Generator protection REG670
Pre-configured
Product Guide
1. Application

The REG670 is used for protection, control and monitoring of generators and generator-transformer blocks from relatively small units up to the largest generating units. The IED has a comprehensive function library, covering the requirements for most generator applications. The large number of analog inputs available enables, together with the large functional library, integration of many functions in one IED. In typical applications two units can provide total functionality, also providing a high degree of redundancy. REG670 can as well be used for protection and control of shunt reactors.

The protection function library includes differential protection for generator, block, auxiliary transformer and the whole generator block. Stator earth fault protection, both traditional 95% protection as well as 100% 3rd harmonic based stator earth fault protection are included. The 100% protection uses a differential voltage approach giving high sensitivity and a high degree of security. Well proven algorithms for pole slip, underexcitation, rotor earth fault, negative sequence current protections, and so on, are included in the IED.

The generator differential protection in the REG670 adapted to operate correctly for generator applications where factors as long DC time constants and requirement on short trip time have been considered.

As many of the protection functions can be used as multiple instances there are possibilities to protect more than one object in one IED. It is possible to have protection for an auxiliary power transformer integrated in the same IED having main protections for the generator. The concept thus enables very cost effective solutions.

The REG670 also enables valuable monitoring possibilities as many of the process values can be transferred to an operator HMI.

The wide application flexibility makes this product an excellent choice for both new installations and for refurbishment in existing power plants.

Serial data communication is via optical connections to ensure immunity against disturbances.

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Figure 1. Typical generator protection application with generator differential and back-up protection, including 12 analog input transformers and half 19" case size.
Figure 2. Enhanced generator protection application with generator differential and back-up protection, including 24 analog input transformers and full 19" case size. Optional pole slip protection and overall differential protection can be activated.
Figure 3. Block protection including generator and generator transformer protection with 24 analog input transformers and full 19" rack. The application is prepared to cover hydro as well as gas turbine arrangements.
## 2. Available functions

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*) In order to utilize it, an appropriate optional hardware port must be ordered.
4. Functionality

Differential protection

**Generator differential protection GENPDIF**

Short circuit between the phases of the stator windings causes normally very large fault currents. The short circuit gives risk of damages on insulation, windings and stator iron core. The large short circuit currents cause large forces, which can cause damage even to other components in the power plant, such as turbine and generator-turbine shaft.

To limit the damage due to stator winding short circuits, the fault clearance must be as fast as possible (instantaneous). If the generator block is connected to the power system close to other generating blocks, the fast fault clearance is essential to maintain the transient stability of the non-faulted generators.

Normally, the short circuit fault current is very large, that is, significantly larger than the generator rated current. There is a risk that a short circuit can occur between phases close to the neutral point of the generator, thus causing a relatively small fault current. The fault current can also be limited due to low excitation of the generator. Therefore, it is desired that the detection of generator phase-to-phase short circuits shall be relatively sensitive, detecting small fault currents.

It is also of great importance that the generator differential protection does not trip for external faults, with large fault currents flowing from the generator.

To combine fast fault clearance, as well as sensitivity and selectivity, the generator differential protection is normally the best choice for phase-to-phase generator short circuits.

Generator differential protection GENPDIF is also well suited to generate fast, sensitive and selective fault clearance, if used to protect shunt reactors and small busbars.

**Transformer differential protection T2WPDIF/T3WPDIF**

The functions Transformer differential protection, two-winding (T2WPDIF) and Transformer differential protection, three-winding (T3WPDIF) are provided with internal CT ratio matching and vector group compensation and when required zero sequence current elimination is also made internally in the software.

The function can be provided with up to six three phase sets of current inputs. All current inputs are provided with percentage bias restraint features, making the IED suitable for two- or three-winding transformers in multi-breaker station arrangements.
The setting facilities cover for applications of the differential protection to all types of power transformers and autotransformers with or without load tap changer as well as for shunt reactors or and local feeders within the station. An adaptive stabilizing feature is included for heavy through-faults. By introducing the load tap changer position, the differential protection pick-up can be set to optimum sensitivity thus covering internal faults with low fault level.

Stabilization is included for inrush currents respectively for overexcitation condition. Adaptive stabilization is also included for system recovery inrush and CT saturation for external faults. A fast high set unrestrained differential current protection is included for very high speed tripping at high internal fault currents.

Innovative sensitive differential protection feature, based on the theory of symmetrical components, offers best possible coverage for power transformer windings turn-to-turn faults.
**1Ph High impedance differential protection HZPDIF**

The 1Ph High impedance differential protection HZPDIF function can be used when the involved CT cores have the same turn ratio and similar magnetizing characteristic. It utilizes an external summation of the phases and neutral current and a series resistor and a voltage dependent resistor externally to the IED.

**Restricted earth fault protection (PDIF, 87N)**

Restricted earth-fault protection, low impedance function (REFPDIF) can be used on all directly or low impedance earthed windings. REFPDIF function can provide higher sensitivity (down to 5%) and higher speed as it measures individually on each winding and thus do not need inrush stabilization.

The low impedance function is a percentage biased function with an additional zero sequence current directional comparison criteria. This gives excellent sensitivity and stability for through faults. The function allows use of different CT ratios and magnetizing characteristics on the phase and neutral CT cores and mixing with other functions and protection IEDs on the same cores.

**Impedance protection**

**Full-scheme distance measuring, Mho characteristic ZMHPDIS**

The numerical mho line distance protection is a three zone full scheme protection for back-up detection of short circuit and earth faults. The three zones have fully independent measuring and settings, which gives high flexibility for all types of lines.

The function can be used as under impedance back-up protection for transformers and generators.

**Directional impedance element for Mho characteristic ZDMRDIR**

The phase-to-earth impedance elements can be optionally supervised by a phase unselective directional function (phase unselective, because it is based on symmetrical components).

**Pole slip protection PSPPPAM**

The situation with pole slip of a generator can be caused by different reasons.

- A short circuit may occur in the external power grid, close to the generator. If the fault clearing time is too long, the generator will accelerate so much, that the synchronism cannot be maintained.

- Un-damped oscillations occur in the power system, where generator groups at different locations, oscillate against each other. If the connection between the generators is too weak the magnitude of the oscillations will increase until the angular stability is lost.

The operation of a generator having pole slip will give risk of damages to the generator, shaft and turbine.

- At each pole slip there will be significant torque impact on the generator-turbine shaft.
- In asynchronous operation there will be induction of currents in parts of the generator normally not carrying current, thus resulting in increased heating. The consequence can be damages on insulation and stator/rotor iron.

The Pole slip protection (PSPPPAM) function shall detect pole slip conditions and trip the generator as fast as possible if the locus of the measured impedance is inside the generator-transformer block. If the centre of pole slip is outside in the power grid, the first action should be to split the network into two parts, after line protection action. If this fails there should be operation of the generator PSPPPAM in zone 2, to prevent further damages to the generator, shaft and turbine.
Loss of excitation LEXPDIS

There are limits for the loss of excitation (LEXPDIS) of a synchronous machine. A reduction of the excitation current weakens the coupling between the rotor and the external power system. The machine may lose the synchronism and start to operate like an induction machine. Then, the reactive consumption will increase. Even if the machine does not loose synchronism it may not be acceptable to operate in this state for a long time. LEXPDIS increases the generation of heat in the end region of the synchronous machine. The local heating may damage the insulation of the stator winding and even the iron core.

To prevent damages to the generator it should be tripped at under-excitation.

Current protection

Instantaneous phase overcurrent protection PHPIOC

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

Four step phase overcurrent protection OC4PTOC

The four step phase overcurrent protection function OC4PTOC 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, current polarized or dual polarized.

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

A second harmonic blocking can be set individually for each step.

EF4PTOC can be used as main protection for phase-to-earth faults.

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

EF4PTOC can be configured to measure the residual current from the three-phase current inputs or the current from a separate current input.

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
The magnitude of the fault current is almost independent on the fault location in the network. The protection can be selected to use either the residual current or residual power component 3U0·3I0·cos φ, for operating quantity with maintained short circuit capacity. There is also available one nondirectional 3I0 step and one 3U0 overvoltage tripping step.

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

If the temperature of a power transformer/generator reaches very high values the equipment might be damaged. The insulation within the transformer/generator will have forced ageing. As a consequence of this the risk of internal phase-to-phase or phase-to-earth faults will increase. High temperature will degrade the quality of the transformer/generator oil.

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

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

**Breaker failure protection CCRBRF**

Breaker failure protection (CCRBRF) ensures fast back-up tripping of surrounding breakers in case of own breaker failure to open. CCRBRF can be current based, contact based, or adaptive combination between these two principles.

A current check with extremely short reset time is used as check criteria to achieve a high security against unnecessary operation. A contact check criteria can be used where the fault current through the breaker is small.

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

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

**Pole discordance protection CCRPLD**

Single pole operated circuit breakers can due to electrical or mechanical failures end up with the different poles in different positions (close-open). This can cause negative and zero sequence currents which gives thermal stress on rotating machines and can cause unwanted operation of zero sequence or negative sequence current functions.

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

The Polediscordance protection function CCRPLD operates based on information from auxiliary contacts of the circuit breaker for the three phases with additional criteria from unsymmetrical phase current when required.

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

The directional over-/under-power protection (GOPPDOP/GUPPDUP) can be used wherever a high/low active, reactive or apparent power protection or alarming is required. The functions can alternatively be used to check the direction of active or reactive power flow in the power system.

There are number of applications where such functionality is needed. Some of them are:

- detection of reversed active power flow
- detection of high reactive power flow
Each function has two steps with definite time delay. Reset times for every step can be set as well.

**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.

Two step overvoltage protection OV2PTOV can be used as open line end detector, normally then combined with directional reactive over-power function or as system voltage supervision, normally then giving alarm only or switching in reactors or switch out capacitor banks to control the voltage.

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

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

**Two step residual overvoltage protection ROV2PTOV**

Residual voltages may occur in the power system during earth faults.

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

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

**Overexcitation protection OEXPVPH**

When the laminated core of a power transformer or generator is subjected to a magnetic flux density beyond its design limits, stray flux will flow into non-laminated components not designed to carry flux and cause eddy currents to flow. The eddy currents can cause excessive heating and severe damage to insulation and adjacent parts in a relatively short time. Overexcitation protection OEXPVPH has settable inverse operating curve and independent alarm stage.

**Voltage differential protection VDCPTOV**

A voltage differential monitoring function is available. It compares the voltages from two three phase sets of voltage transformers and has one sensitive alarm step and one trip step. It can be used to supervise the voltage from two fuse groups or two different voltage transformers fuses as a fuse/MCB supervision function.

**95% and 100% Stator earth fault protection based on 3rd harmonic STEFPHIZ**

Stator earth fault is a fault type having relatively high fault rate. The generator systems normally have high impedance earthing, that is, earthing via a neutral point resistor. This resistor is normally dimensioned to give an earth fault current in the range 3 – 15 A at a solid earth-fault directly at the generator high voltage terminal. The relatively small earth fault currents give much less thermal and mechanical stress on the generator, compared to the short circuit case, which is between conductors of two phases. Anyhow, the earth faults in the generator have to be detected and the generator has to be tripped, even if longer fault time compared to internal short circuits, can be allowed.

In normal non-faulted operation of the generating unit the neutral point voltage is close to zero, and there is no zero sequence current flow in the generator. When a phase-to-earth fault occurs the neutral point voltage
will increase and there will be a current flow through the neutral point resistor.

To detect an earth fault on the windings of a generating unit one may use a neutral point overvoltage IED, a neutral point overcurrent IED, a zero sequence overvoltage IED or a residual differential protection. These protection schemes are simple and have served well during many years. However, at best these simple schemes protect only 95% of the stator winding. They leave 5% at the neutral end unprotected. Under unfavorable conditions the blind zone may extend to 20% from the neutral.

The 95% stator earth fault measures the fundamental frequency voltage component in the generator star point and it operates when it exceeds the preset value. By applying this principle approximately 95% of the stator winding can be protected. In order to protect the last 5% of the stator winding close to the neutral end the 3rd harmonic voltage measurement can be performed. In REG 670 either the 3rd harmonic differential principle or the neutral point 3rd harmonic undervoltage principle can be applied. Combination of these two measuring principles provides coverage for entire stator winding against earth faults.

**Rotor earth fault (GAPC, 64R)**

The field winding, including the rotor winding and the non-rotating excitation equipment, is always insulated from the metallic parts of the rotor. The insulation resistance is high if the rotor is cooled by air or by hydrogen. The insulation resistance is much lower if the rotor winding is cooled by water. This is true even if the insulation is intact. A fault in the insulation of the field circuit will result in a conducting path from the field winding to earth. This means that the fault has caused a field earth fault.

The field circuit of a synchronous generator is normally unearthed. Therefore, a single earth fault on the field winding will cause only a very small fault current. Thus the earth fault does not produce any damage in the generator. Furthermore, it will not affect the operation of a generating unit in any way. However, the existence of a single earth fault increases the electric stress at other points in the field circuit. This means that the risk for a second earth fault at another point on the field winding has increased considerably. A second earth fault will cause a field short-circuit with severe consequences.

The rotor earth fault protection is based on injection of an AC voltage to the isolated field circuit. In non-faulted conditions there will be no current flow associated to this injected voltage. If a rotor earth fault occurs, this condition will be detected by the rotor earth fault protection. Depending on the generator owner philosophy this operational state will be alarmed and/or the generator will be tripped.

**Frequency protection**

**Underfrequency protection SAPTUF**

Underfrequency occurs as a result of 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 provided with an under voltage blocking.

The operation may be based on single-phase, phase-to-phase or positive-sequence voltage measurement.

**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 at 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 used mainly for generation shedding and remedial action schemes. It is also used as a frequency stage initiating load restoring.
SAPTOF is provided with an undervoltage blocking. The operation is based on single-phase, phase-to-phase or positive-sequence voltage measurement.

**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, remedial action schemes. SAPFRC can discriminate between positive or negative change of frequency.

SAPFRC is provided with an undervoltage blocking. The operation may be based on single-phase, phase-to-phase or positive-sequence voltage measurement.

**Multipurpose protection**

**General current and voltage protection CVGAPC**

The protection module is recommended as a general backup protection with many possible application areas due to its flexible measuring and setting facilities.

