Transformer protection IED RET 670

Buyer's Guide

Customized
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Features

- A protection, control, and monitoring IED with extensive functional library and configuration possibilities and expandable hardware design to meet specific user requirements
- For power transformers, autotransformers, shunt reactors, T-protection, generator transformer blocks, phase shifting transformers and small busbar systems
- For two- and three-winding transformers with up to six stabilized inputs
- For multi- or single-breaker arrangements
- Transformer differential protection with:
  - Percentage bias restraint for through faults
  - Waveform and Second harmonic restraint for transformer inrush
  - Fifth harmonic restraint for overexcitation
  - High sensitivity for interturn faults
- Restricted earth fault protection for all direct or low impedance earthed windings
  - Extremely fast operation
  - High sensitivity
  - High and low impedance based
- Full scheme phase-to-phase and phase-to-earth distance protection with up to five zones:
  - Alternative choice of quadrilateral function, quadrilateral function or mho function
  - Sensitive directional earth fault function for high ohmic earthed system.
  - Load encroachment feature
- Power swing detection including additional logic
- Directional power protection
  - Reverse-, low forward-, active-, reactive power protection
  - Phase angle compensation
  - Two steps (alarm/trip)
- Instantaneous high speed short circuit function with low transient overreach
- Directional overcurrent protection with four steps for each winding
  - Each step can be inverse or definite time delayed
  - Each step can be directional or non-directional
- Instantaneous high speed earth fault function with low transient overreach
- Four step directional and/or non-directional phase overcurrent protection
  - Voltage, current or dual polarized
  - Each step can be inverse or definite time delayed
  - Each step can be directional or non-directional
  - Each step can be blocked on second harmonic component
- Synchronizing, synchrocheck and dead-line check function for single- or multi-breaker arrangements:
  - Selectable energizing direction
  - Two functions with built-in voltage selection
  - For automatic and manual synchronizing and synchrocheck with different settings
  - Synchronizing of asynchronous networks with settable breaker closing time
- Selectable additional software functions such as breaker failure protection for each breaker, voltage protection, overexcitation protection, control and monitoring
- Sudden pressure relief/Buchholtz, temperature devices etc. through binary inputs stabilized against capacitive discharges
- Data communication modules for station bus IEC 61850-8-1

- Data communication modules for station bus IEC 60870-5-103, TCP/IP or EIA-485 DNP 3.0, LON and SPA
- Integrated disturbance and event recorder for up to 40 analog and 96 binary signals
- Function for energy calculation and demand handling
  - Outputs from measurement function (MMXU) can be used to calculate energy. Active as well as reactive values are calculated in import respectively export direction. Values can be read or generated as pulses. Maximum demand power values are also calculated by the function.
- Time synchronization over IEC 61850-8-1, LON, SPA, binary input or with optional GPS module (GSM) or IRIG-B module
- Analog measurements accuracy up to below 0.5% for power and 0.25% for current and voltage and with site calibration to optimize total accuracy
- Versatile local human-machine interface
- Extensive self-supervision with internal event recorder
- Six independent groups of complete setting parameters with password protection
- Powerful software PC tool for configuration, setting and disturbance evaluation

