500)% ) of ( I_{\text{Base}} )</td>
<td>± 1.0% of ( I_r ) at ( I &lt; 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%</td>
<td>-</td>
</tr>
<tr>
<td>Operate current for directional comparison</td>
<td>((1–100)% ) of ( I_{\text{Base}} )</td>
<td>± 1.0% of ( I_r )</td>
</tr>
<tr>
<td>Timers</td>
<td>((0.000-60.000)) s</td>
<td>± 0.5% ± ms</td>
</tr>
<tr>
<td>Inverse characteristics, see table 64,</td>
<td>18 curve types</td>
<td>See table 64, table 65 and table 66</td>
</tr>
<tr>
<td>table 65 and table 66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum polarizing voltage</td>
<td>((1–100)% ) of ( U_{\text{Base}} )</td>
<td>± 0.5% of ( U_r )</td>
</tr>
<tr>
<td>Minimum polarizing current</td>
<td>((1-30)% ) of ( I_{\text{Base}} )</td>
<td>±0.25 % of ( I_r )</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 function</td>
<td>25 ms typically at 0 to 2 x ( I_{\text{set}} )</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, start function</td>
<td>25 ms typically at 2 to 0 x ( I_{\text{set}} )</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 23. 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 value, negative sequence current, step 1-4</td>
<td>(1–2500)% of I_{Base}</td>
<td>± 1.0% of I_{r} 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%</td>
<td>-</td>
</tr>
<tr>
<td>Timers</td>
<td>(0.000-60.000) s</td>
<td>± 0.5% ± 10 ms</td>
</tr>
<tr>
<td>Inverse characteristics, see table 64, table 65 and table 66</td>
<td>18 curve types</td>
<td>See table 64, table 65 and table 66</td>
</tr>
<tr>
<td>Minimum operate current for step 1 - 4</td>
<td>(1.00 - 10000.00)% of I_{Base}</td>
<td>± 1.0% of I_{r} at I &lt; I_{r}</td>
</tr>
<tr>
<td></td>
<td></td>
<td>± 1.0% of I at I &gt; I_{r}</td>
</tr>
<tr>
<td>Operate value, negative current for directional release</td>
<td>(1–100)% of I_{Base}</td>
<td>± 1.0% of I_{r}</td>
</tr>
<tr>
<td>Relay characteristic angle</td>
<td>(-180 to 180) degrees</td>
<td>± 2.0 degrees</td>
</tr>
<tr>
<td>Minimum polarizing voltage</td>
<td>(1–100)% of U_{Base}</td>
<td>± 0.5% of U_{r}</td>
</tr>
<tr>
<td>Minimum polarizing current</td>
<td>(2–100)% of I_{Base}</td>
<td>± 1.0% of I_{r}</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 function</td>
<td>25 ms typically at 0.5 to 2 x I_{set}</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, start function</td>
<td>25 ms typically at 2 to 0.5 x I_{set}</td>
<td>-</td>
</tr>
<tr>
<td>Critical impulse time, start function</td>
<td>10 ms typically at 0 to 2 x I_{set}</td>
<td>-</td>
</tr>
<tr>
<td>Impulse margin time, start function</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 24. 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 (\cdot \cos \phi) directional residual overcurrent</td>
<td>(0.25-200.00)% of I_Base</td>
<td>(\pm 1.0% \text{ of } I_l \text{ at } I \leq I_l) (\pm 1.0% \text{ of } I \text{ at } I &gt; I_l) At low setting: (0.25-1.00)% of I_l: (\pm 0.05% \text{ of } I_l) (1.00-5.00)% of I_l: (\pm 0.1% \text{ of } I_l)</td>
</tr>
<tr>
<td>Operate level for 3I (\cdot 3U_0 \cdot \cos \phi) directional residual power</td>
<td>(0.25-200.00)% of S_Base</td>
<td>(\pm 1.0% \text{ of } S \text{ at } S \leq S_l) (\pm 1.0% \text{ of } S \text{ at } S &gt; S_l) At low setting: (0.25-5.00)% of S_Base</td>
</tr>
<tr>
<td>Operate level for 3I and (\phi) residual overcurrent</td>
<td>(0.25-200.00)% of I_Base</td>
<td>(\pm 1.0% \text{ of } I_l \text{ at } I \leq I_l) (\pm 1.0% \text{ of } I \text{ at } I &gt; I_l) At low setting: (0.25-1.00)% of I_l: (\pm 0.05% \text{ of } I_l) (1.00-5.00)% of I_l: (\pm 0.1% \text{ of } I_l)</td>
</tr>
<tr>
<td>Operate level for non-directional overcurrent</td>
<td>(1.00-400.00)% of I_Base</td>
<td>(\pm 1.0% \text{ of } I \text{ at } I \leq I_l) (\pm 1.0% \text{ of } I \text{ at } I &gt; I_l) At low setting &lt;5% of I_l: (\pm 0.1% \text{ of } I_l)</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% \text{ of } U \text{ at } U \leq U_l) (\pm 0.5% \text{ of } U \text{ at } U &gt; U_l)</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% \text{ of } I_l \text{ at } I \leq I_l) (\pm 1.0% \text{ of } I \text{ at } I &gt; I_l) At low setting: (0.25-1.00)% of I_l: (\pm 0.05% \text{ of } I_l) (1.00-5.00)% of I_l: (\pm 0.1% \text{ of } I_l)</td>
</tr>
<tr>
<td>Residual release voltage for all directional modes</td>
<td>(0.01-200.00)% of U_Base</td>
<td>(\pm 0.5% \text{ of } U \text{ at } U \leq U_l) (\pm 0.5% \text{ of } U \text{ at } U &gt; U_l)</td>
</tr>
<tr>
<td>Reset ratio</td>
<td>(&gt; 95%)</td>
<td>-</td>
</tr>
<tr>
<td>Timers</td>
<td>(0.000-60.000) s</td>
<td>(\pm 0.5% \pm \text{ ms})</td>
</tr>
<tr>
<td>Inverse characteristics, see table 64, table 65 and table 66</td>
<td>19 curve types</td>
<td>See table 64, table 65 and table 66</td>
</tr>
<tr>
<td>Relay characteristic angle RCA</td>
<td>(-179 to 180) degrees</td>
<td>(\pm 2.0) degrees</td>
</tr>
<tr>
<td>Relay open angle ROA</td>
<td>(0-90) degrees</td>
<td>(\pm 2.0) degrees</td>
</tr>
<tr>
<td>Operate time, non-directional residual over current</td>
<td>60 ms typically at 0 to 2 (x ) I_set</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 24. Sensitive directional residual overcurrent and power protection SDEPSDE, continued