The built-in overcurrent protection feature has two settable current levels. Both of them can be used either with definite time or inverse time characteristic. The overcurrent protection steps can be made directional with selectable voltage polarizing quantity. Additionally, they can be voltage and/or current controlled/restrained. 2nd harmonic restraining facility is available as well. At too low polarizing voltage the overcurrent feature can be either blocked, made non directional or ordered to use voltage memory in accordance with a parameter setting.

Additionally two overvoltage and two undervoltage steps, either with definite time or inverse time characteristic, are available within each function.

The general function suits applications with underimpedance and voltage controlled overcurrent solutions. The general function can also be utilized for generator transformer protection applications where positive, negative or zero sequence components of current and voltage quantities are typically required.

**Secondary system supervision**

**Current circuit supervision CCSRDF**

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 (CCSRDF) 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 (RFUF)**

Failures in the secondary circuits of the voltage transformer can cause unwanted operation of distance protection, undervoltage protection, neutral point voltage protection, energizing function (synchronism check) etc. The fuse failure supervision function prevents such unwanted operations.

There are three methods to detect fuse failures.

The method based on detection of zero sequence voltage without any zero sequence current. This is a useful principle in a directly earthed system and can detect one or two phase fuse failures.

The method based on detection of negative sequence voltage without any negative sequence current. This is a useful principle in...
a non-directly earthed system and can detect one or two phase fuse failures.

The method based on detection of \( \frac{du}{dt} - \frac{di}{dt} \) where a change of the voltage is compared to a change in the current. Only voltage changes means a voltage transformer fault. This principle can detect one, two or three phase fuse failures.

**Control**

**Synchronizing, synchrocheck and energizing check SESRSYN**

The Synchronizing function allows closing of asynchronous networks at the correct moment including the breaker closing time. The systems can thus be reconnected after an autoreclose or manual closing, which improves the network stability.

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

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

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

For systems which are running asynchronous a synchronizing function is provided. The main purpose of the synchronizing function is to provide controlled closing of circuit breakers when two asynchronous systems are going to be connected. It is used for slip frequencies that are larger than those for synchrocheck and lower than a set maximum level for the synchronizing function.

**Apparatus control APC**

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

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

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

Normal security means that only the command is evaluated and the resulting position is not supervised. Enhanced security means that the command is evaluated with an additional supervision of the status value of the control object. The command security with enhanced security is always terminated by a CommandTermination service primitive.

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

**Logic rotating switch for function selection and LHMI presentation SLGGIO**

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

**Selector mini switch VSGGIO**

Selector mini switch (VSGGIO) function block is a multipurpose function used in the configuration tool in PCM600 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.

**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 complicated function blocks that have the capability to receive commands (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.

**Logic**

**Tripping logic SMPTRC**

A function block for protection tripping is provided for each circuit breaker involved in the tripping of the fault. It provides the 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 includes functionality for evolving faults and breaker lock-out.

**Trip matrix logic TMAGGIO**

Trip matrix logic (TMAGGIO) function is used to route trip signals and/or other logical output signals to different output contacts on the IED.

TMAGGIO output signals and the physical outputs are available in PCM600 and this 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 user to adapt the configuration to the specific application needs.

- **OR** function block.
- **INVERTER** function blocks that inverts the input signal.
- **PULSERTEER** function block can be used, for example, for pulse extensions or limiting of operation of outputs.
- **GATE** function block is used for controlling if a signal should be able to pass from the input to the output or not depending on a setting.
- **XOR** function block.
- **LOOPDELAY** function block used to delay the output signal one execution cycle.
- **TIMRSET** 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 after a power interruption should return to the state before the interruption, or be reset. Set input has priority.
- **RSRMEMORY** 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 after a power interruption should return to the state.
before the interruption, or be reset. 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 a certain logic.

**Monitoring**

**Measurements**

The service value function is used to get on-line information from the IED. These service values makes 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
- the primary and secondary phasors
- differential currents, bias currents
- positive, negative and zero sequence currents and voltages
- mA, input currents
- pulse counters
- event counters
- measured values and other information of the different parameters for included functions
- logical values of all binary in- and outputs and
- general IED information.

**Supervision of mA input signals (MVGGIO)**

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

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

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

**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.

Disturbance report DRPRDRE, always included in the IED, acquires sampled data of all selected analog input and binary signals connected to the function block that is, maximum 40 analog and 96 binary signals.

Disturbance report functionality is a common name for several functions:

- Event list
- Indications
- Event recorder
- Trip value recorder
- Disturbance recorder

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 in the AxRADR or BxRBDR function blocks, which is 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.

Every disturbance report recording is saved in the IED in the standard Comtrade format. The same applies to all events, which are continuously saved in a ring-buffer. The local HMI is used to get information about the recordings, but the disturbance report files may be uploaded to PCM600 and further analysis using the disturbance handling tool.
**Event list DRPRDRE**

Continuous event-logging is useful for monitoring of 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 of 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 (trigged).

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 all selected analog input and binary signals connected to the Disturbance report function (maximum 40 analog and 96 binary signals). The binary signals are the same signals as available under 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.

The disturbance recorder information for the last 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.

Measured value expander block RANGE_XP

The current and voltage measurement functions (CVMMXU, CMMXU, VMMXU 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 that is low-low limit, low limit, high limit and high-high limit. The measure value expander block (RANGE_XP) has been introduced to be able to translate the integer output signal from the measuring functions to 5 binary signals that is 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.

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 pulse counter 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 Measurements (CVMMXU) function can be used to calculate energy. 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.

Basic IED functions

Time synchronization

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

Human machine interface

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.
Station communication

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

Following communication protocols are available:

- IEC 61850-8-1 communication protocol
- LON communication protocol
- SPA or IEC 60870-5-103 communication protocol
- DNP3.0 communication protocol

Theoretically, several protocols can be combined in the same IED.

IEC 61850-8-1 communication protocol
The IED is equipped with single or double optical Ethernet rear ports (order dependent) for the new substation communication standard IEC 61850-8-1 for the station bus. IEC 61850-8-1 communication is also possible from the optical Ethernet front port. IEC 61850-8-1 protocol allows intelligent 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.

Serial communication, LON
Existing stations with ABB station bus LON can be extended with use of the optical LON interface. This allows full SA functionality including peer-to-peer messaging and cooperation between existing ABB IED's and the new IED 670.

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

IEC 60870-5-103 communication protocol
A single glass or plastic port is provided for the IEC60870-5-103 standard. This allows design of simple substation automation systems including equipment from different vendors. Disturbance files uploading is provided.

DNP3.0 communication protocol
An electrical RS485 and an optical Ethernet port is available for the DNP3.0 communication. DNP3.0 Level 2 communication with unsolicited events, time synchronizing and disturbance reporting is provided for communication to RTUs, Gateways or HMI systems.

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.
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).

Remote communication

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

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

Line data communication module, short and medium range LDCM
The line data communication module (LDCM) is used for communication between the IEDs situated at distances <60 km or from the IED to optical to electrical converter with G.703 or G.703E1 interface located on a distances <3 km away. The LDCM module sends and receives data, to and from another LDCM module. The IEEE/ANSI C37.94 standard format is used.

5. 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.

Binary input/output module (IOM)
The binary input/output module is used when only a few input and output channels are needed. The ten standard output channels are used for trip output or any signalling purpose. The two high speed signal output channels are used for applications where short operating time is essential. Eight optically isolated binary inputs cater for required binary input information.
mA input module MIM
The milli-ampere input module is used to interface transducer signals in the –20 to +20 mA range from for example OLTC position, temperature or pressure transducers. The module has six independent, galvanically separated channels.

Optical ethernet module OEM
The optical fast-ethernet module is used 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 one or two optical ports with ST connectors.

Serial SPA/IEC 60870-5-103 and LON communication module SLM
The optical serial channel and LON channel module is used to connect an IED to the communication that use SPA, LON, or IEC60870–5–103. The module has two optical ports for plastic/plastic, plastic/glass, or glass/glass. One port is used for SPA and IEC 60870-5-103 one port is used for LON.

Line data communication module LDCM
Each module has one optical port, one for each remote end to which the IED communicates.
Alternative cards for Medium range (1310 nm single mode) and Short range (850 nm multi mode) are available.

Galvanic RS485 serial communication module
The galvanic RS485 serial communication module is used as an alternative for DNP3.0 communication.

GPS time synchronization module GSM
This module includes the GPS receiver used for time synchronization. The GPS has one SMA contact for connection to an antenna.

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.

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

Layout and dimensions
Dimensions
Figure 6. 1/2 x 19” case with rear cover

Figure 7. Side-by-side mounting

<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, 1/2 x 19”</td>
<td>265.9</td>
<td>223.7</td>
<td>201.1</td>
<td>242.1</td>
<td>252.9</td>
<td>205.7</td>
</tr>
<tr>
<td>6U, 1/1 x 19”</td>
<td>265.9</td>
<td>448.1</td>
<td>201.1</td>
<td>242.1</td>
<td>252.9</td>
<td>430.3</td>
</tr>
</tbody>
</table>

Mounting alternatives
Following mounting alternatives (IP40 protection from the front) are available:

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

<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 or IOM</td>
<td>X31 and X32 etc. to X51 and X52</td>
</tr>
<tr>
<td>BIM, BOM, SOM, IOM or GSM</td>
<td>X51, X52</td>
</tr>
<tr>
<td>SLM</td>
<td>X301:A, B, C, D</td>
</tr>
<tr>
<td>IRIG-B 1)</td>
<td>X302</td>
</tr>
<tr>
<td>OEM</td>
<td>X311:A, B, C, D</td>
</tr>
<tr>
<td>RS485 or LDCM 2) 3)</td>
<td>X312</td>
</tr>
<tr>
<td>LDCM 2)</td>
<td>X313</td>
</tr>
<tr>
<td>TRM</td>
<td>X401</td>
</tr>
</tbody>
</table>

1) IRIG-B installation, when included in seat P30:2
2) LDCM installation sequence: P31:2 or P31:3
3) RS485 installation, when included in seat P31:2

Note!
1 One LDCM can be included depending of availability of IRIG-B respective RS485 modules.
### Table 2. 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>BIM, BOM, SOM, IOM, MIM or GSM</td>
<td>X131, X132</td>
</tr>
<tr>
<td>SLM</td>
<td>X301:A, B, C, D</td>
</tr>
<tr>
<td>IRIG-B or LDCM 1,2)</td>
<td>X302</td>
</tr>
<tr>
<td>LDCM 2)</td>
<td>X303</td>
</tr>
<tr>
<td>OEM 4)</td>
<td>X311:A, B, C, D</td>
</tr>
<tr>
<td>RS485 or LDCM 2) 3)</td>
<td>X312</td>
</tr>
<tr>
<td>LDCM 2)</td>
<td>X313</td>
</tr>
<tr>
<td>LDCM 2)</td>
<td>X322</td>
</tr>
<tr>
<td>LDCM 2)</td>
<td>X323</td>
</tr>
<tr>
<td>TRM 1</td>
<td>X401</td>
</tr>
<tr>
<td>TRM 2</td>
<td>X411</td>
</tr>
</tbody>
</table>

1) IRIG-B installation, when included in seat P30:2
2) LDCM installation sequence: P31:2, P31:3, P32:2, P32:3, P30:2 and P30:3
3) RS485 installation, when included in seat P31:2, P31:3, P32:2 or P32:4
4) OEM X311:A, B (IEC 61850-8-1). OEM X311:C, D

**Note!**
2-4 LDCM can be included depending of availability of IRIG-B respective RS485 modules. When IRIG-B, RS485 and 4 pc of LDCM are in use, needs a second ADM.
<table>
<thead>
<tr>
<th>Current/voltage configuration (50/60 Hz)</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>12I, 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>1A</td>
<td>1A</td>
<td>1A</td>
</tr>
<tr>
<td>12I, 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>5A</td>
<td>5A</td>
<td>5A</td>
</tr>
<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>110-220V</td>
<td>110-220V</td>
<td>110-220V</td>
<td></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>110-220V</td>
<td>110-220V</td>
<td>110-220V</td>
<td></td>
</tr>
<tr>
<td>5I, 1A, +4I, 5A, +5U</td>
<td>1A</td>
<td>1A</td>
<td>1A</td>
<td>1A</td>
<td>1A</td>
<td>5A</td>
<td>5A</td>
<td>5A</td>
<td>110-220V</td>
<td>110-220V</td>
<td>110-220V</td>
<td></td>
</tr>
<tr>
<td>7I+5U, 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>
<td>110-220V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7I+5U, 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>
<td>110-220V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6I, 5A, +1I, 5A, +5U</td>
<td>5A</td>
<td>5A</td>
<td>5A</td>
<td>5A</td>
<td>5A</td>
<td>5A</td>
<td>1A</td>
<td>110-220V</td>
<td>110-220V</td>
<td>110-220V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6I+6U, 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>
<td>110-220V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6I+6U, 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>
<td>110-220V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6I, 1A</td>
<td>1A</td>
<td>1A</td>
<td>1A</td>
<td>1A</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6I, 5A</td>
<td>5A</td>
<td>5A</td>
<td>5A</td>
<td>5A</td>
<td>5A</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></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 9. 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 10. mA input module (MIM)
Figure 11. Communication interfaces (OEM, LDCM, SLM and HMI)

Note to figure 11

1) Rear communication port SPA/IEC 61850-5-103, ST-connector for glass alt. HFBR Snap-in connector for plastic as ordered
2) Rear communication port LON, ST connector for glass alt. HFBR Snap-in connector for plastic as ordered
3) Rear communication port RS485, terminal block
4) Time synchronization port IRIG-B, BNC-connector
5) Time synchronization port PPS or Optical IRIG-B, ST-connector
6) Rear communication port IEC 61850-8-1 for X311:A, B, ST-connector
7) Rear communication port C37.94, ST-connector
8) Front communication port Ethernet, RJ45 connector
9) Rear communication port 15-pole female micro D-sub, 1.27 mm (0.050") pitch
10) Rear communication port, terminal block

Figure 12. Power supply module (PSM)
Figure 13. GPS time synchronization module (GSM)