Functions

- Differential protection
  - Transformer differential protection, two winding (PDIF, 87T)
  - Transformer differential protection, three winding (PDIF, 87T)
  - Restricted earth fault protection (PDIF, 87N)
  - High impedance differential protection (PDIF, 87X)
- Impedance protection
  - Distance protection zones, Mho (PDIS, 21)
  - Distance protection zones, Quad (PDIS, 21)
  - Phase selection with load encroachment, quadrilateral characteristic (PDIS, 21)
  - Phase selection with load encroachment, Mho (PDIS, 21)
  - Power swing detection (RPSB, 78)
  - Power swing logic (RPSL, 78)
  - Broken conductor check (PTOC, 46)
- Current protection
  - Instantaneous phase overcurrent protection (PIOC, 50)
  - Four step phase overcurrent protection (POCM, 51/67)
  - Instantaneous residual overcurrent protection (PIOC, 50N)
  - Four step residual overcurrent protection (PEFM, 51N/67N)
  - Sensitive directional residual over current and power protection (PSDE)
  - Thermal overload protection, two time constants (PTTR, 49)
  - Breaker failure protection (RBRF, 50BF)
  - Pole discordance protection (RPLD, 52PD)
  - Directional underpower protection (PDUP, 37)
  - Directional overpower protection (PDOP, 32)
- Voltage protection
  - Two step undervoltage protection (PUVM, 27)
  - Two step overvoltage protection (POVM, 59)
  - Two step residual overvoltage protection (POVM, 59N)
  - Overexcitation protection (PVPH, 24)
  - Voltage differential protection (PTOV, 60)
  - Loss of voltage check (PTUV, 27)
- Frequency protection
  - Underfrequency protection (PTUF, 81)
  - Overfrequency protection (PTOF, 81)
  - Rate-of-change frequency protection (PFRC, 81)
- Multipurpose protection
  - General current and voltage protection (GAPC)
- Secondary system supervision
  - Current circuit supervision (RDIF)
  - Fuse failure supervision (RFUF)
- Control
  - Synchronizing, synchrocheck and energizing check (RSYN, 25)
  - Apparatus control for up to 6 bays, max 30 app. (6CBs) incl. Interlocking (APC30)
- Scheme communication
  - Scheme communication logic for residual overcurrent protection (PSCH, 85)
  - Current reversal and weak-end infeed logic for residual overcurrent protection (PSCH, 85)
- Logic
  - Tripping logic (PTRC, 94)
  - Trip matrix logic
  - Configurable logic blocks
  - Fixed signal function block
- Monitoring
  - Measurements (MMXU)
  - Supervision of mA input signals (MVGGIO)
  - Event counter (GGIO)
  - Event function
  - Disturbance report (RDRE)
- Metering
  - Energy metering (MMTR)
  - Pulse counter logic (GGIO)

- Station communication
  - LON communication protocol
  - SPA communication protocol
  - IEC 60870-5-103 communication protocol
  - Horizontal communication via GOOSE
  - DNP3.0 communication
  - Single command, 16 signals
  - Multiple Command, 16 signals each
  - Ethernet configuration of links
- Remote communication
  - Binary signal transfer
- Basic IED functions
  - Self supervision with internal event list
  - Time synchronization (TIME)
  - Parameter setting groups
  - Test mode functionality (TEST)
  - Change lock function
  - IED identifiers
  - Rated system frequency
- Hardware
  - Power supply module (PSM)
  - Binary input module (BIM)
  - Binary output module (BOM)
  - Static binary output module (SOM)
  - Binary in/out module (IOM)
  - mA input module (MIM)
  - Transformer input module
  - Optical ethernet module (OEM)
  - SPA/LON/IEC module (SLM)
  - DNP3.0 Serial communication module (RS485)
  - Line data communication module (LDCM)
  - GPS time synchronization module (GSM)
  - IRIG-B time synchronization module (IRIG-B)
- Accessories
  - GPS antenna, including mounting kit
  - External interface converter from C37.94 to G703 resp G703.E1
  - High impedance resistor unit
  - Test switch module RTXP24
  - On/off switch

Application

RET 670 provides fast and selective protection, monitoring and control for two- and three-winding transformers, autotransformers, generator-transformer units, phase shifting transformers, special railway transformers and shunt reactors. The transformer IED is designed to operate correctly over a wide frequency range in order to accommodate power system frequency variations during disturbances and generator start-up and shut-down.

A very fast differential protection function, with automatic CT ratio matching and vector group compensation, makes this IED the ideal solution even for the most demanding applications. RET 670 has very low requirements on the main CTs, no interposing CTs are required. It is suitable for differential applications with multi-breaker arrangements with up to six restraint CT inputs. The differential protection function is provided with 2nd harmonic and wave-block restraint features to avoid tripping for magnetizing inrush, and 5th harmonic restraint to avoid tripping for overexcitation.