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reset time, non-directional residual over current</td>
<td>60 ms typically at 2 to 0 x Iset</td>
<td>-</td>
</tr>
<tr>
<td>Operate time, start function</td>
<td>ms typically at 0 to 2 x Iset</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, start function</td>
<td>50 ms typically at 2 to 0 x Iset</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 25. 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>(0-400)% of IBase</td>
<td>±1.0% of Ii</td>
</tr>
<tr>
<td>Reference temperature</td>
<td>(0-1)</td>
<td>±1.0°C, ±2°F</td>
</tr>
<tr>
<td>Operate time:</td>
<td></td>
<td>IEC 60255-8, ±5.0% or ±200 ms whichever is greater</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t = \tau \ln \left[ \frac{I^2 - I_p^2}{I^2 - I_p^2 - \frac{T_{tmp} - T_{shk}}{T_{ref} \cdot I_{ref}} \cdot I_{ref}} \right]$</td>
<td>(Equation 1)</td>
<td></td>
</tr>
<tr>
<td>$T_{Trip} = $ set operate temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_{Amb} = $ ambient temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_{ref} = $ temperature rise above ambient at Iref</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iref = reference load current</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I = actual measured current</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ip = load current before overload occurs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alarm temperature</td>
<td>(0-200)°C, (0-400)°F</td>
<td>±2.0% of heat content trip</td>
</tr>
<tr>
<td>Trip temperature</td>
<td>(0-400)°C, (0-600)°F</td>
<td>±2.0% of heat content trip</td>
</tr>
<tr>
<td>Reset level temperature</td>
<td>(0-400)°C, (0-600)°F</td>
<td>±2.0% of heat content trip</td>
</tr>
</tbody>
</table>
### Voltage protection

Table 26. 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>(1–100)% of UBase</td>
<td>± 0.5% of U_r</td>
</tr>
<tr>
<td>Absolute hysteresis</td>
<td>(0–100)% of UBase</td>
<td>± 0.5% of U_r</td>
</tr>
<tr>
<td>Internal blocking level, step 1 and step 2</td>
<td>(1–100)% of UBase</td>
<td>± 0.5% of U_r</td>
</tr>
<tr>
<td>Inverse time characteristics for step 1 and step 2, see table</td>
<td>-</td>
<td>See table 68</td>
</tr>
<tr>
<td>Definite time delay, step 1</td>
<td>(0.00 - 6000.00) s</td>
<td>± 0.5% ± ms</td>
</tr>
<tr>
<td>Definite time delays</td>
<td>(0.000-60.000) s</td>
<td>± 0.5% ± ms</td>
</tr>
<tr>
<td>Minimum operate time, inverse characteristics</td>
<td>(0.000-60.000) s</td>
<td>± 0.5% ± ms</td>
</tr>
<tr>
<td>Operate time, start function</td>
<td>25 ms typically at 2 x U_set to 0</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, start function</td>
<td>25 ms typically at 0 to 2 x U_set</td>
<td>-</td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>10 ms typically at 2 x U_set to 0</td>
<td>-</td>
</tr>
<tr>
<td>Impulse margin time</td>
<td>15 ms typically</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 27. 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>(1-200)% of UBase</td>
<td>± 0.5% of U_r when U &lt; U_r, ± 0.5% of U at U &gt; U_r</td>
</tr>
<tr>
<td>Absolute hysteresis</td>
<td>(0–100)% of UBase</td>
<td>± 0.5% of U_r when U &lt; U_r, ± 0.5% of U at U &gt; U_r</td>
</tr>
<tr>
<td>Inverse time characteristics for steps 1 and 2, see table</td>
<td>-</td>
<td>See table 67</td>
</tr>
<tr>
<td>Definite time delay, step 1</td>
<td>(0.00 - 6000.00) s</td>
<td>± 0.5% ± ms</td>
</tr>
<tr>
<td>Definite time delays</td>
<td>(0.000-60.000) s</td>
<td>± 0.5% ± ms</td>
</tr>
<tr>
<td>Minimum operate time, Inverse characteristics</td>
<td>(0.000-60.000) s</td>
<td>± 0.5% ± ms</td>
</tr>
<tr>
<td>Operate time, start function</td>
<td>25 ms typically at 0 to 2 x U_set</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, start function</td>
<td>ms typically at 2 to 0 x U_set</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>
### Frequency protection