Table 1: Types of GSM

<table>
<thead>
<tr>
<th>Type of GSM</th>
<th>Pno</th>
<th>XAx</th>
</tr>
</thead>
<tbody>
<tr>
<td>XA 1</td>
<td>PS</td>
<td>X01</td>
</tr>
<tr>
<td>XA 2</td>
<td>PL</td>
<td>X02</td>
</tr>
<tr>
<td>XA 3</td>
<td>PT</td>
<td>X03</td>
</tr>
</tbody>
</table>

Figure 14. 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 15. Static output module (SOM)

Figure 16. 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.
7. Technical data

General

Definitions

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

Energizing quantities, rated values and limits

Analog inputs

Table 3. TRM - Energizing quantities, rated values and limits

<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>(0.2-40) × I_r</td>
</tr>
<tr>
<td>Operative range</td>
<td>(0-100) × I_r</td>
<td></td>
</tr>
<tr>
<td>Permissive overload</td>
<td>4 × I_r cont.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100 × I_r for 1 s</td>
<td></td>
</tr>
<tr>
<td>Burden</td>
<td>&lt; 150 mVA at I_r = 5 A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt; 20 mVA at I_r = 1 A</td>
<td></td>
</tr>
<tr>
<td>Ac voltage</td>
<td>U_r = 110 V</td>
<td>0.5–288 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 mVA at 110 V</td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td>f_r = 50/60 Hz</td>
<td>± 5%</td>
</tr>
</tbody>
</table>

*) max. 350 A for 1 s when COMBITEST test switch is included.
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>$R_{in} = 194 \text{ Ohm}$</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>$\leq 4 \text{ W}$</td>
<td>-</td>
</tr>
<tr>
<td>each mA input</td>
<td>$\leq 0.1 \text{ W}$</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>1 or 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>$EL = (24 - 60) \text{ V}$</td>
<td>$EL \pm 20%$</td>
</tr>
<tr>
<td></td>
<td>$EL = (90 - 250) \text{ V}$</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>$&lt; 5 \text{ A during 0.1 } \text{s}$</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>24/40 V</td>
<td>RL ± 20%</td>
</tr>
<tr>
<td></td>
<td>48/60 V</td>
<td>RL ± 20%</td>
</tr>
<tr>
<td></td>
<td>110/125 V</td>
<td>RL ± 20%</td>
</tr>
<tr>
<td></td>
<td>220/250 V</td>
<td>RL ± 20%</td>
</tr>
<tr>
<td>Power consumption</td>
<td>max. 0.05 W/input</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>max. 0.1 W/input</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>max. 0.2 W/input</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>max. 0.4 W/input</td>
<td>-</td>
</tr>
<tr>
<td>Counter input frequency</td>
<td>10 pulses/s max</td>
<td>-</td>
</tr>
<tr>
<td>Oscillating signal discriminator</td>
<td>Blocking settable 1–40 Hz Release settable 1–30 Hz</td>
<td></td>
</tr>
</tbody>
</table>

### 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>24/40 V</td>
<td>RL ± 20%</td>
</tr>
<tr>
<td></td>
<td>48/60 V</td>
<td>RL ± 20%</td>
</tr>
<tr>
<td></td>
<td>110/125 V</td>
<td>RL ± 20%</td>
</tr>
<tr>
<td></td>
<td>220/250 V</td>
<td>RL ± 20%</td>
</tr>
<tr>
<td>Power consumption</td>
<td>max. 0.05 W/input</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>max. 0.1 W/input</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>max. 0.2 W/input</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>max. 0.4 W/input</td>
<td>-</td>
</tr>
<tr>
<td>Counter input frequency</td>
<td>10 pulses/s max</td>
<td>-</td>
</tr>
<tr>
<td>Balanced counter input frequency</td>
<td>40 pulses/s max</td>
<td></td>
</tr>
<tr>
<td>Oscillating signal discriminator</td>
<td>Blocking settable 1–40 Hz Release settable 1–30 Hz</td>
<td></td>
</tr>
</tbody>
</table>
### Table 9. IOM - Binary input/output module

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Rated value</th>
<th>Nominal range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binary inputs</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>DC voltage, RL</td>
<td>24/40 V</td>
<td>RL ± 20%</td>
</tr>
<tr>
<td></td>
<td>48/60 V</td>
<td>RL ± 20%</td>
</tr>
<tr>
<td></td>
<td>110/125 V</td>
<td>RL ± 20%</td>
</tr>
<tr>
<td></td>
<td>220/250 V</td>
<td>RL ± 20%</td>
</tr>
<tr>
<td>Power consumption</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24/40 V</td>
<td>max. 0.05 W/input</td>
<td></td>
</tr>
<tr>
<td>48/60 V</td>
<td>max. 0.1 W/input</td>
<td></td>
</tr>
<tr>
<td>110/125 V</td>
<td>max. 0.2 W/input</td>
<td></td>
</tr>
<tr>
<td>220/250 V</td>
<td>max. 0.4 W/input</td>
<td></td>
</tr>
</tbody>
</table>

### Table 10. IOM - Binary input/output module contact data (reference standard: IEC 61810-2)

<table>
<thead>
<tr>
<th>Function or quantity</th>
<th>Trip and signal relays</th>
<th>Fast signal relays (parallel reed relay)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binary outputs</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Max system voltage</td>
<td>250 V AC, DC</td>
<td>250 V AC, DC</td>
</tr>
<tr>
<td>Test voltage across open contact, 1 min</td>
<td>1000 V rms</td>
<td>800 V DC</td>
</tr>
<tr>
<td>Current carrying capacity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 s</td>
<td>8 A</td>
<td>8 A</td>
</tr>
<tr>
<td></td>
<td>10 A</td>
<td>10 A</td>
</tr>
<tr>
<td>Making capacity at inductive load with L/R&gt;10 ms</td>
<td>30 A</td>
<td>0.4 A</td>
</tr>
<tr>
<td>0.2 s</td>
<td>10 A</td>
<td>0.4 A</td>
</tr>
<tr>
<td>1.0 s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breaking capacity for AC, cos φ &gt; 0.4</td>
<td>250 V/8.0 A</td>
<td>250 V/8.0 A</td>
</tr>
<tr>
<td>Breaking capacity for DC with L/R &lt; 40 ms</td>
<td>48 V/1 A</td>
<td>48 V/1 A</td>
</tr>
<tr>
<td></td>
<td>110 V/0.4 A</td>
<td>110 V/0.4 A</td>
</tr>
<tr>
<td></td>
<td>125 V/0.35 A</td>
<td>125 V/0.35 A</td>
</tr>
<tr>
<td></td>
<td>220 V/0.2 A</td>
<td>220 V/0.2 A</td>
</tr>
<tr>
<td></td>
<td>250 V/0.15 A</td>
<td>250 V/0.15 A</td>
</tr>
<tr>
<td>Maximum capacitive load</td>
<td>-</td>
<td>10 nF</td>
</tr>
</tbody>
</table>
Table 11. SOM - Static Output Module (reference standard: IEC 61810-2): Static binary outputs

<table>
<thead>
<tr>
<th>Function of quantity</th>
<th>Static binary output trip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage</td>
<td>48 - 60 VDC</td>
</tr>
<tr>
<td></td>
<td>110 - 250 VDC</td>
</tr>
<tr>
<td>Number of outputs</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Impedance open state</td>
<td>~300 kΩ</td>
</tr>
<tr>
<td></td>
<td>~810 kΩ</td>
</tr>
<tr>
<td>Test voltage across open contact, 1 min</td>
<td>No galvanic separation</td>
</tr>
<tr>
<td></td>
<td>No galvanic separation</td>
</tr>
<tr>
<td>Current carrying capacity:</td>
<td></td>
</tr>
<tr>
<td>Continuous</td>
<td>5A</td>
</tr>
<tr>
<td></td>
<td>5A</td>
</tr>
<tr>
<td>1.0s</td>
<td>10A</td>
</tr>
<tr>
<td></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></td>
<td>30A</td>
</tr>
<tr>
<td>1.0s</td>
<td>10A</td>
</tr>
<tr>
<td></td>
<td>10A</td>
</tr>
<tr>
<td>Breaking capacity for DC with L/R ≤ 40ms</td>
<td>48V / 1A</td>
</tr>
<tr>
<td></td>
<td>110V / 0.4A</td>
</tr>
<tr>
<td></td>
<td>60V / 0.75A</td>
</tr>
<tr>
<td></td>
<td>125V / 0.35A</td>
</tr>
<tr>
<td></td>
<td>220V / 0.2A</td>
</tr>
<tr>
<td></td>
<td>250V / 0.15A</td>
</tr>
<tr>
<td>Operating time</td>
<td>&lt;1ms</td>
</tr>
<tr>
<td></td>
<td>&lt;1ms</td>
</tr>
</tbody>
</table>
Table 12. 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</td>
</tr>
<tr>
<td></td>
<td>110V / 0.4A</td>
</tr>
<tr>
<td></td>
<td>125V / 0.35A</td>
</tr>
<tr>
<td></td>
<td>220V / 0.2A</td>
</tr>
<tr>
<td></td>
<td>250V / 0.15A</td>
</tr>
</tbody>
</table>

Table 13. 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>Continuous</td>
<td>8 A</td>
</tr>
<tr>
<td>1 s</td>
<td>10 A</td>
</tr>
<tr>
<td>Making capacity at inductive load with L/R&gt;10 ms</td>
<td>30 A</td>
</tr>
<tr>
<td>0.2 s</td>
<td>10 A</td>
</tr>
<tr>
<td>1.0 s</td>
<td></td>
</tr>
<tr>
<td>Breaking capacity for AC, cos φ&gt;0.4</td>
<td>250 V/8.0 A</td>
</tr>
<tr>
<td>Breaking capacity for DC with L/R &lt; 40 ms</td>
<td>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 14. 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 Operative range</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 15. 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% Full wave rectified</td>
<td>12% of EL</td>
<td>0.01% /%</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></td>
<td></td>
<td>No restart</td>
</tr>
<tr>
<td>interruption interval</td>
<td>24-60 V DC ± 20%</td>
<td></td>
<td>Correct behaviour at power down &lt;180 s</td>
</tr>
<tr>
<td>Restart time</td>
<td>90-250 V DC ± 20%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 16. Frequency influence (reference standard: IEC 60255–6)

<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 $f_r \pm 3.0$ Hz for 60 Hz</td>
<td>$\pm 1.0% /Hz$</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>
Table 17. 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, Class III</td>
</tr>
<tr>
<td>Ring wave immunity test</td>
<td>2-4 kV</td>
<td>IEC 61000-4-12, Class III</td>
</tr>
<tr>
<td>Surge withstand capability test</td>
<td>2.5 kV, oscillatory 4.0 kV, fast transient</td>
<td>IEEE/ANSI C37.90.1</td>
</tr>
<tr>
<td>Electrostatic discharge</td>
<td>15 kV air discharge 8 kV contact discharge</td>
<td>IEC 60255-22-2, Class IV</td>
</tr>
<tr>
<td>Direct application</td>
<td>8 kV contact discharge</td>
<td>IEC 60255-22-2, Class IV</td>
</tr>
<tr>
<td>Indirect application</td>
<td>8 kV contact discharge</td>
<td>IEC 61000-4-2, Class IV</td>
</tr>
<tr>
<td>Electrostatic discharge</td>
<td>15 kV air discharge 8 kV contact discharge</td>
<td>IEEE/ANSI C37.90.1</td>
</tr>
<tr>
<td>Direct application</td>
<td>8 kV contact discharge</td>
<td>IEC 60255-22-2, Class IV</td>
</tr>
<tr>
<td>Indirect application</td>
<td>8 kV contact discharge</td>
<td>IEC 61000-4-2, Class IV</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 μs 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>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>Radiated electromagnetic field disturbance</td>
<td>20 V/m, 80-2500 MHz</td>
<td>EN 61000-4-3</td>
</tr>
<tr>
<td>Radiated electromagnetic field disturbance</td>
<td>35 V/m 26-1000 MHz</td>
<td>IEEE/ANSI C37.90.2</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 18. 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 μs, 0.5 J</td>
<td></td>
</tr>
<tr>
<td>Insulation resistance</td>
<td>&gt;100 MΩ at 500 VDC</td>
<td></td>
</tr>
</tbody>
</table>

### Table 19. 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 20. 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 21. 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>
**Table 22. Generator differential protection (PDIF, 87G)**

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reset ratio</td>
<td>&gt; 95%</td>
<td>-</td>
</tr>
<tr>
<td>Unrestrained differential current limit</td>
<td>(1-50)pu of $I_{\text{base}}$</td>
<td>± 2.0% of set value</td>
</tr>
<tr>
<td>Base sensitivity function</td>
<td>(0.05–1.00)pu of $I_{\text{base}}$</td>
<td>± 2.0% of $I_r$</td>
</tr>
<tr>
<td>Negative sequence current level</td>
<td>(0.02–0.2)pu of $I_{\text{base}}$</td>
<td>± 1.0% of $I_r$</td>
</tr>
<tr>
<td>Operate time, restrained function</td>
<td>25 ms typically at 0 to 2 x set level</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, restrained function</td>
<td>20 ms typically at 2 to 0 x set level</td>
<td>-</td>
</tr>
<tr>
<td>Operate time, unrestrained function</td>
<td>12 ms typically at 0 to 5 x set level</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, unrestrained function</td>
<td>25 ms typically at 5 to 0 x set level</td>
<td>-</td>
</tr>
<tr>
<td>Operate time, negative sequence unrestrained function</td>
<td>15 ms typically at 0 to 5 x set level</td>
<td>-</td>
</tr>
<tr>
<td>Critical impulse time, unrestrained function</td>
<td>2 ms typically at 0 to 5 x set level</td>
<td>-</td>
</tr>
<tr>
<td>Function</td>
<td>Range or value</td>
<td>Accuracy</td>
</tr>
<tr>
<td>------------------------------------------------------</td>
<td>---------------------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>Operating characteristic</td>
<td>Adaptable</td>
<td>± 2.0% of Ir for I &lt; Ir&lt;br&gt;± 2.0% of Ir for I &gt; Ir</td>
</tr>
<tr>
<td>Reset ratio</td>
<td>&gt; 95%</td>
<td>-</td>
</tr>
<tr>
<td>Unrestrained differential current limit</td>
<td>(100-5000)% of IBase on high voltage winding</td>
<td>± 2.0% of set value</td>
</tr>
<tr>
<td>Base sensitivity function</td>
<td>(10-60)% of IBase</td>
<td>± 2.0% of Ir</td>
</tr>
<tr>
<td>Second harmonic blocking</td>
<td>(5.0-100.0)% of fundamental</td>
<td>± 2.0% of Ir</td>
</tr>
<tr>
<td>Fifth harmonic blocking</td>
<td>(5.0-100.0)% of fundamental</td>
<td>± 5.0% of Ir</td>
</tr>
<tr>
<td>Connection type for each of the windings</td>
<td>Y or D</td>
<td>-</td>
</tr>
<tr>
<td>Phase displacement between high voltage winding, W1 and each of the windings, W2 and W3. Hour notation</td>
<td>0–11</td>
<td>-</td>
</tr>
<tr>
<td>Operate time, restrained function</td>
<td>25 ms typically at 0 to 2 x Id</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, restrained function</td>
<td>20 ms typically at 2 to 0 x Id</td>
<td>-</td>
</tr>
<tr>
<td>Operate time, unrestrained function</td>
<td>12 ms typically at 0 to 5 x Id</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, unrestrained function</td>
<td>25 ms typically at 5 to 0 x Id</td>
<td>-</td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>2 ms typically at 0 to 5 x Id</td>
<td>-</td>
</tr>
</tbody>
</table>
### Table 24. Restricted earth fault protection, low impedance REFPDIF