The differential function offers a high sensitivity for low-level internal faults. RET 670's unique and innovative sensitive differential protection feature, based on well-known theory of symmetrical components provide best possible coverage for winding internal turn-to-turn faults.

A low impedance restricted earth-fault protection function is available as complimentary sensitive and fast main protection against winding earth faults. This function includes a directional zero-sequence current criterion for additional security.

Alternatively a high impedance differential function is available. It can be used as restricted earth fault or, as three functions are included, also as differential protection on autotransformers, as differential protection for a tertiary connected reactor, as T-differential protection for the transformer feeder in a mesh-corner or ring arrangement, as tertiary bus protection etc.

Tripping from Pressure relief / Buchholz and temperature devices can be done through the IED where pulsing, lock-out etc. is performed. The binary inputs are heavily stabilized against disturbance to prevent incorrect operations at e.g. dc system capacitive discharges.

Distance protection functionality for phase to phase and/or phase to earth faults is available as back-up protection for faults within the transformer and in the connected power system.

Versatile phase, earth, positive, negative and zero sequence overcurrent functions, which can optionally be made directional and/or voltage controlled, provide further alternative backup protection. Thermal overload, volts per hertz, over/under voltage and over/under frequency protection functions are also available.

Built-in disturbance and event recorder provides valuable data to the user about status and operation for post-fault disturbance analysis.

Breaker failure protection for each transformer breaker allow high speed back-up tripping of surrounding breakers.

The IED can also be provided with a full control and interlocking functionality including Synchro-

check function to allow integration of the main or a local back-up control.

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

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

The wide application flexibility makes this product an excellent choice for both new installations and the refurbishment of existing installations.

Functionality

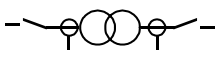
Differential protection

Transformer differential protection (PDIF, 87T)

The REx 670 differential function for two winding and three winding transformers is provided with internal CT ratio matching and vector group compensation, when required zero sequence current elimination is 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 REx 670 suitable for two- or three winding transformers in multi-breaker station arrangements.

2-winding applications



2-winding power transformer

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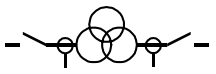

2-winding power transformer with unconnected delta tertiary winding

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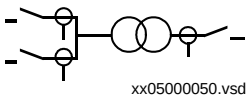

2-winding power transformer with 2 circuit breakers on one side

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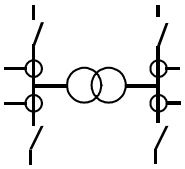

2-winding power transformer with 2 circuit breakers and 2 CT-sets on both sides

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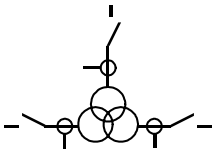
3-winding applications



3-winding power transformer with all three windings connected

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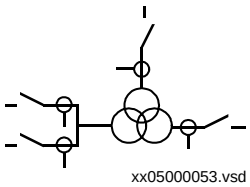

3-winding power transformer with 2 circuit breakers and 2 CT-sets on one side

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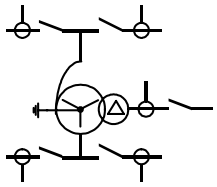

Autotransformer with 2 circuit breakers and 2 CT-sets on 2 out of 3 sides

xx05000057.vsd

Figure 1: CT group arrangement for differential protection and other protections

The setting facilities cover for applications of the differential protection to all types of power transformers and autotransformers with or without on-load tap-changer as well as for shunt reactor or and local feeder within the station. An adaptive stabilizing feature is included for heavy through-faults. By introducing the tap changer position, the differential protection pick-up can be set to optimum sensitivity 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.

High impedance differential protection (PDIF, 87)

The high impedance differential protection 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 relay.

Restricted earth fault protection (PDIF, 87N)

The function can be used on all directly or low impedance earthed windings. The restricted earth fault function can provide higher sensitivity (down to 5%) and higher speed as it measures individually on each winding and thus do not need harmonics 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 IED's on the same cores.