#### Table 28. 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</td>
<td>(35.00-75.00) Hz</td>
<td>± 2.0 mHz</td>
</tr>
<tr>
<td>Operate time, start function</td>
<td>100 ms typically</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, start function</td>
<td>100 ms typically</td>
<td>-</td>
</tr>
<tr>
<td>Operate time, definite time function</td>
<td>(0.000-60.000)s</td>
<td>± 0.5% ± 10 ms</td>
</tr>
<tr>
<td>Reset time, definite time function</td>
<td>(0.000-60.000)s</td>
<td>± 0.5% ± 10 ms</td>
</tr>
</tbody>
</table>

Voltage dependent time delay

\[
\tau = \left( \frac{U - U_{\text{Min}}}{U_{\text{Nom}} - U_{\text{Min}}} \right)^{\text{Exponent}} \times (t_{\text{Max}} - t_{\text{Min}}) + t_{\text{Min}}
\]

(Equation 2)

\[
U = U_{\text{measured}}
\]

Settings:

- \(U_{\text{Nom}}=(50-150)\% \, \text{of} \, U_{\text{base}}\)
- \(U_{\text{Min}}=(50-150)\% \, \text{of} \, U_{\text{base}}\)
- Exponent=0.0-5.0
- \(t_{\text{Max}}=(0.000-60.000)\) s
- \(t_{\text{Min}}=(0.000-60.000)\) s

5% + 200 ms

#### Table 29. 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</td>
<td>(35.00-75.00) Hz</td>
<td>± 2.0 mHz at symmetrical three-phase voltage</td>
</tr>
<tr>
<td>Operate time, start function</td>
<td>100 ms typically at (f_{\text{set}} - 0.5 , \text{Hz} ) to (f_{\text{set}} + 0.5 , \text{Hz})</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, start function</td>
<td>100 ms typically</td>
<td>-</td>
</tr>
<tr>
<td>Operate time, definite time function</td>
<td>(0.000-60.000)s</td>
<td>ms</td>
</tr>
<tr>
<td>Reset time, definite time function</td>
<td>(0.000-60.000)s</td>
<td>ms</td>
</tr>
</tbody>
</table>

#### Table 30. Rate-of-change 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, internal blocking level</td>
<td>(0-100)% of UBase</td>
<td>± 0.5% of U_t</td>
</tr>
<tr>
<td>Operate time, start function</td>
<td>100 ms typically</td>
<td>-</td>
</tr>
</tbody>
</table>
## Multipurpose protection

### Table 31. 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>Base current</td>
<td>(1 - 99999) A</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>Base voltage</td>
<td>(0.05 - 2000.00) kV</td>
<td>-</td>
</tr>
<tr>
<td>Start overcurrent, step 1 and 2</td>
<td>(2 - 5000)% of IBase</td>
<td>± 1.0% of I for I&lt;l_r</td>
</tr>
<tr>
<td></td>
<td></td>
<td>± 1.0% of I for I&gt;I_r</td>
</tr>
<tr>
<td>Start undercurrent, step 1 and 2</td>
<td>(2 - 150)% of IBase</td>
<td>± 1.0% of I for I&lt;l_r</td>
</tr>
<tr>
<td></td>
<td></td>
<td>± 1.0% of I for I&gt;I_r</td>
</tr>
<tr>
<td>Definite time delay</td>
<td>(0.00 - 6000.00) s</td>
<td>± 0.5% ± 10 ms</td>
</tr>
<tr>
<td>Operate time start overcurrent</td>
<td>25 ms typically at 0 to 2 x I_{set}</td>
<td>-</td>
</tr>
<tr>
<td>Reset time start overcurrent</td>
<td>25 ms typically at 2 to 0 x I_{set}</td>
<td>-</td>
</tr>
<tr>
<td>Operate time start undercurrent</td>
<td>25 ms typically at 2 to 0 x I_{set}</td>
<td>-</td>
</tr>
<tr>
<td>Reset time start undercurrent</td>
<td>25 ms typically at 0 to 2 x I_{set}</td>
<td>-</td>
</tr>
<tr>
<td>See table 64 and table 65</td>
<td>Parameter ranges for customer defined characteristic no 17:</td>
<td>See table 64 and table 65</td>
</tr>
<tr>
<td>Voltage level where voltage memory takes over</td>
<td>(0.0 - 5.0)% of U_{Base}</td>
<td>± 0.5% of U_r</td>
</tr>
<tr>
<td>Start overvoltage, step 1 and 2</td>
<td>(2.0 - 200.0)% of U_{Base}</td>
<td>± 0.5% of U for U&lt;U_r</td>
</tr>
<tr>
<td></td>
<td></td>
<td>± 0.5% of U for U&gt;U_r</td>
</tr>
<tr>
<td>Start undervoltage, step 1 and 2</td>
<td>(2.0 - 150.0)% of U_{Base}</td>
<td>± 0.5% of U for U&lt;U_r</td>
</tr>
<tr>
<td></td>
<td></td>
<td>± 0.5% of U for U&gt;U_r</td>
</tr>
<tr>
<td>Operate time, start overvoltage</td>
<td>25 ms typically at 0 to 2 x U_{set}</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, start overvoltage</td>
<td>25 ms typically at 2 to 0 x U_{set}</td>
<td>-</td>
</tr>
<tr>
<td>Operate time start undervoltage</td>
<td>25 ms typically 2 to 0 x U_{set}</td>
<td>-</td>
</tr>
<tr>
<td>Reset time start undervoltage</td>
<td>25 ms typically at 0 to 2 x U_{set}</td>
<td>-</td>
</tr>
<tr>
<td>High and low voltage limit, voltage dependent operation</td>
<td>(1.0 - 200.0)% of U_{Base}</td>
<td>± 1.0% of U for U&lt;U_r</td>
</tr>
<tr>
<td></td>
<td></td>
<td>± 1.0% of U for U&gt;U_r</td>
</tr>
<tr>
<td>Directional function</td>
<td>Settable: NonDir, forward and reverse</td>
<td>-</td>
</tr>
</tbody>
</table>
### Table 31. General current and voltage protection CVGAPC, continued