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate characteristic</td>
<td>Adaptable</td>
<td>± 2.0% of Ir&lt;sub&gt;r&lt;/sub&gt; for I &lt; Ir&lt;sub&gt;Base&lt;/sub&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>± 2.0% of I for I &gt; Ir&lt;sub&gt;Base&lt;/sub&gt;</td>
</tr>
<tr>
<td>Reset ratio</td>
<td>&gt;95%</td>
<td>-</td>
</tr>
<tr>
<td>Base sensitivity function</td>
<td>(4.0-100.0)% of I&lt;sub&gt;Base&lt;/sub&gt;</td>
<td>± 2.0% of I&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Directional characteristic</td>
<td>Fixed 180 degrees or ± 60 to ± 90 degrees</td>
<td>± 2.0 degree</td>
</tr>
<tr>
<td>Operate time</td>
<td>20 ms typically at 0 to 10 x Idiff</td>
<td>-</td>
</tr>
<tr>
<td>Reset time</td>
<td>25 ms typically at 0 to 10 x Idiff</td>
<td>-</td>
</tr>
<tr>
<td>Second harmonic blocking</td>
<td>(5.0-100.0)% of fundamental</td>
<td>± 2.0% of I&lt;sub&gt;r&lt;/sub&gt;Base</td>
</tr>
</tbody>
</table>

### Table 25. High impedance differential protection (PDIF, 87)

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate voltage</td>
<td>(20-400) V</td>
<td>± 1.0% of U&lt;sub&gt;r&lt;/sub&gt; for U &lt; U&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>± 1.0% of U for U &gt; U&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Reset ratio</td>
<td>&gt;95%</td>
<td>-</td>
</tr>
<tr>
<td>Maximum continuous voltage</td>
<td>U&gt;TripPickup&lt;sup&gt;2&lt;/sup&gt;/series resistor ≤200 W</td>
<td>-</td>
</tr>
<tr>
<td>Operate time</td>
<td>10 ms typically at 0 to 10 x U&lt;sub&gt;d&lt;/sub&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Reset time</td>
<td>90 ms typically at 0 to 10 x U&lt;sub&gt;d&lt;/sub&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>2 ms typically at 0 to 10 x U&lt;sub&gt;d&lt;/sub&gt;</td>
<td>-</td>
</tr>
</tbody>
</table>
Impedance protection

Table 26. Full-scheme distance protection, Mho characteristic ZMHPDIS

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of zones with selectable directions</td>
<td>3 with selectable direction</td>
<td>-</td>
</tr>
<tr>
<td>Minimum operate current</td>
<td>(10–30)% of $I_{base}$</td>
<td>-</td>
</tr>
<tr>
<td>Positive sequence impedance, phase-to-earth loop</td>
<td>(0.005–3000.000) Ω/phase</td>
<td>± 2.0% static accuracy</td>
</tr>
<tr>
<td>Positive sequence impedance angle, phase-to-earth loop</td>
<td>(10–90) degrees</td>
<td>Conditions: Voltage range: (0.1-1.1) x $U_r$ Current range: (0.5-30) x $I_r$ Angle: at 0 degrees and 85 degrees</td>
</tr>
<tr>
<td>Reverse reach, phase-to-earth loop (Magnitude)</td>
<td>(0.005–3000.000) Ω/phase</td>
<td></td>
</tr>
<tr>
<td>Magnitude of earth return compensation factor KN</td>
<td>(0.00–3.00)</td>
<td></td>
</tr>
<tr>
<td>Angle for earth compensation factor KN</td>
<td>(-180–180) degrees</td>
<td></td>
</tr>
<tr>
<td>Dynamic overreach</td>
<td>&lt;5% at 85 degrees measured with CVT's and 0.5&lt; SIR&lt;30</td>
<td>-</td>
</tr>
<tr>
<td>Timers</td>
<td>(0.000-60.000) s</td>
<td>± 0.5% ± 10 ms</td>
</tr>
<tr>
<td>Operate time</td>
<td>20 ms typically (with static outputs)</td>
<td>-</td>
</tr>
<tr>
<td>Reset ratio</td>
<td>105% typically</td>
<td>-</td>
</tr>
<tr>
<td>Reset time</td>
<td>30 ms typically</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 27. Pole slip protection (PPAM, 78)

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impedance reach</td>
<td>(0.00–1000.00)% of $Z_{base}$</td>
<td>± 2.0% of $U_r/I_r$</td>
</tr>
<tr>
<td>Characteristic angle</td>
<td>(72.00–90.00) degrees</td>
<td>± 5.0 degrees</td>
</tr>
<tr>
<td>Start and trip angles</td>
<td>(0.0–180.0) degrees</td>
<td>± 5.0 degrees</td>
</tr>
<tr>
<td>Zone 1 and Zone 2 trip counters</td>
<td>(1-20)</td>
<td>-</td>
</tr>
</tbody>
</table>
**Table 28. Loss of excitation (PDIS, 40)**

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>X offset of Mho top point</td>
<td>(–1000.00–1000.00)% of (Z_{\text{base}})</td>
<td>± 2.0% of (U_r/I_r)</td>
</tr>
<tr>
<td>Diameter of Mho circle</td>
<td>(0.00–3000.00)% of (Z_{\text{base}})</td>
<td>± 2.0% of (U_r/I_r)</td>
</tr>
<tr>
<td>Timers</td>
<td>(0.00–6000.00) s</td>
<td>± 0.5% ± 10 ms</td>
</tr>
</tbody>
</table>

**Current protection**

**Table 29. Instantaneous phase overcurrent protection PHPIOC**

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate current</td>
<td>(1-2500)% 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>Reset ratio</td>
<td>&gt; 95%</td>
<td>-</td>
</tr>
<tr>
<td>Operate time</td>
<td>25 ms typically at 0 to 2 x (I_{\text{set}})</td>
<td>-</td>
</tr>
<tr>
<td>Reset time</td>
<td>25 ms typically at 2 to 0 x (I_{\text{set}})</td>
<td>-</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>Operate time</td>
<td>10 ms typically at 0 to 10 x (I_{\text{set}})</td>
<td>-</td>
</tr>
<tr>
<td>Reset time</td>
<td>35 ms typically at 10 to 0 x (I_{\text{set}})</td>
<td>-</td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>2 ms typically at 0 to 10 x (I_{\text{set}})</td>
<td>-</td>
</tr>
<tr>
<td>Dynamic overreach</td>
<td>&lt; 5% at (\tau = 100) ms</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 30. Four step phase overcurrent protection OC4PTOC

<table>
<thead>
<tr>
<th>Function</th>
<th>Setting range</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate current</td>
<td>(1-2500)% of IBase</td>
<td>± 1.0% of Ir at I ≤ Ir, ± 1.0% of I at I &gt; Ir</td>
</tr>
<tr>
<td>Reset ratio</td>
<td>&gt; 95%</td>
<td>-</td>
</tr>
<tr>
<td>Min. operating current</td>
<td>(1-100)% of IBase</td>
<td>± 1.0% of Ir</td>
</tr>
<tr>
<td>Maximum forward angle</td>
<td>(40.0–70.0) degrees</td>
<td>± 2.0 degrees</td>
</tr>
<tr>
<td>Minimum forward angle</td>
<td>(75.0–90.0) degrees</td>
<td>± 2.0 degrees</td>
</tr>
<tr>
<td>2nd harmonic blocking</td>
<td>(5–100)% of fundamental</td>
<td>± 2.0% of Ir</td>
</tr>
<tr>
<td>Independent time delay</td>
<td>(0.000-60.000) s</td>
<td>± 0.5% ± 10 ms</td>
</tr>
<tr>
<td>Minimum operate time</td>
<td>(0.000-60.000) s</td>
<td>± 0.5% ± 10 ms</td>
</tr>
<tr>
<td>Inverse characteristics, see table 84, table 85 and table 86</td>
<td>19 curve types See table 84, table 85 and table 86</td>
<td></td>
</tr>
<tr>
<td>Operate time, start function</td>
<td>25 ms typically at 0 to 2 x Iset</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, start function</td>
<td>25 ms typically at 2 to 0 x Iset</td>
<td>-</td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>10 ms typically at 0 to 2 x Iset</td>
<td>-</td>
</tr>
<tr>
<td>Impulse margin time</td>
<td>15 ms typically</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 31. Instantaneous residual overcurrent protection EFPIOC

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate current</td>
<td>(1-2500)% of IBase</td>
<td>± 1.0% of Ir at I ≤ Ir, ± 1.0% of I at I &gt; Ir</td>
</tr>
<tr>
<td>Reset ratio</td>
<td>&gt; 95%</td>
<td>-</td>
</tr>
<tr>
<td>Operate time</td>
<td>25 ms typically at 0 to 2 x Iset</td>
<td>-</td>
</tr>
<tr>
<td>Reset time</td>
<td>25 ms typically at 2 to 0 x Iset</td>
<td>-</td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>10 ms typically at 0 to 2 x Iset</td>
<td>-</td>
</tr>
<tr>
<td>Operate time</td>
<td>10 ms typically at 0 to 10 x Iset</td>
<td>-</td>
</tr>
<tr>
<td>Reset time</td>
<td>35 ms typically at 10 to 0 x Iset</td>
<td>-</td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>2 ms typically at 0 to 10 x Iset</td>
<td>-</td>
</tr>
<tr>
<td>Dynamic overreach</td>
<td>&lt; 5% at τ = 100 ms</td>
<td>-</td>
</tr>
</tbody>
</table>
### Table 32. 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 $I_{Base}$</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>Reset ratio</td>
<td>&gt; 95%</td>
<td>-</td>
</tr>
<tr>
<td>Operate current for direction comparison</td>
<td>(1–100)% of $I_{Base}$</td>
<td>± 1.0% of $I_r$</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 84, table 85 and table 86</td>
<td>18 curve types</td>
<td>See table 84, table 85 and table 86</td>
</tr>
<tr>
<td>Second harmonic restrain operation</td>
<td>(5–100)% of fundamental</td>
<td>± 2.0% 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>(1-30)% of $I_{Base}$</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 $I_{set}$</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, start function</td>
<td>25 ms typically at 2 to 0 x $I_{set}$</td>
<td>-</td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>10 ms typically at 0 to 2 x $I_{set}$</td>
<td>-</td>
</tr>
<tr>
<td>Impulse margin time</td>
<td>15 ms typically</td>
<td>-</td>
</tr>
<tr>
<td>Function</td>
<td>Range or value</td>
<td>Accuracy</td>
</tr>
<tr>
<td>----------</td>
<td>---------------</td>
<td>----------</td>
</tr>
<tr>
<td>Operate level for $3I_0 \cdot \cos \phi$ directional residual overcurrent</td>
<td>$(0.25-200.00)% \text{ of } I_{\text{Base}}$&lt;br&gt;At low setting:&lt;br&gt;(2.5-10) mA&lt;br&gt;(10-50) mA</td>
<td>$\pm 1.0%$ of $I_r$ at $I \leq I_r$&lt;br&gt;$\pm 1.0%$ of $I$ at $I &gt; I_r$&lt;br&gt;$\pm 1.0$ mA&lt;br&gt;$\pm 0.5$ mA</td>
</tr>
<tr>
<td>Operate level for $3I_0 \cdot 3U_0 \cdot \cos \phi$ directional residual power</td>
<td>$(0.25-200.00)% \text{ of } S_{\text{Base}}$&lt;br&gt;At low setting:&lt;br&gt;(0.25-5.00) $% \text{ of } S_{\text{Base}}$</td>
<td>$\pm 1.0%$ of $S_r$ at $S \leq S_r$&lt;br&gt;$\pm 1.0%$ of $S$ at $S &gt; S_r$&lt;br&gt;$\pm 10%$ of set value</td>
</tr>
<tr>
<td>Operate level for $3I_0$ and $\phi$ residual overcurrent</td>
<td>$(0.25-200.00)% \text{ of } I_{\text{Base}}$&lt;br&gt;At low setting:&lt;br&gt;(2.5-10) mA&lt;br&gt;(10-50) mA</td>
<td>$\pm 1.0%$ of $I_r$ at $I \leq I_r$&lt;br&gt;$\pm 1.0%$ of $I$ at $I &gt; I_r$&lt;br&gt;$\pm 1.0$ mA&lt;br&gt;$\pm 0.5$ mA</td>
</tr>
<tr>
<td>Operate level for non directional overcurrent</td>
<td>$(1.00-400.00)% \text{ of } I_{\text{Base}}$&lt;br&gt;At low setting:&lt;br&gt;(10-50) mA</td>
<td>$\pm 1.0%$ of $I_r$ at $I \leq I_r$&lt;br&gt;$\pm 1.0%$ of $I$ at $I &gt; I_r$&lt;br&gt;$\pm 1.0$ mA</td>
</tr>
<tr>
<td>Operate level for non directional residual overvoltage</td>
<td>$(1.00-200.00)% \text{ of } U_{\text{Base}}$&lt;br&gt;</td>
<td>$\pm 0.5%$ of $U_r$ at $U \leq U_r$&lt;br&gt;$\pm 0.5%$ of $U$ at $U &gt; U_r$</td>
</tr>
<tr>
<td>Residual release current for all directional modes</td>
<td>$(0.25-200.00)% \text{ of } I_{\text{Base}}$&lt;br&gt;At low setting:&lt;br&gt;(2.5-10) mA&lt;br&gt;(10-50) mA</td>
<td>$\pm 1.0%$ of $I_r$ at $I \leq I_r$&lt;br&gt;$\pm 1.0%$ of $I$ at $I &gt; I_r$&lt;br&gt;$\pm 1.0$ mA&lt;br&gt;$\pm 0.5$ mA</td>
</tr>
<tr>
<td>Residual release voltage for all directional modes</td>
<td>$(0.01-200.00)% \text{ of } U_{\text{Base}}$&lt;br&gt;</td>
<td>$\pm 0.5%$ of $U_r$ at $U \leq U_r$&lt;br&gt;$\pm 0.5%$ of $U$ at $U &gt; U_r$</td>
</tr>
<tr>
<td>Reset ratio</td>
<td>&gt; 95%</td>
<td>-</td>
</tr>
<tr>
<td>Timers</td>
<td>$(0.000-60.000) \text{ s}$</td>
<td>$\pm 0.5% \pm 10 \text{ ms}$</td>
</tr>
<tr>
<td>Inverse characteristics, see table 84, table 85 and table 86</td>
<td>19 curve types</td>
<td>See table 84, table 85 and table 86</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>
</tbody>
</table>
### Table 33. 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>Operate time, non directional residual over current</td>
<td>60 ms typically at 0 to 2 x I_set</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, non directional residual over current</td>
<td>60 ms typically at 2 to 0 x I_set</td>
<td>-</td>
</tr>
<tr>
<td>Operate time, start function</td>
<td>150 ms typically at 0 to 2 x I_set</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, start function</td>
<td>50 ms typically at 2 to 0 x I_set</td>
<td>-</td>
</tr>
</tbody>
</table>