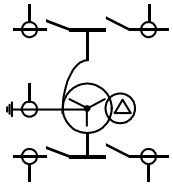

Figure 2: Autotransformer low-impedance REF

Impedance protection

Distance measuring zones, quadrilateral characteristic (PDIS, 21)

The line distance protection is a zone full scheme protection with three fault loops for phase to phase faults and three fault loops for phase to earth fault for each of the independent zones. Individual settings for each zone in resistive and reactive reach gives flexibility for use on overhead lines and cables.

Mho alternative Quad characteristic is available.

The function has a functionality for load encroachment which increases the possibility to detect high resistive faults on heavily loaded lines (see figure 3).

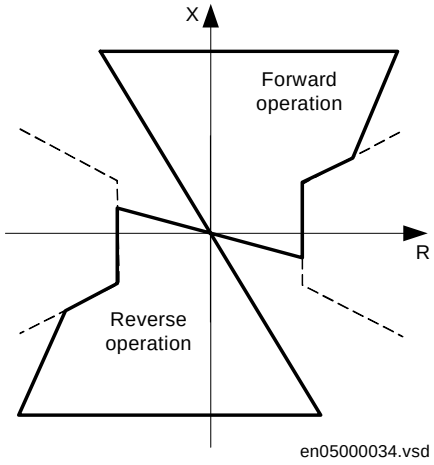

Figure 3: Typical quadrilateral distance protection zone with load encroachment function activated

The distance protection zones can operate, independent of each other, in directional (forward or reverse) or non-directional mode.

Full-scheme distance measuring, Mho characteristic, PDIS 21

The numerical mho line distance protection is a five zone full scheme protection for back-up detection of short circuit and earth faults. The full scheme technique provides back-up protection of power lines with high sensitivity and low requirement on remote end communication. The four zones have fully independent measuring and settings which gives high flexibility for all types of lines.

The modern technical solution offers fast operating time down to $^{3}/_{4}$ cycles.

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

Phase selection with load encroachment (PDIS, 21)

The operation of transmission networks today is in many cases close to the stability limit. Due to environmental considerations the rate of expansion and reinforcement of the power system is reduced e.g. difficulties to get permission to build new power lines. The ability to accurately and reliable classify the different types of fault so that single pole tripping and auto-reclosing can be used plays an important roll in this matter. The phase selection function is designed to accurately select the proper fault loop in the distance function dependent on the fault type.

The heavy load transfer that is common in many transmission networks may make fault resistance coverage difficult to achieve. Therefore the function has a built in algorithm for load encroach-

ment, which gives the possibility to enlarge the resistive setting of both the phase selection and the measuring zones without interfering with the load.

The extensive output signals from the phase selection gives also important information about faulty phase(s) which can be used for fault analysis.

Full scheme distance protection, quadrilateral for Mho

The line distance protection is a five zone protection with three fault loops for phase to earth fault for each of the independent zones. Individual settings for each zone resistive and reactive reach gives flexibility for use on overhead lines and cables of different types and lengths.

The function has a functionality for load encroachment which increases the possibility to detect high resistive faults on heavily loaded lines (see figure 3).

The independent measurement of impedance for each fault loop together with a sensitive and reliable built in phase selection makes the function suitable in applications with single phase auto-reclosing.

The distance protection zones can operate, independent of each other, in directional (forward or reverse) or non-directional mode. This makes them suitable, together with different communication schemes, for the protection of power lines and cables in complex network configurations, such as parallel lines, multi-terminal lines etc.

Directional impedance Mho (RDIR)

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).

Faulty phase identification with load enchroachment (PDIS, 21)

The operation of transmission networks today is in many cases close to the stability limit. Due to environmental considerations the rate of expansion and reinforcement of the power system is reduced e.g. difficulties to get permission to build new power lines. The ability to accurate and reliable classifying the different types of fault so that single pole tripping and auto-reclosing can be used plays an important roll in this matter. The phase selection function is design to accurate select the proper fault loop in the distance function dependent on the fault type.

The heavy load transfer that is common in many transmission networks may in some cases interfere with the distance protection zone reach and cause unwanted operation. Therefore the function has a built in algorithm for load encroachment, which gives the possibility to enlarge the resistive setting of the measuring zones without interfering with the load.