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<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, underrange</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 to 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 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>
Secondary system supervision

Table 32. Current circuit supervision CCSRDIF

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate current</td>
<td>(5-200)% of $I_r$</td>
<td>$\pm 10.0%$ of $I_r$ at $I \leq I_r$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$\pm 10.0%$ of $I$ at $I &gt; I_r$</td>
</tr>
<tr>
<td>Block current</td>
<td>(5-500)% of $I_r$</td>
<td>$\pm 5.0%$ of $I_r$ at $I \leq I_r$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$\pm 5.0%$ of $I$ at $I &gt; I_r$</td>
</tr>
</tbody>
</table>

Table 33. Fuse failure supervision SDDRFUF

<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 $U_{Base}$</td>
<td>$\pm 1.0%$ of $U_r$</td>
</tr>
<tr>
<td>Operate current, zero sequence</td>
<td>(1-100)% of $I_{Base}$</td>
<td>$\pm 1.0%$ of $I_r$</td>
</tr>
<tr>
<td>Operate voltage, negative sequence</td>
<td>(1-100)% of $U_{Base}$</td>
<td>$\pm 0.5%$ of $U_r$</td>
</tr>
<tr>
<td>Operate current, negative sequence</td>
<td>(1-100)% of $I_{Base}$</td>
<td>$\pm 1.0%$ of $I_r$</td>
</tr>
<tr>
<td>Operate voltage change level</td>
<td>(1-100)% of $U_{Base}$</td>
<td>$\pm 5.0%$ of $U_r$</td>
</tr>
<tr>
<td>Operate current change level</td>
<td>(1-100)% of $I_{Base}$</td>
<td>$\pm 5.0%$ of $I_r$</td>
</tr>
<tr>
<td>Operate phase voltage</td>
<td>(1-100)% of $U_{Base}$</td>
<td>$\pm 0.5%$ of $U_r$</td>
</tr>
<tr>
<td>Operate phase current</td>
<td>(1-100)% of $I_{Base}$</td>
<td>$\pm 1.0%$ of $I_r$</td>
</tr>
<tr>
<td>Operate phase dead line voltage</td>
<td>(1-100)% of $U_{Base}$</td>
<td>$\pm 0.5%$ of $U_r$</td>
</tr>
<tr>
<td>Operate phase dead line current</td>
<td>(1-100)% of $I_{Base}$</td>
<td>$\pm 1.0%$ of $I_r$</td>
</tr>
</tbody>
</table>
### Logic

**Table 34. Tripping logic SMPTRC**

<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>Timers</td>
<td>(0.000-60.000) s</td>
<td>± 0.5% ± 10 ms</td>
</tr>
</tbody>
</table>

**Table 35. Configurable logic blocks**

<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>Logic block</td>
<td>fast</td>
<td>medium</td>
<td>normal</td>
</tr>
<tr>
<td>LogicAND</td>
<td>60</td>
<td>60</td>
<td>160</td>
</tr>
<tr>
<td>LogicOR</td>
<td>60</td>
<td>60</td>
<td>160</td>
</tr>
<tr>
<td>LogicXOR</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>LogicInverter</td>
<td>30</td>
<td>30</td>
<td>80</td>
</tr>
<tr>
<td>LogicSRMemory</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>LogicRSMemory</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>LogicGate</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>LogicTimer</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>LogicPulseTimer</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>LogicTimerSet</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>LogicLoopDelay</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Trip Matrix Logic</td>
<td>6</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>Boolean 16 to Integer</td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Boolean 16 to integer with Logic Node</td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Integer to Boolean 16</td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Integer to Boolean 16 with Logic Node</td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
</tbody>
</table>
### Monitoring

Table 36. Phase current measurement CMMXU

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>$(0.1–4.0) \times I_r$</td>
<td>$\pm 0.2%$ of $I_r$ at $I \leq 0.5 \times I_r$, $\pm 0.2%$ of $I_r$ at $I &gt; 0.5 \times I_r$</td>
</tr>
<tr>
<td>Phase angle</td>
<td>$(0.1–4.0) \times I_r$</td>
<td>$\pm 0.5^\circ$ at $0.2 \times I &lt; I &lt; 0.5 \times I$, $\pm 0.2^\circ$ at $0.5 \times I \leq I &lt; 4.0 \times I$</td>
</tr>
</tbody>
</table>

Table 37. 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>$\pm 0.3%$ of $U$ at $U \leq 50$ V $\pm 0.2%$ of $U$ at $U &gt; 50$ V</td>
</tr>
<tr>
<td>Phase angle</td>
<td>(10 to 300) V</td>
<td>$\pm 0.3^\circ$ at $U \leq 50$ V $\pm 0.2^\circ$ at $U &gt; 50$ V</td>
</tr>
</tbody>
</table>