### Table 34. Thermal overload protection, two time constants TRPTTR

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base current 1 and 2</td>
<td>(30–250)% of I_base</td>
<td>± 1.0% of I_r</td>
</tr>
</tbody>
</table>
| Operate time:                         | I_p = load current before overload occurs
   \[ t = \tau \cdot \ln \left( \frac{I_p^2 - I_o^2}{I^2 - I_o^2} \right) \]
| Alarm level 1 and 2                   | (50–99)% of heat content trip value                  | ± 2.0% of heat content trip                   |
| Operate current                       | (50–250)% of I_base                                  | ± 1.0% of I_r                                 |
| Reset level temperature               | (10–95)% of heat content trip                        | ± 2.0% of heat content trip                   |
Table 35. Breaker failure protection CCRBRF

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
</table>
| Operate phase current                         | (5-200)% of IBase | ± 1.0% of I<sub>r</sub> at I ≤ I<sub>r</sub>,  
|                                               |                | ± 1.0% of I at I > I<sub>r</sub>              |
| Reset ratio, phase current                    | > 95%          | -                                             |
| Operate residual current                      | (2-200)% of IBase | ± 1.0% of I<sub>r</sub> at I ≤ I<sub>r</sub>,  
|                                               |                | ± 1.0% of I at I > I<sub>r</sub>              |
| Reset ratio, residual current                 | > 95%          | -                                             |
| Phase current level for blocking of contact function | (5-200)% of IBase | ± 1.0% of I<sub>r</sub> at I ≤ I<sub>r</sub>,  
|                                               |                | ± 1.0% of I at I > I<sub>r</sub>              |
| Reset ratio                                   | > 95%          | -                                             |
| Timers                                        | (0.000-60.000) s | ± 0.5% ± 10 ms                                |
| Operate time for current detection            | 10 ms typically | -                                             |
| Reset time for current detection              | 15 ms maximum  | -                                             |

Table 36. Pole discordance protection CCRPLD

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate current</td>
<td>(0–100)% of IBase</td>
<td>± 1.0% of I&lt;sub&gt;r&lt;/sub&gt;</td>
</tr>
<tr>
<td>Time delay</td>
<td>(0.000-60.000) s</td>
<td>± 0.5% ± 10 ms</td>
</tr>
</tbody>
</table>

Table 37. Directional underpower protection GUPPDUP

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
</table>
| Power level             | (0.0–500.0)% of Sbase | ± 1.0% of S<sub>r</sub> at S < S<sub>r</sub>,  
|                         | (0.5-2.0)% of Sbase | ± 1.0% of S at S > S<sub>r</sub>              |
|                         | (2.0-10)% of Sbase | < ±50% of set value                           |
|                         |                 | < ± 20% of set value                          |
| Characteristic angle    | (-180.0–180.0) degrees | 2 degrees                                    |
| Timers                 | (0.00-6000.00) s | ± 0.5% ± 10 ms                                |
### Table 38. Directional overpower protection GOPPDOP

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power level</td>
<td>(0.0–500.0)% of $S_{\text{base}}$</td>
<td>± 1.0% of $S_\text{r}$ at $S &lt; S_\text{r}$</td>
</tr>
<tr>
<td></td>
<td>At low setting:</td>
<td>± 1.0% of $S$ at $S &gt; S_\text{r}$</td>
</tr>
<tr>
<td></td>
<td>(0.5–2.0)% of $S_{\text{base}}$</td>
<td>&lt; ± 50% of set value</td>
</tr>
<tr>
<td></td>
<td>(2.0–10)% of $S_{\text{base}}$</td>
<td>&lt; ± 20% of set value</td>
</tr>
<tr>
<td>Characteristic angle</td>
<td>(-180.0–180.0) degrees</td>
<td>2 degrees</td>
</tr>
<tr>
<td>Timers</td>
<td>(0.00–6000.00) s</td>
<td>± 0.5% ± 10 ms</td>
</tr>
</tbody>
</table>

### Voltage protection

### Table 39. 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 $U_{\text{Base}}$</td>
<td>± 1.0% of $U_\text{r}$</td>
</tr>
<tr>
<td>Absolute hysteresis</td>
<td>(0–100)% of $U_{\text{Base}}$</td>
<td>± 1.0% of $U_\text{r}$</td>
</tr>
<tr>
<td>Internal blocking level, low and high step</td>
<td>(1–100)% of $U_{\text{Base}}$</td>
<td>± 1.0% of $U_\text{r}$</td>
</tr>
<tr>
<td>Inverse time characteristics for low and high step, see table 87</td>
<td>-</td>
<td>See table 87</td>
</tr>
<tr>
<td>Definite time delays</td>
<td>(0.000–60.000) s</td>
<td>± 0.5% ± 10 ms</td>
</tr>
<tr>
<td>Minimum operate time, inverse characteristics</td>
<td>(0.000–60.000) s</td>
<td>± 0.5% ± 10 ms</td>
</tr>
<tr>
<td>Operate time, start function</td>
<td>25 ms typically at 2 to 0.5 x $U_{\text{set}}$</td>
<td>-</td>
</tr>
<tr>
<td>Reset time, start function</td>
<td>25 ms typically at 0 to 2 x $U_{\text{set}}$</td>
<td>-</td>
</tr>
<tr>
<td>Critical impulse time</td>
<td>10 ms typically at 2 to 0 x $U_{\text{set}}$</td>
<td>-</td>
</tr>
<tr>
<td>Impulse margin time</td>
<td>15 ms typically</td>
<td>-</td>
</tr>
</tbody>
</table>
### Table 40. Two step overvoltage protection OV2PTOV

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
</table>
| Operate voltage, low and high step          | (1-200)% of Ubase | ± 1.0% of $U_r$ at $U < U_r$  
± 1.0% of $U$ at $U > U_r$ |
| Absolute hysteresis                         | (0–100)% of $U_{base}$ | ± 1.0% of $U_r$ at $U < U_r$  
± 1.0% of $U$ at $U > U_r$ |
| Inverse time characteristics for low and high step, see table 88 | - | See table 88 |
| Definite time delays                       | (0.000-60.000) s | ± 0.5% ± 10 ms |
| Minimum operate time, Inverse characteristics | (0.000-60.000) s | ± 0.5% ± 10 ms |
| Operate time, start function               | 25 ms typically at 0 to 2 x $U_{set}$ | - |
| Reset time, start function                 | 25 ms typically at 2 to 0 x $U_{set}$ | - |
| Critical impulse time                      | 10 ms typically at 0 to 2 x $U_{set}$ | - |
| Impulse margin time                         | 15 ms typically | - |

### Table 41. Two step residual overvoltage protection ROV2PTOV

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
</table>
| Operate voltage, low and high step          | (1-200)% of Ubase | ± 1.0% of $U_r$ at $U < U_r$  
± 1.0% of $U$ at $U > U_r$ |
| Absolute hysteresis                         | (0–100)% of U_{base} | ± 1.0% of $U_r$ at $U < U_r$  
± 1.0% of $U$ at $U > U_r$ |
| Inverse time characteristics for low and high step, see table 89 | - | See table 89 |
| Definite time setting                       | (0.000–60.000) s | ± 0.5% ± 10 ms |
| Minimum operate time                        | (0.000-60.000) s | ± 0.5% ± 10 ms |
| Operate time, start function                | 25 ms typically at 0 to 2 x $U_{set}$ | - |
| Reset time, start function                  | 25 ms typically at 2 to 0 x $U_{set}$ | - |
| Critical impulse time                       | 10 ms typically at 0 to 2 x $U_{set}$ | - |
| Impulse margin time                         | 15 ms typically | - |
### Table 42. Overexcitation protection OEXPVPH

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate value, start</td>
<td>(100–180)% of (U_{base}/f_{rated})</td>
<td>± 1.0% of U</td>
</tr>
<tr>
<td>Operate value, alarm</td>
<td>(50–120)% of start level</td>
<td>± 1.0% of U_{r} at U ≤ U_{r}</td>
</tr>
<tr>
<td></td>
<td></td>
<td>± 1.0% of U at U &gt; U_{r}</td>
</tr>
<tr>
<td>Operate value, high level</td>
<td>(100–200)% of (U_{base}/f_{rated})</td>
<td>± 1.0% of U</td>
</tr>
<tr>
<td>Curve type</td>
<td>IEEE or customer defined</td>
<td>Class 5 + 40 ms</td>
</tr>
<tr>
<td></td>
<td>( t = \frac{(0.18 - M)}{(M - 1)^2} ) (Equation 2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>where ( M = ) relative (V/Hz) = (E/f)/(U_{r}/f_{r})</td>
<td></td>
</tr>
<tr>
<td>Minimum time delay for inverse function</td>
<td>(0.000–60.000) s</td>
<td>± 0.5% ± 10 ms</td>
</tr>
<tr>
<td>Maximum time delay for inverse function</td>
<td>(0.00–9000.00) s</td>
<td>± 0.5% ± 10 ms</td>
</tr>
<tr>
<td>Alarm time delay</td>
<td>(0.000–60.000) s</td>
<td>± 0.5% ± 10 ms</td>
</tr>
</tbody>
</table>

### Table 43. Voltage differential protection (PTOV)

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage difference for alarm and trip</td>
<td>(0.0–100.0) % of U_{base}</td>
<td>± 0.5 % of U_{r}</td>
</tr>
<tr>
<td>Under voltage level</td>
<td>(0.0–100.0) % of U_{base}</td>
<td>± 0.5 % of U_{r}</td>
</tr>
<tr>
<td>Timers</td>
<td>(0.000–60.000)s</td>
<td>± 0.5% ± 10 ms</td>
</tr>
</tbody>
</table>
### Table 44. 100% stator earth fault protection (PHIZ, 59THD)

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fundamental frequency level UN (95% Stator EF)</td>
<td>(1.0–50.0)% of $U_{\text{base}}$</td>
<td>± 0.5% of $U_r$</td>
</tr>
<tr>
<td>Third harmonic differential level</td>
<td>(0.5–10.0)% of $U_{\text{base}}$</td>
<td>± 0.5% of $U_r$</td>
</tr>
<tr>
<td>Third harmonic differential block level</td>
<td>(0.1–10.0)% of $U_{\text{base}}$</td>
<td>± 0.5% of $U_r$</td>
</tr>
<tr>
<td>Timers</td>
<td>(0.020–60.000) s</td>
<td>± 0.5% ± 10 ms</td>
</tr>
<tr>
<td>Filter characteristic:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fundamental</td>
<td>Reject third harmonic by 1–40</td>
<td></td>
</tr>
<tr>
<td>Third harmonic</td>
<td>Reject fundamental harmonic by 1–40</td>
<td></td>
</tr>
</tbody>
</table>

### Table 45. Rotor earth fault protection (PHIZ, 59THD) Based on General current and voltage protection (GAPC) and (RXTTE4)

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permitted field voltage maximum</td>
<td>1200 V DC</td>
<td>-</td>
</tr>
<tr>
<td>Supply voltage 120 or 230 V</td>
<td>50/60 Hz</td>
<td>-</td>
</tr>
<tr>
<td>Operate earth fault resistance value</td>
<td>Approx. 1–20 kΩ</td>
<td>-</td>
</tr>
<tr>
<td>Influence of harmonics in the DC field voltage</td>
<td>Negligible influence of 50 V, 150 Hz or 50 V, 300 Hz</td>
<td>-</td>
</tr>
<tr>
<td>Permitted leakage capacitance</td>
<td>(1–5) μF</td>
<td>-</td>
</tr>
<tr>
<td>Permitted shaft earthing resistance</td>
<td>Maximum 200 Ω</td>
<td>-</td>
</tr>
<tr>
<td>Protective resistor</td>
<td>220 Ω, 100 W, plate 135 x 160 mm</td>
<td>-</td>
</tr>
</tbody>
</table>
Frequency protection