The output signals from the phase selection function produce important information about faulty phase(s) which can be used for fault analysis as well.

Power swing detection (RPSB, 78)

Power swings may occur after disconnection of heavy loads or trip of big generation plants.

Power swing detection function is used to detect power swings and initiate block of selected distance protection zones. Occurrence of earth fault currents during a power swing can block the power swing detection function to allow fault clearance.

Power swing logic (RPSL, 78)

Additional logic is available to secure tripping for faults during power swings and prevent tripping at power swings started by a fault in the network.

Current protection

Instantaneous phase overcurrent protection (PIOC, 50)

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, with the reach limited to less than typical eighty percent of the fault current at minimum source impedance.

Four step phase overcurrent protection (POCM, 51/67)

The four step phase overcurrent function 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 time characteristic.

The function can be set to be directional or non-directional independently for each of the steps.

Instantaneous residual overcurrent protection (PIOC, 50N)

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

Four step residual overcurrent protection (PTOC, 51N/67N)

The four step residual single input overcurrent function 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.

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

The function can be used as main protection for phase to earth faults.

The function can be used to provide a system back-up e.g. in the case of the primary protection being out of service due to communication or voltage transformer circuit failure.

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

The function 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 (PSDE, 67N)

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

Thermal overload protection, two time constants (PTTR, 49)

If the temperature of a power transformer/generator reaches too 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 (RBRF, 50BF)

The circuit breaker failure function ensures fast back-up tripping of surrounding breakers. The breaker failure protection operation can be current based, contact based or adaptive combination between these two principles.

A current check with extremely short reset time is used as a check criteria to achieve a high security against unnecessary operation.

The breaker failure protection can be single- or three-phase initiated to allow use with single phase tripping applications. For the three-phase version of the breaker failure protection the current criteria can be set to operate only if two out of four e.g. two phases or one phase plus the residual current starts. This gives a higher security to the back-up trip command.

The 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 (RPLD, 52PD)

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 the positions. If the situation consists the remote end can be intertripped to clear the unsymmetrical load situation.

The pole discordance function 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 (PDOP, 32) and (PDUP, 37)

These two functions can be used wherever a high/low active, reactive or apparent power protection or alarming is required. Alternatively they can 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.

Broken conductor check

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

Voltage protection

Two step undervoltage protection (PTUV, 27)
Undervoltages can occur in the power system during faults or abnormal conditions. The 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.

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

Two step overvoltage protection (PTOV, 59)
Overvoltages will occur in the power system during abnormal conditions such as sudden power loss, tap changer regulating failures, open line ends on long lines.

The function 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.

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

The overvoltage function has an extremely high reset ratio to allow setting close to system service voltage.

Two step residual overvoltage protection (PTOV, 59N)
Residual voltages will occur in the power system during earth faults.

The function can be configured to calculate 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.

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

Overexcitation protection (PVPH, 24)
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. Function has settable inverse operating curve and independent alarm stage.

Voltage differential protection (PTOV, 60)
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.

Loss of voltage check (PTUV, 27)
The loss of voltage detection, (PTUV, 27), is suitable for use in networks with an automatic System restoration function. The function issues a three-pole trip command to the circuit breaker, if all three phase voltages fall below the set value for a time longer the set time and the circuit breaker remains closed.

Frequency protection

Underfrequency protection (PTUF, 81)
Underfrequency occurs as a result of lack of generation in the network.

The function can be used for load shedding systems, remedial action schemes, gas turbine start-up etc.

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

Overfrequency protection (PTOF, 81)
Overfrequency will occur at sudden load drops or shunt faults in the power network. In some cases close to generating part governor problems can also cause overfrequency.

The function can be used for generation shedding, remedial action schemes etc. It can also be used as a sub-nominal frequency stage initiating load restoring.

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

Rate-of-change frequency protection (PFRC, 81)
Rate of change of frequency function gives an early indication of a main disturbance in the system.