Table 38. 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>(10 to 300) V</td>
<td>$\pm 0.3%$ of $U$ at $U \leq 50$ V $\pm 0.2%$ of $U$ at $U &gt; 50$ V</td>
</tr>
<tr>
<td>Phase angle</td>
<td>(10 to 300) V</td>
<td>$\pm 0.3^\circ$ at $U \leq 50$ V $\pm 0.2^\circ$ at $U &gt; 50$ V</td>
</tr>
</tbody>
</table>

Table 39. 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>$(0.1–4.0) \times I_r$</td>
<td>$\pm 0.2%$ of $I_r$ at $I \leq 0.5 \times I_r$, $\pm 0.2%$ of $I_r$ at $I &gt; 0.5 \times I_r$</td>
</tr>
<tr>
<td>Current zero sequence, 3I0</td>
<td>$(0.1–1.0) \times I_r$</td>
<td>$\pm 0.2%$ of $I_r$ at $I \leq 0.5 \times I_r$, $\pm 0.2%$ of $I_r$ at $I &gt; 0.5 \times I_r$</td>
</tr>
<tr>
<td>Current negative sequence, I2</td>
<td>$(0.1–1.0) \times I_r$</td>
<td>$\pm 0.2%$ of $I_r$ at $I \leq 0.5 \times I_r$, $\pm 0.2%$ of $I_r$ at $I &gt; 0.5 \times I_r$</td>
</tr>
<tr>
<td>Phase angle</td>
<td>$(0.1–4.0) \times I_r$</td>
<td>$\pm 0.5^\circ$ at $0.2 \times I &lt; I &lt; 0.5 \times I$, $\pm 0.2^\circ$ at $0.5 \times I \leq I &lt; 4.0 \times I$</td>
</tr>
</tbody>
</table>

Table 40. 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>$\pm 0.3%$ of $U$ at $U \leq 50$ V $\pm 0.2%$ of $U$ at $U &gt; 50$ V</td>
</tr>
<tr>
<td>Voltage zero sequence, 3U0</td>
<td>(10 to 300) V</td>
<td>$\pm 0.3%$ of $U$ at $U \leq 50$ V $\pm 0.2%$ of $U$ at $U &gt; 50$ V</td>
</tr>
<tr>
<td>Voltage negative sequence, U2</td>
<td>(10 to 300) V</td>
<td>$\pm 0.3%$ of $U$ at $U \leq 50$ V $\pm 0.2%$ of $U$ at $U &gt; 50$ V</td>
</tr>
<tr>
<td>Phase angle</td>
<td>(10 to 300) V</td>
<td>$\pm 0.3^\circ$ at $U \leq 50$ V $\pm 0.2^\circ$ at $U &gt; 50$ V</td>
</tr>
</tbody>
</table>

Phasor measurement unit RES670

Pre-configured

Product version: 1.2
Table 41. 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, 0-5, 0-10, 0-20, 4-20 mA</td>
<td>± 0.1 % of set value ± 0.005 mA</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 42. Event counter CNTGIO

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Counter value</td>
<td>0-100000</td>
<td></td>
</tr>
<tr>
<td>Max. count up speed</td>
<td>10 pulses/s (50% duty cycle)</td>
<td></td>
</tr>
</tbody>
</table>

Table 43. Disturbance report

<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 60</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>96</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, 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 44. 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 1000</td>
</tr>
<tr>
<td>Resolution</td>
<td>1 ms</td>
</tr>
<tr>
<td>Accuracy</td>
<td>Depending on time synchronizing</td>
</tr>
</tbody>
</table>
### Table 45. 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 46. 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>1 ms</td>
</tr>
<tr>
<td>Accuracy</td>
<td>Depending on time synchronizing</td>
</tr>
</tbody>
</table>

### Table 47. 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 48. 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>
### Metering

**Table 49. Pulse counter PCGGIO**

<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 50. 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>Input from MMXU. No extra error at steady load</td>
<td></td>
</tr>
</tbody>
</table>


Station communication

Table 51. IEC 61850-8-1 communication protocol

<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 608–5–103</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 52. 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 53. 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>Protocol</td>
<td>IEC 61850-8-1</td>
</tr>
<tr>
<td>Communication speed</td>
<td>100 Base-FX</td>
</tr>
</tbody>
</table>
Hardware

IED

Table 54. Case

<table>
<thead>
<tr>
<th>Material</th>
<th>Steel sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front plate</td>
<td>Steel sheet profile with cut-out for HMI</td>
</tr>
<tr>
<td>Surface treatment</td>
<td>Aluzink preplated steel</td>
</tr>
<tr>
<td>Finish</td>
<td>Light grey (RAL 7035)</td>
</tr>
</tbody>
</table>

Table 55. Water and dust protection level according to IEC 60529

<table>
<thead>
<tr>
<th>Location</th>
<th>Protection Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front</td>
<td>IP40 (IP54 with sealing strip)</td>
</tr>
<tr>
<td>Sides, top and bottom</td>
<td>IP20</td>
</tr>
<tr>
<td>Rear side</td>
<td>IP20 with screw compression type</td>
</tr>
<tr>
<td></td>
<td>IP10 with ring lug terminals</td>
</tr>
</tbody>
</table>