Table 46. 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>
<tr>
<td>Voltage dependent time delay</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$t = \left[ \frac{U - U_{Min}}{U_{Nom} - U_{Min}} \right]^{exp} (t_{Max} - t_{Min}) + t_{Min}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$U = U_{measured}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Equation 3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Settings:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$U_{Nom} = (50-150)%$ of $U_{base}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$U_{Min} = (50-150)%$ of $U_{base}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exponent=0.0-5.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$t_{Max}=(0.000-60.000)s$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$t_{Min}=(0.000-60.000)s$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Class 5 + 200 ms</td>
<td></td>
</tr>
</tbody>
</table>

Table 47. 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</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>

Table 48. 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 $U_{base}$</td>
<td>± 1.0% of $U_r$</td>
</tr>
<tr>
<td>Operate time, start function</td>
<td>100 ms typically</td>
<td>-</td>
</tr>
</tbody>
</table>
## Multipurpose protection

### Table 49. General current and voltage protection (GAPC)

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Measuring current input</strong></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><strong>Base current</strong></td>
<td>(1 - 99999) A</td>
<td>-</td>
</tr>
<tr>
<td><strong>Measuring voltage input</strong></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><strong>Base voltage</strong></td>
<td>(0.05 - 2000.00) kV</td>
<td>-</td>
</tr>
<tr>
<td><strong>Start overcurrent, step 1 and 2</strong></td>
<td>(2 - 5000)% of I$_{\text{base}}$</td>
<td>± 1.0% of I$_r$ for I$&lt;I_r$ (\pm 1.0%) of I for I$&gt;I_r$</td>
</tr>
<tr>
<td><strong>Start undercurrent, step 1 and 2</strong></td>
<td>(2 - 150)% of I$_{\text{base}}$</td>
<td>± 1.0% of I$_r$ for I$&lt;I_r$ (\pm 1.0%) of I for I$&gt;I_r$</td>
</tr>
<tr>
<td><strong>Definite time delay</strong></td>
<td>(0.00 - 6000.00) s</td>
<td>± 0.5% (\pm 10) ms</td>
</tr>
<tr>
<td><strong>Operate time start overcurrent</strong></td>
<td>25 ms typically at 0 to 2 x I$_{\text{set}}$</td>
<td>-</td>
</tr>
<tr>
<td><strong>Reset time start overcurrent</strong></td>
<td>25 ms typically at 2 to 0 x I$_{\text{set}}$</td>
<td>-</td>
</tr>
<tr>
<td><strong>Operate time start undercurrent</strong></td>
<td>25 ms typically at 2 to 0 x I$_{\text{set}}$</td>
<td>-</td>
</tr>
<tr>
<td><strong>Reset time start undercurrent</strong></td>
<td>25 ms typically at 0 to 2 x I$_{\text{set}}$</td>
<td>-</td>
</tr>
<tr>
<td><strong>See table 84 and table 85</strong></td>
<td>Parameter ranges for customer defined characteristic no 17: k: 0.05 - 999.00 A: 0.0000 - 999.0000 B: 0.0000 - 99.0000 C: 0.0000 - 1.0000 P: 0.0001 - 10.0000 PR: 0.005 - 3.000 TR: 0.005 - 600.000 CR: 0.1 - 10.0</td>
<td>See table 84 and table 85</td>
</tr>
</tbody>
</table>

---

**Generator protection REG670 1MRK 502 019-BEN B**

Pre-configured
Product version: 1.1
Issued: June 2010

58 ABB
### Table 49. General current and voltage protection (GAPC), continued

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage level where voltage memory takes over</td>
<td>(0.0 - 5.0)% of U_{base}</td>
<td>± 1.0% of U_r</td>
</tr>
<tr>
<td>Start overvoltage, step 1 and 2</td>
<td>(2.0 - 200.0)% of U_{base}</td>
<td>± 1.0% of U_r for U&lt;U_r, ± 1.0% 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>± 1.0% of U_r for U&lt;U_r, ± 1.0% 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_r for U&lt;U_r, ± 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>
<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, undervoltage</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_{set}</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_{set}</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_{set}</td>
<td>-</td>
</tr>
<tr>
<td>Impulse margin time</td>
<td>15 ms typically</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 49. General current and voltage protection (GAPC), continued

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<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_set</td>
<td></td>
</tr>
<tr>
<td>Impulse margin time</td>
<td>15 ms typically</td>
<td></td>
</tr>
</tbody>
</table>

Secondary system supervision

Table 50. 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>± 10.0% of I_r at I ≤ I_r</td>
</tr>
<tr>
<td></td>
<td></td>
<td>± 10.0% of I at I &gt; I_r</td>
</tr>
<tr>
<td>Block current</td>
<td>(5-500)% of I_r</td>
<td>± 5.0% of I_r at I ≤ I_r</td>
</tr>
<tr>
<td></td>
<td></td>
<td>± 5.0% of I at I &gt; I_r</td>
</tr>
</tbody>
</table>

Table 51. 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 UBase</td>
<td>± 1.0% of U_r</td>
</tr>
<tr>
<td>Operate current, zero sequence</td>
<td>(1–100)% of IBase</td>
<td>± 1.0% of I_r</td>
</tr>
<tr>
<td>Operate voltage, negative sequence</td>
<td>(1–100)% of UBase</td>
<td>± 1.0% of U_r</td>
</tr>
<tr>
<td>Operate current, negative sequence</td>
<td>(1–100)% of IBase</td>
<td>± 1.0% of I_r</td>
</tr>
<tr>
<td>Operate voltage change level</td>
<td>(1–100)% of UBase</td>
<td>± 5.0% of U_r</td>
</tr>
<tr>
<td>Operate current change level</td>
<td>(1–100)% of IBase</td>
<td>± 5.0% of I_r</td>
</tr>
</tbody>
</table>
## Control

### Table 52. Synchronizing, synchrocheck and energizing check SESRSYN

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase shift, $\varphi_{\text{line}} - \varphi_{\text{bus}}$</td>
<td>(-180 to 180) degrees</td>
<td>-</td>
</tr>
<tr>
<td>Voltage ratio, $U_{\text{bus}}/U_{\text{line}}$</td>
<td>(0.40-25.000) % of $U_{\text{Base}}$</td>
<td>-</td>
</tr>
<tr>
<td>Voltage high limit for synchronizing and synchrocheck</td>
<td>(50.0-120.0)% of $U_{\text{Base}}$</td>
<td>$\pm$ 1.0% of $U_r$ at $U \leq U_r$  $\pm$ 1.0% of $U$ at $U &gt; U_r$</td>
</tr>
<tr>
<td>Reset ratio, synchrocheck</td>
<td>$&gt; 95%$</td>
<td>-</td>
</tr>
<tr>
<td>Frequency difference limit between bus and line</td>
<td>(0.003-1.000) Hz</td>
<td>$\pm$ 2.0 mHz</td>
</tr>
<tr>
<td>Phase angle difference limit between bus and line</td>
<td>(5.0-90.0) degrees</td>
<td>$\pm$ 2.0 degrees</td>
</tr>
<tr>
<td>Voltage difference limit between bus and line</td>
<td>(2.0-50.0)% of $U_{\text{Base}}$</td>
<td>$\pm$ 1.0% of $U_r$</td>
</tr>
<tr>
<td>Time delay output for synchrocheck</td>
<td>(0.000-60.000) s</td>
<td>$\pm$ 0.5% $\pm$ 10 ms</td>
</tr>
<tr>
<td>Voltage high limit for energizing check</td>
<td>(50.0-120.0)% of $U_{\text{Base}}$</td>
<td>$\pm$ 1.0% of $U_r$ at $U \leq U_r$  $\pm$ 1.0% of $U$ at $U &gt; U_r$</td>
</tr>
<tr>
<td>Reset ratio, voltage high limit</td>
<td>$&gt; 95%$</td>
<td>-</td>
</tr>
<tr>
<td>Voltage low limit for energizing check</td>
<td>(10.0-80.0)% of $U_{\text{Base}}$</td>
<td>$\pm$ 1.0% of $U_r$</td>
</tr>
<tr>
<td>Reset ratio, voltage low limit</td>
<td>$&lt; 105%$</td>
<td>-</td>
</tr>
<tr>
<td>Maximum voltage for energizing</td>
<td>(50.0-180.0)% of $U_{\text{Base}}$</td>
<td>$\pm$ 1.0% of $U_r$ at $U \leq U_r$  $\pm$ 1.0% of $U$ at $U &gt; U_r$</td>
</tr>
<tr>
<td>Time delay for energizing check</td>
<td>(0.000-60.000) s</td>
<td>$\pm$ 0.5% $\pm$ 10 ms</td>
</tr>
<tr>
<td>Operate time for synchrocheck function</td>
<td>160 ms typically</td>
<td>-</td>
</tr>
<tr>
<td>Operate time for energizing function</td>
<td>80 ms typically</td>
<td>-</td>
</tr>
</tbody>
</table>

## Logic

### Table 53. Tripping logic SMPPTRC

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trip action</td>
<td>3-ph, 1/3-ph, 1/2/3-ph</td>
<td>-</td>
</tr>
<tr>
<td>Minimum trip pulse length</td>
<td>(0.000-60.000) s</td>
<td>$\pm$ 0.5% $\pm$ 10 ms</td>
</tr>
<tr>
<td>Timers</td>
<td>(0.000-60.000) s</td>
<td>$\pm$ 0.5% $\pm$ 10 ms</td>
</tr>
</tbody>
</table>
Table 54. 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></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>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>
</tbody>
</table>

Monitoring

Table 55. Measurements CVMMXN

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>(0.95-1.05) × f_r</td>
<td>± 2.0 mHz</td>
</tr>
<tr>
<td>Voltage</td>
<td>(0.1-1.5) × U_r</td>
<td>± 0.5% of U_r at U≤U_r</td>
</tr>
<tr>
<td></td>
<td></td>
<td>± 0.5% of U at U &gt; U_r</td>
</tr>
<tr>
<td>Connected current</td>
<td>(0.2-4.0) × I_r</td>
<td>± 0.5% of I_r at I ≤ I_r</td>
</tr>
<tr>
<td></td>
<td></td>
<td>± 0.5% of I at I &gt; I_r</td>
</tr>
<tr>
<td>Active power, P</td>
<td>0.1 × U_r &lt; U &lt; 1.5 × U_r</td>
<td>± 1.0% of S_r at S ≤ S_r</td>
</tr>
<tr>
<td></td>
<td>0.2 × I_r &lt; I &lt; 4.0 × I_r</td>
<td>± 1.0% of S at S &gt; S_r</td>
</tr>
<tr>
<td>Reactive power, Q</td>
<td>0.1 × U_r &lt; U &lt; 1.5 × U_r</td>
<td>± 1.0% of S_r at S ≤ S_r</td>
</tr>
<tr>
<td></td>
<td>0.2 × I_r &lt; I &lt; 4.0 × I_r</td>
<td>± 1.0% of S at S &gt; S_r</td>
</tr>
<tr>
<td>Apparent power, S</td>
<td>0.1 × U_r &lt; U &lt; 1.5 × U_r</td>
<td>± 1.0% of S_r at S ≤ S_r</td>
</tr>
<tr>
<td></td>
<td>0.2 × I_r &lt; I &lt; 4.0 × I_r</td>
<td>± 1.0% of S at S &gt; S_r</td>
</tr>
<tr>
<td>Power factor, cos (φ)</td>
<td>0.1 × U_r &lt; U &lt; 1.5 × U_r</td>
<td>± 0.02</td>
</tr>
<tr>
<td></td>
<td>0.2 × I_r &lt; I &lt; 4.0 × I_r</td>
<td></td>
</tr>
</tbody>
</table>

Generator protection REG670
Pre-configured
Product version: 1.1
Issued: June 2010

ABB
Table 56. Supervision of mA input signals (MVGGIO)

<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 57. Event counter CNTGGIO

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Counter value</td>
<td>0-10000</td>
<td>-</td>
</tr>
<tr>
<td>Max. count up speed</td>
<td>10 pulses/s</td>
<td>-</td>
</tr>
</tbody>
</table>
### Table 58. Disturbance report DRPRDRE

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-fault time</td>
<td>(0.05–1.00) 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</td>
<td>-</td>
</tr>
<tr>
<td>Time tagging resolution</td>
<td>1 ms</td>
<td>See table 80</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 59. Event list

<table>
<thead>
<tr>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffer capacity</td>
<td>Maximum number of events in the list</td>
</tr>
<tr>
<td>Resolution Accuracy</td>
<td>1 ms</td>
</tr>
<tr>
<td></td>
<td>Depending on time synchronizing</td>
</tr>
</tbody>
</table>
### Table 60. 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>96</td>
</tr>
<tr>
<td></td>
<td>Maximum number of recorded disturbances</td>
</tr>
<tr>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

### Table 61. 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>150</td>
</tr>
<tr>
<td></td>
<td>Maximum number of disturbance reports</td>
</tr>
<tr>
<td></td>
<td>100</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 62. 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>30</td>
</tr>
<tr>
<td></td>
<td>Maximum number of disturbance reports</td>
</tr>
<tr>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

### Table 63. 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>40</td>
</tr>
<tr>
<td></td>
<td>Maximum number of binary inputs</td>
</tr>
<tr>
<td></td>
<td>96</td>
</tr>
<tr>
<td></td>
<td>Maximum number of disturbance reports</td>
</tr>
<tr>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Maximum total recording time</td>
<td>340 seconds (100 recordings) at 50 Hz</td>
</tr>
<tr>
<td>(3.4 s recording time and maximum</td>
<td>280 seconds (80 recordings) at 60 Hz</td>
</tr>
<tr>
<td>number of channels, typical value)</td>
<td></td>
</tr>
</tbody>
</table>

### Metering

#### Table 64. 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</td>
<td>(1–3600) s</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 65. Energy metering ETPMTR

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

Station communication

Table 66. 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>
</tbody>
</table>

Table 67. LON communication protocol

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

Table 68. SPA communication protocol

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

Table 69. IEC 60870-5-103 communication protocol

<table>
<thead>
<tr>
<th>Function</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocol</td>
<td>IEC 60870-5-103</td>
</tr>
<tr>
<td>Communication speed</td>
<td>9600, 19200 Bd</td>
</tr>
</tbody>
</table>
Table 70. SLM – LON port