The function can be used for generation shedding, load shedding, remedial action schemes etc.

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

Each step can discriminate between positive or negative change of frequency.

Multipurpose protection

General current and voltage protection (GAPC)

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 is typically required.

Secondary system supervision

Current circuit supervision (RDIF)

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 occurring open CT circuit will mean that the situation will remain and extremely high voltages will stress the secondary circuit.

The current circuit supervision function 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 du/dt-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 (RSYN, 25)

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 auto-reclose or manual closing which improves the network stability.

The synchrocheck 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.

The function includes a built-in voltage selection scheme for double bus and one- and a half 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.

Voltage control (VCTR)

The voltage control function is used for control of power transformers with a motor driven on-load tap changer. The function provides automatic regulation of the voltage on the secondary side of trans-

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

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

Logic rotating switch for function selection and LHMI presentation (SLGGIO)

The SLGGIO function block (or the selector switch function block) is used within the CAP tool in order 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)

The VSGGIO function block (or the versatile switch function block) is a multipurpose function used within the CAP tool for a variety of applications, as a general – purpose switch.

The switch can be controlled from the menu or from a symbol on the SLD of the LHMI.

Single point generic control 8 signals (SPC8GGIO)

The SC function block is a collection of 8 single point commands, designed to bring in commands from REMOTE (SCADA) or LOCAL (HMI) 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.

Scheme communication

Scheme communication logic for residual overcurrent protection (PSCH, 85)

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

In the directional scheme, information of the fault current direction must be transmitted to the other line end. With directional comparison, an operate time of the protection of 50 – 60 ms including a channel transmission time of 20 ms, can be achieved. This short operate time enables rapid autoreclosing function after the fault clearance.

The communication logic module for directional residual current protection enables blocking as well as permissive under/overreach schemes.

Current reversal and weak-end infeed logic for residual overcurrent protection (PSCH, 85)

The EFCA additional communication logic is a supplement to the EFC scheme communication logic for the residual overcurrent protection.

To achieve fast fault clearing for all earth faults on the line, the directional earth-fault protection function can be supported with logic, that uses communication channels. REx 670 terminals have for this reason available additions to scheme communication logic.

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

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

Logic

Tripping logic (PTRC, 94)
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 (GGIO)
Twelve trip matrix logic blocks are included in the IED. The function blocks are used in the configuration of the IED to route trip signals and/or other logical output signals to the different output relays.

The matrix and the physical outputs will be seen in the PCM 600 engineering tool 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.

Fixed signal function block
The fixed signals function block 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 the other function blocks to a certain level/value, or for creating a certain logic.

Monitoring

Measurements (MMXU)
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 (GGIO)
The function consists of six counters which are used for storing the number of times each counter input has been activated.

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

The disturbance report, always included in the IED, acquires sampled data of all selected analog input and binary signals connected to the function block i.e. maximum 40 analog and 96 binary signals.

The disturbance report functionality is a common name for several functions:

- Event List (EL)
- Indications (IND)
- Event recorder (ER)
- Trip Value recorder (TVR)
- Disturbance recorder (DR)

The 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 DRAx or DRBy 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 Human Machine Interface (LHMI) is used to get information about the recordings, but the disturbance report files may be uploaded to the PCM 600 (Protection and Control IED Manager) and further analysis using the disturbance handling tool.

Event list (RDRE)

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 (RDRE)

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

There are three LEDs on the LHMI (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 (RDRE)

Quick, complete and reliable information about disturbances in the primary and/or in the secondary system is vital e.g. time tagged events logged during disturbances. This information is used for different purposes in the short term (e.g. corrective actions) and in the long term (e.g. 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 (RDRE)

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 (RDRE)

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 (e.g. corrective actions) and long perspective (e.g. 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 Human Machine Interface (LHMI) is used to view the list of recordings.

Event function (EV)

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 block. The event function block is used for LON and SPA communication.

Analog and double indication values are also transferred through the event block.