Table 56. Weight

<table>
<thead>
<tr>
<th>Case size</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>6U, 1/1 x 19&quot;</td>
<td>≤ 18 kg</td>
</tr>
</tbody>
</table>

Connection system

Table 57. CT and VT circuit connectors

<table>
<thead>
<tr>
<th>Connector type</th>
<th>Rated voltage and current</th>
<th>Maximum conductor area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screw compression type</td>
<td>250 V AC, 20 A</td>
<td>4 mm² (AWG12) 2 x 2.5 mm² (2 x AWG14)</td>
</tr>
<tr>
<td>Terminal blocks suitable for ring lug terminals</td>
<td>250 V AC, 20 A</td>
<td>4 mm² (AWG12)</td>
</tr>
</tbody>
</table>

Table 58. Binary I/O connection system

<table>
<thead>
<tr>
<th>Connector type</th>
<th>Rated voltage</th>
<th>Maximum conductor area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screw compression type</td>
<td>250 V AC</td>
<td>2.5 mm² (AWG14) 2 x 1 mm² (2 x AWG18)</td>
</tr>
<tr>
<td>Terminal blocks suitable for ring lug terminals</td>
<td>300 V AC</td>
<td>3 mm² (AWG14)</td>
</tr>
</tbody>
</table>
Basic IED functions

Table 59. 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 60. 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 61. 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 62. 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>+/-2µs</td>
</tr>
</tbody>
</table>
### Table 63. 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 channels PPS</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 PPS and IRIG-B</td>
<td>Type ST</td>
</tr>
<tr>
<td>Type of fibre</td>
<td>62.5/125 μm multimode fibre</td>
</tr>
<tr>
<td>Supported formats</td>
<td>IRIG-B 00x, PPS</td>
</tr>
<tr>
<td>Accuracy</td>
<td>+/- 2μs</td>
</tr>
</tbody>
</table>
### Inverse characteristic

Table 64. 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>( t = \left( \frac{A}{(I^2 - 1)} + B \right) \cdot k )</td>
<td>k = (0.05-999) in steps of 0.01</td>
</tr>
<tr>
<td>Reset characteristic:</td>
<td>( t = \frac{t_f}{(I^2 - 1)} \cdot k )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I = \frac{I_{\text{measured}}}{I_{\text{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>ANSI/IEEE C37.112, 5%</td>
</tr>
<tr>
<td>ANSI Very inverse</td>
<td>A=19.61, B=0.491, P=2.0, tr=21.6</td>
<td>+ 40 ms</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 65. 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></td>
<td></td>
</tr>
<tr>
<td>( t = \left( \frac{A}{I^k - 1} \right) \times k )</td>
<td>( k = (0.05-999) ) in steps of 0.01</td>
<td>-</td>
</tr>
<tr>
<td>( I = \frac{I_{\text{measured}}}{I_{\text{set}}} )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time delay to reset, IEC inverse time</td>
<td>( (0.000-60.000) ) s</td>
<td>± 0.5% of set time ± 10 ms</td>
</tr>
<tr>
<td>IEC Normal Inverse</td>
<td>( A=0.14, P=0.02 )</td>
<td>IEC 60255-151, 5% + 40 ms</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></td>
<td></td>
</tr>
<tr>
<td>Operate characteristic:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( t = \left( \frac{A}{I^k - C} + B \right) \times k )</td>
<td>( k = (0.05-999) ) in steps of 0.01</td>
<td></td>
</tr>
<tr>
<td>( A=(0.005-200.000) ) in steps of 0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( B=(0.00-20.00) ) in steps of 0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( C=(0.1-10.0) ) in steps of 0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( P=(0.005-3.000) ) in steps of 0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( T_R=(0.005-100.000) ) in steps of 0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( C_R=(0.1-10.0) ) in steps of 0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( P_R=(0.005-3.000) ) in steps of 0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reset characteristic:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( t = \frac{T_R}{(I_{PR} - C_R)} \times k )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I = \frac{I_{\text{measured}}}{I_{\text{set}}} )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 66. 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></td>
<td></td>
</tr>
<tr>
<td>( t = \frac{1}{0.339 - \frac{0.236}{I}} \times k )</td>
<td>( k = (0.05-999) ) in steps of 0.01</td>
<td>IEC 60255-151, 5% + 40 ms</td>
</tr>
<tr>
<td>( I = \frac{I_{\text{measured}}}{I_{\text{set}}} )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RD type logarithmic inverse characteristic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( t = 5.8 - \left( 1.35 \cdot ln \frac{I}{k} \right) )</td>
<td>( k = (0.05-999) ) in steps of 0.01</td>
<td></td>
</tr>
<tr>
<td>( I = \frac{I_{\text{measured}}}{I_{\text{set}}} )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 67. 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% +40 ms</td>
</tr>
<tr>
<td>$t = \frac{k}{\left( \frac{U - U_\text{sat}}{U} \right)}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$U_\text{sat} = U_\text{set}$</td>
<td>$U = U_\text{measured}$</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>$t = \frac{k \cdot 480}{\left(32 \cdot \left(\frac{U - U_\text{sat}}{U} - 0.5\right)^{2.0} - 0.035\right)}$</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>$t = \frac{k \cdot 480}{\left(32 \cdot \left(\frac{U - U_\text{sat}}{U} - 0.5\right)^{3.0} - 0.035\right)}$</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>$t = \frac{k \cdot A}{\left(\frac{B \cdot \left(\frac{U - U_\text{sat}}{U} - C\right)}{A}\right)^{D}}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$A = (0.005-200.000)$ in steps of 0.001</td>
<td>$B = (0.50-100.00)$ in steps of 0.01</td>
<td></td>
</tr>
<tr>
<td>$C = (0.0-1.0)$ in steps of 0.1</td>
<td>$D = (0.000-60.000)$ in steps of 0.001</td>
<td></td>
</tr>
<tr>
<td>$P = (0.000-3.000)$ in steps of 0.001</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 68. Inverse time characteristics for undervoltage 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 &lt; -U} ) ( U &lt; U_{\text{set}} )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( k = (0.05-1.10) ) in steps of 0.01</td>
<td>5% +40 ms</td>
</tr>
<tr>
<td>Type B curve:</td>
<td>( t = \frac{k \cdot 480}{32 \left( U &lt; -U \right)^2 + 0.055} )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( k = (0.05-1.10) ) in steps of 0.01</td>
<td></td>
</tr>
<tr>
<td>Programmable curve</td>
<td>( t = \left[ \frac{k \cdot A}{B \left( U &lt; -U \right)^2 + D} \right] )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( k = (0.05-1.10) ) in steps of 0.01</td>
<td></td>
</tr>
<tr>
<td></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>
</tbody>
</table>
19. Ordering