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

*) depending on optical budget calculation

Table 71. SLM – SPA/IEC 60870-5-103 port

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

*) depending on optical budget calculation

Table 72. 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>

Remote communication
Table 73. Line data communication module

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Range or value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of LDCM</strong></td>
<td><strong>Type of fibre</strong></td>
</tr>
<tr>
<td></td>
<td>Short range (SR)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of fibre</td>
<td>Graded-index multimode 62.5/125 µm or 50/125 µm</td>
</tr>
<tr>
<td>Wave length</td>
<td>850 nm</td>
</tr>
<tr>
<td>Optical budget</td>
<td>13 dB (typical distance about 3 km *) 9 dB (typical distance about 2 km *)</td>
</tr>
<tr>
<td>Graded-index multimode 62.5/125 µm</td>
<td></td>
</tr>
<tr>
<td>Graded-index multimode 50/125 µm</td>
<td></td>
</tr>
<tr>
<td>Optical connector</td>
<td>Type ST</td>
</tr>
<tr>
<td>Protocol</td>
<td>C37.94</td>
</tr>
<tr>
<td>Data transmission</td>
<td>Synchronous</td>
</tr>
<tr>
<td>Transmission rate / Data rate</td>
<td>2 Mb/s / 64 kbit/s</td>
</tr>
<tr>
<td>Clock source</td>
<td>Internal or derived from received signal</td>
</tr>
</tbody>
</table>

*) depending on optical budget calculation  
**) C37.94 originally defined just for multimode; using same header, configuration and data format as C37.94

Hardware
### IED

#### Table 74. 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 75. Water and dust protection level according to IEC 60529

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Front</td>
<td>IP40 (IP54 with sealing strip)</td>
</tr>
<tr>
<td>Rear, sides, top and bottom</td>
<td>IP20</td>
</tr>
</tbody>
</table>

#### Table 76. Weight

<table>
<thead>
<tr>
<th>Case size</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>6U, 1/2 x 19&quot;</td>
<td>≤ 10 kg</td>
</tr>
<tr>
<td>6U, 1/1 x 19&quot;</td>
<td>≤ 18 kg</td>
</tr>
</tbody>
</table>

### Connection system

#### Table 77. 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>Terminal blocks of feed through type</td>
<td>250 V AC, 20 A</td>
<td>4 mm²</td>
</tr>
<tr>
<td>Terminal blocks suitable for ring lug terminals</td>
<td>250 V AC, 20 A</td>
<td>4 mm²</td>
</tr>
</tbody>
</table>

#### Table 78. 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 2 × 1 mm²</td>
</tr>
<tr>
<td>Terminal blocks suitable for ring lug terminals</td>
<td>300 V AC</td>
<td>3 mm²</td>
</tr>
</tbody>
</table>
### Basic IED functions

#### Table 79. 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>1000 events, first in-first out</td>
</tr>
</tbody>
</table>

#### Table 80. 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 81. GPS time synchronization module (GSM)

<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 82. 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</td>
</tr>
<tr>
<td></td>
<td>TNC in antenna end</td>
</tr>
</tbody>
</table>
Table 83. 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>Electrical connector IRIG-B</td>
<td>BNC</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>
</tbody>
</table>

Inverse characteristic

Table 84. 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>$t = \left( \frac{A}{(t^2 - 1)} + B \right) \cdot k$</td>
<td>$k = (0.05-999)$ in steps of 0.01 unless otherwise stated</td>
</tr>
<tr>
<td>Reset characteristic:</td>
<td>$t = \frac{t_r}{(t^2 - 1)} \cdot k$</td>
<td></td>
</tr>
<tr>
<td>I = $I_{measured}/I_{set}$</td>
<td></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, class 5 + 30 ms</td>
</tr>
<tr>
<td>ANSI Very inverse</td>
<td>A=19.61, B=0.491, P=2.0, tr=21.6</td>
<td></td>
</tr>
<tr>
<td>ANSI Normal Inverse</td>
<td>A=0.0086, B=0.0185, P=0.02, tr=0.46</td>
<td></td>
</tr>
<tr>
<td>ANSI Moderately Inverse</td>
<td>A=0.0515, B=0.1140, P=0.02, tr=4.85</td>
<td></td>
</tr>
<tr>
<td>ANSI Long Time Extremely Inverse</td>
<td>A=64.07, B=0.250, P=2.0, tr=30</td>
<td></td>
</tr>
<tr>
<td>ANSI Long Time Very Inverse</td>
<td>A=28.55, B=0.712, P=2.0, tr=13.46</td>
<td></td>
</tr>
<tr>
<td>ANSI Long Time Inverse</td>
<td>$k=(0.05-999)$ in steps of 0.01</td>
<td>A=0.086, B=0.185, P=0.02, tr=4.6</td>
</tr>
</tbody>
</table>
Table 85. IEC Inverse time characteristics

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating characteristic:</td>
<td>$t = \left( \frac{A}{(P - 1)} \right)^k$</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>$I = \frac{I_{\text{measured}}}{I_{\text{set}}}$</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 60255-3, class 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>$k = (0.05-999)$ in steps of 0.01</td>
<td>IEC 60255, class 5 + 40 ms</td>
</tr>
<tr>
<td>Operate characteristic:</td>
<td>$A=(0.005-200.000)$ in steps of 0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$B=(0.00-20.00)$ in steps of 0.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$C=(0.1-10.0)$ in steps of 0.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$P=(0.005-3.000)$ in steps of 0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$TR=(0.005-100.000)$ in steps of 0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$CR=(0.1-10.0)$ in steps of 0.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$PR=(0.005-3.000)$ in steps of 0.001</td>
<td></td>
</tr>
<tr>
<td>Reset characteristic:</td>
<td>$t = \frac{TR}{(I_{\text{set}} - CR)}^k$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$I = \frac{I_{\text{measured}}}{I_{\text{set}}}$</td>
<td></td>
</tr>
</tbody>
</table>


Table 86. RI and RD type inverse time characteristics

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>RI type inverse characteristic</td>
<td>$t = \frac{1}{0.339 - \frac{0.236}{I}} \cdot k$</td>
<td>$k = (0.05-999)$ in steps of 0.01</td>
</tr>
<tr>
<td></td>
<td>$I = I_{measured}/I_{set}$</td>
<td></td>
</tr>
<tr>
<td>RD type logarithmic inverse</td>
<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>
</tr>
<tr>
<td>characteristic</td>
<td>$I = I_{measured}/I_{set}$</td>
<td></td>
</tr>
</tbody>
</table>
Table 87. Inverse time characteristics for Two step undervoltage protection (PUVM, 27)

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A curve:</td>
<td>$t = \frac{k}{(U &lt; U - U)}$</td>
<td>k = (0.05-1.10) in steps of 0.01 Class 5 +40 ms</td>
</tr>
<tr>
<td></td>
<td>$U &lt; = U_{set}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$U = U_{measured}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Equation 4)</td>
<td></td>
</tr>
<tr>
<td>Type B curve:</td>
<td>$t = \frac{k \cdot 480}{(32 \cdot (\frac{U &lt; U - U}{U &lt;} - 0.5)^{2.5} + 0.055)}$</td>
<td>k = (0.05-1.10) in steps of 0.01</td>
</tr>
<tr>
<td></td>
<td>$U &lt; = U_{set}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$U = U_{measured}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Equation 5)</td>
<td></td>
</tr>
<tr>
<td>Programmable curve:</td>
<td>$t = \left[ \frac{k \cdot A}{(B \cdot (\frac{U &lt; U - U}{U &lt;} - C)^{2})} \right] + D$</td>
<td>k = (0.05-1.10) in steps of 0.01</td>
</tr>
<tr>
<td></td>
<td>$U &lt; = U_{set}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$U = U_{measured}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Equation 6)</td>
<td>A = (0.005-200.000) in steps of 0.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B = (0.50-100.00) in steps of 0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C = (0.0-1.0) in steps of 0.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D = (0.000-60.000) in steps of 0.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P = (0.000-3.000) in steps of 0.001</td>
</tr>
<tr>
<td>Function</td>
<td>Range or value</td>
<td>Accuracy</td>
</tr>
<tr>
<td>---------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Type A curve:</td>
<td>$t = \frac{k}{U &gt; - U &gt;}$</td>
<td>Class 5 +40 ms</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$U &gt; = U_{set}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$U = U_{measured}$</td>
<td></td>
</tr>
<tr>
<td>Type B curve:</td>
<td>$t = \frac{k \cdot 480}{\left(32 \cdot \frac{U - U &gt;}{U &gt;} - 0.5\right)^{2.0} - 0.035}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$k = (0.05-1.10)$ in steps of 0.01</td>
<td></td>
</tr>
<tr>
<td>Type C curve:</td>
<td>$t = \frac{k \cdot 480}{\left(32 \cdot \frac{U - U &gt;}{U &gt;} - 0.5\right)^{3.0} - 0.035}$</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>$t = \frac{k \cdot A}{B \cdot \left(\frac{U - U &gt;}{U &gt;} - C\right)^p + D}$</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>
Table 89. Inverse time characteristics for Two step residual overvoltage protection (POVM, 59N)

<table>
<thead>
<tr>
<th>Function</th>
<th>Range or value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type A curve:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t = \frac{k}{U-U&gt;}$</td>
<td>$k = (0.05-1.10)$ in steps of 0.01</td>
<td>Class 5 +40 ms</td>
</tr>
<tr>
<td>$U &gt; = U_{set}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$U = U_{measured}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Type B curve:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t = \frac{k \cdot 480}{32 \left( \frac{U-U&gt;}{U}&gt; - 0.5 \right)^2 - 0.035}$</td>
<td>$k = (0.05-1.10)$ in steps of 0.01</td>
<td></td>
</tr>
<tr>
<td><strong>Type C curve:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t = \frac{k \cdot 480}{32 \left( \frac{U-U&gt;}{U}&gt; - 0.5 \right)^3 - 0.035}$</td>
<td>$k = (0.05-1.10)$ in steps of 0.01</td>
<td></td>
</tr>
<tr>
<td><strong>Programmable curve:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t = \frac{k \cdot A}{B \left( \frac{U-U&gt;}{U}&gt; - C \right)^P} + D$</td>
<td>$k = (0.05-1.10)$ in steps of 0.01</td>
<td></td>
</tr>
<tr>
<td>$A = (0.005-200.000)$</td>
<td>in steps of 0.001</td>
<td></td>
</tr>
<tr>
<td>$B = (0.50-100.00)$</td>
<td>in steps of 0.001</td>
<td></td>
</tr>
<tr>
<td>$C = (0.0-1.0)$</td>
<td>in steps of 0.1</td>
<td></td>
</tr>
<tr>
<td>$D = (0.000-60.000)$</td>
<td>in steps of 0.001</td>
<td></td>
</tr>
<tr>
<td>$P = (0.000-3.000)$</td>
<td>in steps of 0.001</td>
<td></td>
</tr>
</tbody>
</table>
8. 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: REG670*1.1-A20X00-X00-A-B-A6-X0-CA-XD. Using the code of each position #1-12 specified as REG670*1-2 3 3 3 4-5-6-7 7-8-9 9-10 10 10 10 10 10 10 10 10 11 11 11 11 11-12 12

<table>
<thead>
<tr>
<th>#</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>REG670*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SOFTWARE</th>
<th>#1 Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version number</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Selection for position #1.

<table>
<thead>
<tr>
<th>Configuration alternatives</th>
<th>#2 Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gen diff + backup 12 Al</td>
<td>A20</td>
</tr>
<tr>
<td>Gen diff + backup 24 Al</td>
<td>B30</td>
</tr>
<tr>
<td>Gen and block transformer protection 24 Al</td>
<td>C30</td>
</tr>
</tbody>
</table>

ACT configuration
ABB standard configuration
X00

Selection for position #2.

<table>
<thead>
<tr>
<th>Software options</th>
<th>#3 Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>No option</td>
<td>X00</td>
</tr>
<tr>
<td>Restricted earth fault protection, low impedance</td>
<td>A01 Note: A01 only for B30</td>
</tr>
<tr>
<td>High impedance differential protection - 3 blocks</td>
<td>A02 Note: A02 only for A20</td>
</tr>
<tr>
<td>Transformer differential protection, 2 winding</td>
<td>A11 Note: A11 only for A20</td>
</tr>
<tr>
<td>Transformer differential protection, 2 and 3 winding</td>
<td>A13 Note: A13 only for B30</td>
</tr>
<tr>
<td>Pole slip protection</td>
<td>B21</td>
</tr>
<tr>
<td>Sensitive directional residual overcurrent and power protection</td>
<td>C16</td>
</tr>
<tr>
<td>100% Stator E/F 3rd harmonic</td>
<td>D21 Note: D21 only for A20</td>
</tr>
<tr>
<td>Apparatus control 30 objects</td>
<td>H09</td>
</tr>
</tbody>
</table>

Selection for position #3
### First local HMI user dialogue language

<table>
<thead>
<tr>
<th>Language</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMI language, English IEC</td>
<td>B1</td>
</tr>
<tr>
<td>HMI language, English US</td>
<td>B2</td>
</tr>
</tbody>
</table>

### Additional local HMI user dialogue language

<table>
<thead>
<tr>
<th>Language</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>No second HMI language</td>
<td>X0</td>
</tr>
<tr>
<td>German</td>
<td>A1</td>
</tr>
<tr>
<td>Russian</td>
<td>A2</td>
</tr>
<tr>
<td>French</td>
<td>A3</td>
</tr>
<tr>
<td>Spanish</td>
<td>A4</td>
</tr>
<tr>
<td>Italian</td>
<td>A5</td>
</tr>
<tr>
<td>Polish</td>
<td>A6</td>
</tr>
<tr>
<td>Hungarian</td>
<td>A7</td>
</tr>
<tr>
<td>Czech</td>
<td>A8</td>
</tr>
<tr>
<td>Swedish</td>
<td>A9</td>
</tr>
</tbody>
</table>

### Casing

<table>
<thead>
<tr>
<th>Case</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 x 19&quot; case A</td>
<td></td>
</tr>
<tr>
<td>1/1 x 19&quot; case 2 TRM slots E</td>
<td></td>
</tr>
</tbody>
</table>