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: RES670*1.2-A20-A01A02B12C05D01D03E01F02H09-B1-X0-C-B-KA-B3X0-A-ABC-X-XD. Using the code of each position #1-12 specified as RES670*1.2 2-3 3 3 3-4-5-6-7 7-8-9 9 10 10 10 10 10 10 10 10 10 10 11 11 11 11 11-12

<table>
<thead>
<tr>
<th>Position</th>
<th>#1</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOFTWARE</td>
<td></td>
<td>Selection for position #1.</td>
</tr>
<tr>
<td>Version number</td>
<td></td>
<td>Version no 1.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Configuration alternatives</th>
<th>#2</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>3Ix1U phasors</td>
<td>A20</td>
<td>Selection for position #2.</td>
</tr>
<tr>
<td>6Ix2U phasors</td>
<td>B20</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ACT configuration</th>
<th>#3</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABB standard configuration</td>
<td>X00</td>
<td>Selection for position #3.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Software options</th>
<th>#4</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>No option</td>
<td>X00</td>
<td>All fields in the ordering form do not need to be filled in</td>
</tr>
<tr>
<td>Current protection - PMU</td>
<td>C25</td>
<td></td>
</tr>
<tr>
<td>General current and voltage protection - PMU</td>
<td>F03</td>
<td>Note: Not in B20</td>
</tr>
<tr>
<td>Second system supervision, single busbar</td>
<td>G01</td>
<td>Note: Not in A20</td>
</tr>
<tr>
<td>Second system supervision, double busbar</td>
<td>G02</td>
<td></td>
</tr>
<tr>
<td>IEC 62439-3 Edition 2 parallel redundancy protocol</td>
<td>P02</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Casing</th>
<th>#5</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1 x 19&quot; case 2 TRM slots</td>
<td>E</td>
<td>Selection for position #5.</td>
</tr>
<tr>
<td>Mounting details with IP40 of protection from the front</td>
<td>#6</td>
<td>Notes and Rules</td>
</tr>
<tr>
<td>No mounting kit included</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>19&quot; rack mounting kit for 1/1 x 19&quot; case</td>
<td>C</td>
<td>Note: Wall mounting not recommended with communication modules with fibre connection (OEM)</td>
</tr>
<tr>
<td>Wall mounting kit</td>
<td>D</td>
<td></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>Selection for position #6.</td>
</tr>
</tbody>
</table>
### Connection type for Power supply, Input/output and Communication modules

<table>
<thead>
<tr>
<th>Notes and Rules</th>
<th>#7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compression terminals</td>
<td>K</td>
</tr>
<tr>
<td><strong>Auxiliary power supply</strong></td>
<td></td>
</tr>
<tr>
<td>24-60 VDC</td>
<td>A</td>
</tr>
<tr>
<td>90-250 VDC</td>
<td>B</td>
</tr>
</tbody>
</table>

*Selection for position #7.* K

### Human machine hardware interface

<table>
<thead>
<tr>
<th>Notes and Rules</th>
<th>#8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium size - graphic display, IEC keypad symbols</td>
<td>B</td>
</tr>
<tr>
<td>Medium size - graphic display, ANSI keypad symbols</td>
<td>C</td>
</tr>
</tbody>
</table>

*Selection for position #8.*

### Connection type for Analog modules

<table>
<thead>
<tr>
<th>Notes and Rules</th>
<th>#9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compression terminals</td>
<td>A</td>
</tr>
<tr>
<td>Ringlug terminals</td>
<td>B</td>
</tr>
</tbody>
</table>

**Analog system**

- First TRM, 9I+3U 1A, 110/220V
- First TRM, 9I+3U 5A, 110/220V
- First TRM, 5I, 1A+4I, 5A+3U, 110/220V

*No second TRM included.* X0

- Second TRM, 9I+3U 1A, 110/220V
- Second TRM, 9I+3U 5A, 110/220V
- Second TRM, 5I, 1A+4I, 5A+3U, 110/220V

*Note: B20 must include a second TRM.*

*Selection for position #9.*

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

**Note:** 1BIM and 1 BOM included.

| Notes and Rules | #10 |

*For pulse counting, for example kWh metering, the BIM with enhanced pulse counting capabilities must be used.*

**Slot position (rear view)**

| Notes and Rules | #10 |

*Selection for position #10.*

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

**Note:** Max 11 positions in 1/1 rack with 2 TRM.
### Remote end communication, DNP serial comm. and time synchronization modules

<table>
<thead>
<tr>
<th>Slot position (rear view)</th>
<th>#11</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available slots in 1/1 case with 2 TRM</td>
<td>X X X X X X</td>
<td></td>
</tr>
<tr>
<td>No remote communication board included</td>
<td>X X X X X X</td>
<td></td>
</tr>
<tr>
<td>GPS time module GTM</td>
<td>S</td>
<td>Rule: One, and only one, Time synchronization must be ordered.</td>
</tr>
<tr>
<td>IRIG-B Time synchronization module</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>Galvanic RS485 communication module</td>
<td>G G G G G G</td>
<td></td>
</tr>
</tbody>
</table>

Selection for position #11.

### Serial communication unit for station communication

<table>
<thead>
<tr>
<th>Slot position (rear view)</th>
<th>#12</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optical ethernet module, 2 channel glass</td>
<td>E</td>
<td></td>
</tr>
</tbody>
</table>

Selection for position #12. E

### Guidelines

Carefully read and follow the set of rules to ensure problem-free order management. Be aware that certain functions can only be ordered in combination with other functions and that some functions require specific hardware selections.

Please refer to the available functions table for included application functions.

### Accessories

#### GPS antenna and mounting details

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>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</td>
<td></td>
<td>1MRK 001 665-AA</td>
</tr>
<tr>
<td>Cable for antenna, 40 m</td>
<td></td>
<td>1MRK 001 665-BA</td>
</tr>
</tbody>
</table>

### Test switch

The test system COMBITEST intended for use with the IED 670 products is described in 1MRK 512 001-BEN and 1MRK 001024-CA. Please refer to the website: www.abb.com/substationautomation for detailed information.

1 TRM/2 TRM with external neutral on currents circuits (ordering number RK926 315–DC).

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

1 TRM/2 TRM with internal neutral on currents circuits (ordering number RK926 315–AM).

### Protection cover

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<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>

### Combiflex
Phasor measurement unit RES670

Pre-configured

Product version: 1.2

Key switch for settings

Key switch for lock-out of settings via LCD-HMI

Quantity: 

1MRK 000 611-A

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

Configuration and monitoring tools

Front connection cable between LCD-HMI and PC

Quantity: 

1MRK 001 665-CA

LED Label special paper A4, 1 pc

Quantity: 

1MRK 002 038-CA

LED Label special paper Letter, 1 pc

Quantity: 

1MRK 002 038-DA

Manuals

Note: One (1) IED Connect CD containing user documentation (Operator’s manual, Technical reference manual, Installation and commissioning manual, Application manual and Getting started guide), Connectivity packages and LED label template is always included for each IED.

Rule: Specify additional quantity of IED Connect CD requested.

Quantity: 

1MRK 002 290-AB

User documentation

Rule: Specify the number of printed manuals requested

Operator’s manual

IEC Quantity: 

1MRK 511 251–UEN

ANSI Quantity: 

1MRK 511 251–UUS

Technical reference manual

IEC Quantity: 

1MRK 511 250–UEN

ANSI Quantity: 

1MRK 511 250–UUS

Installation and commissioning manual

IEC Quantity: 

1MRK 511 252–UEN

ANSI Quantity: 

1MRK 511 252–UUS

Application manual

IEC Quantity: 

1MRK 511 253–UEN

ANSI Quantity: 

1MRK 511 253–UUS

Engineering manual, 670 series

Quantity: 

1MRK 511 240-UEN
Reference information

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

<table>
<thead>
<tr>
<th>Country:</th>
<th>End user:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Station name:</td>
<td>Voltage level: kV</td>
</tr>
</tbody>
</table>

Related documents

Documents related to RES670

<table>
<thead>
<tr>
<th>Identity number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1MRK 511 251-UEN</td>
<td>Operator's manual</td>
</tr>
<tr>
<td>1MRK 511 252-UEN</td>
<td>Installation and commissioning manual</td>
</tr>
<tr>
<td>1MRK 511 250-UEN</td>
<td>Technical reference manual</td>
</tr>
<tr>
<td>1MRK 511 253-UEN</td>
<td>Application manual</td>
</tr>
<tr>
<td>1MRK 511 266-BEN</td>
<td>Product guide pre-configured</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Identity number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1MRK 513 003-BEN</td>
<td>Connection and Installation components</td>
</tr>
<tr>
<td>1MRK 512 001-BEN</td>
<td>Test system, COMBITEST</td>
</tr>
<tr>
<td>1MRK 514 012-BEN</td>
<td>Accessories for 670 series IEDs</td>
</tr>
<tr>
<td>1MRK 500 092-WEN</td>
<td>670 series SPA and signal list</td>
</tr>
<tr>
<td>1MRK 500 091-WEN</td>
<td>IEC 61850 Data objects list for 670 series</td>
</tr>
<tr>
<td>1MRK 511 240-UEN</td>
<td>Engineering manual 670 series</td>
</tr>
<tr>
<td>1MRK 505 260-UEN</td>
<td>Communication set-up for Relion 670 series</td>
</tr>
</tbody>
</table>

More information can be found on www.abb.com/substationautomation.