### Mounting details with IP40 of protection from the front

<table>
<thead>
<tr>
<th>Mounting Kit</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>No mounting kit included X</td>
<td></td>
</tr>
<tr>
<td>19&quot; rack mounting kit for 1/2 x 19&quot; case of 2xRHGS6 or RHGS12 A</td>
<td>Note: Only for A20</td>
</tr>
<tr>
<td>19&quot; rack mounting kit for 1/1 x 19&quot; case C</td>
<td>Note: Only for B20 and C30</td>
</tr>
<tr>
<td>Wall mounting kit D</td>
<td>Note: Wall mounting not recommended with communication modules with fibre connection (SLM, OEM, LDCM)</td>
</tr>
<tr>
<td>Flush mounting kit E</td>
<td></td>
</tr>
<tr>
<td>Flush mounting kit + IP54 mounting seal F</td>
<td></td>
</tr>
</tbody>
</table>

### Connection type for Power supply, Input/output and Communication modules

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

### Human machine hardware interface

<table>
<thead>
<tr>
<th>Interface Type</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small size - text only, IEC keypad symbols A</td>
<td></td>
</tr>
<tr>
<td>Medium size - graphic display, IEC keypad symbols B</td>
<td></td>
</tr>
<tr>
<td>Medium size - graphic display, ANSI keypad symbols C</td>
<td></td>
</tr>
</tbody>
</table>

---

**Abbreviations:**
- IEC: International Electrotechnical Commission
- TRM: Terminal Replacement Module
- IEC: International Electrotechnical Commission
- ANSI: American National Standards Institute
<table>
<thead>
<tr>
<th>Connection type for Analog modules</th>
<th>#9</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compression terminals</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Ringlug terminals</td>
<td>B</td>
<td></td>
</tr>
</tbody>
</table>

### Analog system

<table>
<thead>
<tr>
<th>Description</th>
<th>#9</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>First TRM, 9I+3U 1A, 110/220V</td>
<td>3</td>
<td>Note: Only for B30/C30</td>
</tr>
<tr>
<td>First TRM, 9I+3U 5A, 110/220V</td>
<td>4</td>
<td>Note: Only for B30/C30</td>
</tr>
<tr>
<td>First TRM, 5I, 1A+2I, 5A+3U, 110/220V</td>
<td>5</td>
<td>Note: Only for B30/C30</td>
</tr>
<tr>
<td>First TRM, 7I+5U 1A, 110/220V</td>
<td>12</td>
<td>Note: Only for A20</td>
</tr>
<tr>
<td>First TRM, 7I+5U 5A, 110/220V</td>
<td>13</td>
<td>Note: Only for A20</td>
</tr>
<tr>
<td>First TRM 6I, 5A+II, 1A+5U, 50/60 Hz, 100/220V</td>
<td>14</td>
<td>Note: Only for A20</td>
</tr>
</tbody>
</table>

**No second TRM included**

<table>
<thead>
<tr>
<th>Description</th>
<th>#9</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second TRM, 9I+3U 1A, 110/220V</td>
<td>3</td>
<td>Note: Only for B30</td>
</tr>
<tr>
<td>Second TRM, 9I+3U 5A, 110/220V</td>
<td>4</td>
<td>Note: Only for B30</td>
</tr>
<tr>
<td>Second TRM, 5I, 1A+2I, 5A+3U, 110/220V</td>
<td>5</td>
<td>Note: Only for B30</td>
</tr>
<tr>
<td>Second TRM, 6I+6U 1A, 100/220V</td>
<td>6</td>
<td>Note: Only for C30</td>
</tr>
<tr>
<td>Second TRM, 6I+6U 5A, 100/220V</td>
<td>7</td>
<td>Note: Only for C30</td>
</tr>
</tbody>
</table>

**Selection for position #9.**
<table>
<thead>
<tr>
<th>Slot position (rear view)</th>
<th>#10</th>
<th>Notes and Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note: Max 3 positions in 1/2 rack and 11 in 1/1 rack with 2 TRM and 14 in 1/1 rack with 1 TRM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/2 Case with 1 TRM</td>
<td>Note: Only for A20</td>
<td></td>
</tr>
<tr>
<td>1/1 Case with 2 TRM</td>
<td>Note: Only for B30/C30</td>
<td></td>
</tr>
<tr>
<td>No board in slot</td>
<td>X X X X X X X X X</td>
<td></td>
</tr>
<tr>
<td>Binary output module 24 output relays (BOM)</td>
<td>A A A A A A A A</td>
<td></td>
</tr>
<tr>
<td>Note: Maximum 4 (BOM+SOM+MIM) boards.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIM 16 inputs, RL24-30 VDC</td>
<td>B B B B B B B B</td>
<td></td>
</tr>
<tr>
<td>Note: Select 1 BIM in position X31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIM 16 inputs, RL48-60 VDC</td>
<td>C C C C C C C C</td>
<td></td>
</tr>
<tr>
<td>BIM 16 inputs, RL110-125 VDC</td>
<td>D D D D D D D D D</td>
<td></td>
</tr>
<tr>
<td>BIM 16 inputs, RL220-250 VDC</td>
<td>E E E E E E E E E</td>
<td></td>
</tr>
<tr>
<td>BIMp 16 inputs, RL24-30 VDC for pulse counting</td>
<td>F F F F F F F F F</td>
<td></td>
</tr>
<tr>
<td>BIMp 16 inputs, RL48-60 VDC for pulse counting</td>
<td>G G G G G G G G G</td>
<td></td>
</tr>
<tr>
<td>BIMp 16 inputs, RL110-125 VDC for pulse counting</td>
<td>H H H H H H H H H</td>
<td></td>
</tr>
<tr>
<td>BIMp 16 inputs, RL220-250 VDC for pulse counting</td>
<td>K K K K K K K K K</td>
<td></td>
</tr>
<tr>
<td>IOM 8 inputs, 10+2 output, RL24-30 VDC</td>
<td>L L L L L L L L L</td>
<td></td>
</tr>
<tr>
<td>IOM 8 inputs, 10+2 output, RL48-60 VDC</td>
<td>M M M M M M M M M</td>
<td></td>
</tr>
<tr>
<td>IOM 8 inputs, 10+2 output, RL110-125 VDC</td>
<td>N N N N N N N N N</td>
<td></td>
</tr>
<tr>
<td>IOM 8 inputs, 10+2 output, RL220-250 VDC</td>
<td>P P P P P P P P P</td>
<td></td>
</tr>
<tr>
<td>IOM with MOV 8 inputs, 10-2 output, 24-30 VDC</td>
<td>U U U U U U U U U</td>
<td></td>
</tr>
<tr>
<td>IOM with MOV 8 inputs, 10-2 output, 48-60 VDC</td>
<td>V V V V V V V V V</td>
<td></td>
</tr>
<tr>
<td>IOM with MOV 8 inputs, 10-2 output, 110-125 VDC</td>
<td>W W W W W W W W W</td>
<td></td>
</tr>
<tr>
<td>IOM with MOV 8 inputs, 10-2 output, 220-250 VDC</td>
<td>Y Y Y Y Y Y Y Y Y</td>
<td></td>
</tr>
<tr>
<td>mA input module MIM 6 channels</td>
<td>R R R R R R R</td>
<td></td>
</tr>
<tr>
<td>Note: Max 4 (BOM+SOM+MIM) board in 1/1 case. No MIM board in 1/2 case</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPS time synchronization module (in last slot)</td>
<td>S S</td>
<td></td>
</tr>
<tr>
<td>SOM Static outputs module, 12 outputs, 48-60 VDC</td>
<td>T1 T1 T1 T1 T1 T1 T1 T1 T1 T1 T1 T1</td>
<td></td>
</tr>
<tr>
<td>Note: Max 4 (BOM+SOM+MIM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOM static outputs module, 12 outputs, 110-250 VDC</td>
<td>T2 T2 T2 T2 T2 T2 T2 T2 T2 T2 T2 T2</td>
<td></td>
</tr>
</tbody>
</table>

Selection for position #10.
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 1/2 case with 1TRM</td>
<td>X X X X</td>
<td>Note: Max 1 LDCM</td>
</tr>
<tr>
<td>Available slots in 1/1 case with 2 TRM slots</td>
<td>X X X X X X</td>
<td>Note: Max 2 LDCM</td>
</tr>
<tr>
<td>No remote communication board included</td>
<td>X X X X X X</td>
<td>Note: Max 2 LDCM</td>
</tr>
<tr>
<td>Optical short range LDCM</td>
<td>A A A A A A</td>
<td>Note: Not in A21</td>
</tr>
<tr>
<td>Optical medium range, LDCM 1310 nm</td>
<td>B B B B B B</td>
<td>Note: Not in A21</td>
</tr>
<tr>
<td>IRIG-B Time synchronization module, with PPS</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>Galvanic RS485 communication module</td>
<td>G 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>No first communication board included</td>
<td>X</td>
<td>Note: Optical ethernet module, 2 channel glass is not allowed together with SLM.</td>
</tr>
<tr>
<td>No second communication board included</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Serial and LON communication module (plastic)</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Serial (plastic) and LON (glass) communication module</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>Serial and LON communication module (glass)</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Optical ethernet module, 1 channel glass</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Optical ethernet module, 2 channel glass</td>
<td>E</td>
<td></td>
</tr>
</tbody>
</table>

Selection for position #12.

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.

Basic hardware and functions

Manuals on CD

Operator's manual (English)
Installation and commissioning manual (English)
Technical reference manual (English)
Application manual (English)
Getting started guide (English)
Basic IED functions

- Self-supervision with internal event list
- Time and synchronization error
- Time synchronization
- Parameter setting groups
- Test mode functionality
- Change lock function
- IED Identifiers
- Product information
- Misc Base common
- IED Runtime comp
- Rated system frequency
- Signal Matrix for binary inputs
- Signal Matrix for binary outputs
- Signal Matrix for mA inputs
- Signal Matrix for analog inputs
- Summation block 3 phase
- Parameter setting function for HMI in PCM 600
- Local HMI signals
- Authority status
- Authority check
- FTP access with password
- SPA communication mapping

Accessories

GPS antenna and mounting details

- GPS antenna, including mounting kits
  - Quantity: 1MRK 001 640-AA
- Cable for antenna, 20 m
  - Quantity: 1MRK 001 665-AA
- Cable for antenna, 40 m
  - Quantity: 1MRK 001 665-BA

Interface converter (for remote end data communication)

- External interface converter from C37.94 to G703 including 1U 19” rack mounting accessories
  - Quantity: 1MRK 002 245-AA
- External interface converter from C37.94 to G703.E1
  - Quantity: 1MRK 002 245-BA
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 and ABB Product Guide > High Voltage Products > Protection and Control > Modular Relay > Test Equipment for detailed information. When FT switches are considered, please refer to the website: www.abb.com>ProductGuide>Medium Voltage Products>Protection and Control (Distribution) for detailed information.

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

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

However our proposal for suitable variants are:

Two winding transformer with internal neutral on current circuits. Two pcs can be used in applications for three winding transformers in single or multi-breaker arrangement (ordering number RK926 215-BD)

Two winding transformer with external neutral on current circuits. Two pcs can be used in applications for three winding transformers in single or multi-breaker arrangement (ordering number RK926 215-BH).

Three winding transformer with internal neutral on current circuits (ordering number RK926 215-BX).

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

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

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

Protection cover

Protective cover for rear side of IED, 6U, 1/2 x 19” Quantity: 1MRK 002 420-AC

Protective cover for rear side of IED, 6U, 1/1 x 19” Quantity: 1MRK 002 420-AA

External resistor unit for high impedance differential protection

High impedance resistor unit 1-ph with resistor 1.8 kOhms and voltage dependent resistor for 20-100V operating voltage Quantity: 1 2 3 RK795101-MA

High impedance resistor unit 3-ph with resistor 1.8 kOhms and voltage dependent resistor for 20-100V operating voltage Quantity: RK795101-MB

High impedance resistor unit 1-ph with resistor 6.8 kOhms and voltage dependent resistor for 100-400V operating voltage Quantity: 1 2 3 RK795101-CB

High impedance resistor unit 3-ph with resistor 6.8 kOhms and voltage dependent resistor for 100-400V operating voltage Quantity: RK795101-DC

Generator protection REG670 1MRK 502 019-BEN B Pre-configured Product version: 1.1 Issued: June 2010
Combiflex

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.

Side-by-side mounting kit  Quantity: 1MRK 002 420-Z

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

<table>
<thead>
<tr>
<th>IEC</th>
<th>Quantity:</th>
<th>1MRK 502 014-UEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANSI</td>
<td>Quantity:</td>
<td>1MRK 502 014-UUS</td>
</tr>
</tbody>
</table>

Technical reference manual

<table>
<thead>
<tr>
<th>IEC</th>
<th>Quantity:</th>
<th>1MRK 502 013-UEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANSI</td>
<td>Quantity:</td>
<td>1MRK 502 013-UUS</td>
</tr>
</tbody>
</table>

Installation and commissioning manual

<table>
<thead>
<tr>
<th>IEC</th>
<th>Quantity:</th>
<th>1MRK 502 015-UEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANSI</td>
<td>Quantity:</td>
<td>1MRK 502 015-UUS</td>
</tr>
</tbody>
</table>

Application manual

<table>
<thead>
<tr>
<th>IEC</th>
<th>Quantity:</th>
<th>1MRK 502 016-UEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANSI</td>
<td>Quantity:</td>
<td>1MRK 502 016-UUS</td>
</tr>
</tbody>
</table>

Engineering guide IED 670 products

| Quantity: | 1MRK 511 179-UEN |

Reference information

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

Country: End user:

Station name: Voltage level: kV

Generator manufacturer: Rated power: MVA

Type of prime mover: steam ☐, gas ☐, hydro ☐, pumpstorage ☐, nuclear ☐, other ______________________

Related documents

Documents related to REG670

Operator's manual 1MRK 502 014-UEN
Installation and commissioning manual 1MRK 502 015-UEN
Technical reference manual 1MRK 502 013-UEN
Application manual 1MRK 502 016-UEN
Buyer's guide 1MRK 502 019-BEN
Connection and Installation components
Test system, COMBITEST
Accessories for IED 670
Getting started guide IED 670
SPA and LON signal list for IED 670, ver. 1.1
IEC 61850 Data objects list for IED 670, ver. 1.1
Engineering guide IED 670 products
Buyer’s guide REG 216
Communication set-up for RED 670 Differential protection and 670 series

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