Measured value expander block

The functions MMXU (SVR, CP and VP), MSQI (CSQ and VSQ) and MVGGIO (MV) are provided with measurement supervision functionality. All measured values can be supervised with four settable limits, i.e. low-low limit, low limit, high limit and high-high limit. The measure value expander block (XP) has been introduced to be able to translate the integer output signal from the measuring functions to 5 binary signals i.e. 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 (GGIO)

The pulse counter logic 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.

Energy metering and demand handling (MMTR)

Outputs from measurement function (MMXU) can be used to calculate energy. Active as well as reactive values are calculated in import respectively 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 SA system possible.

Human machine interface

The local human machine interface is available in a small, and a medium sized model. The principle difference between the two is the size of the LCD. The small size LCD can display seven line of text and the medium size LCD can display the single line diagram with up to 15 objects on each page.

Up to 12 SLD pages can be defined, depending on the product capability.

The local human machine interface is equipped with an LCD that can display the single line diagram with up to 15 objects.

The local human-machine interface is simple and easy to understand – the whole front plate is divided into zones, each of them with a well-defined functionality:

- Status indication LEDs
- Alarm indication LEDs which consists of 15 LEDs (6 red and 9 yellow) with user printable label. All LEDs are configurable from the PCM 600 tool
- Liquid crystal display (LCD)
- Keypad with push buttons for control and navigation purposes, switch for selection between local and remote control and reset
- An isolated RJ45 communication port

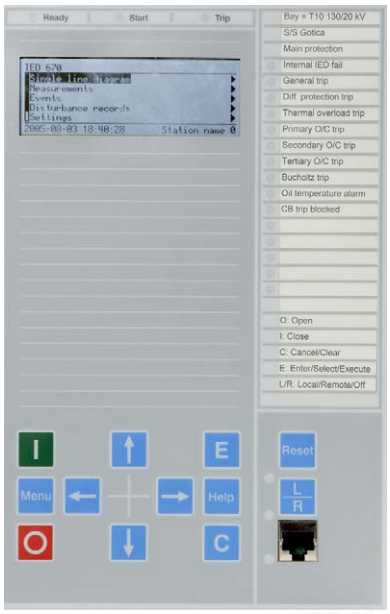

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Figure 4: Small graphic HMI

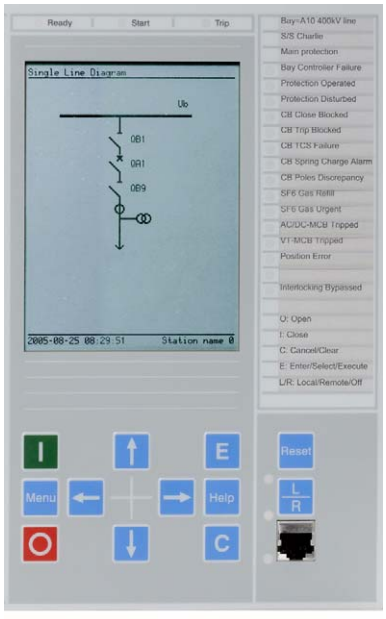

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Figure 5: Medium graphic HMI, 15 controllable objects

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.

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 human-machine interface, LHMI. 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 <90 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.

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

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 modules (BOM)
The binary output module has 24 independent output relays and is used for trip output or any signalling 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. 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.

Line data communication module (LDCM)
The line data communication module is used for binary signal transfer. 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 (900 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 termnals.

Layout and dimensions

Dimensions

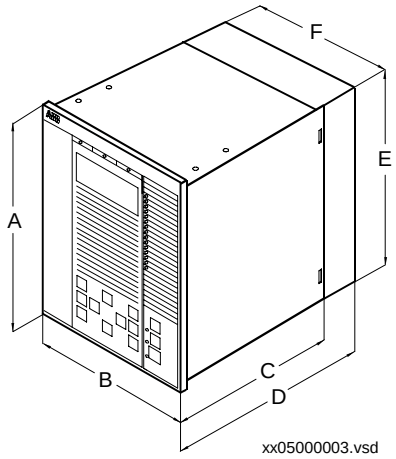


Figure 6: 1/2 x 19” case with rear cover

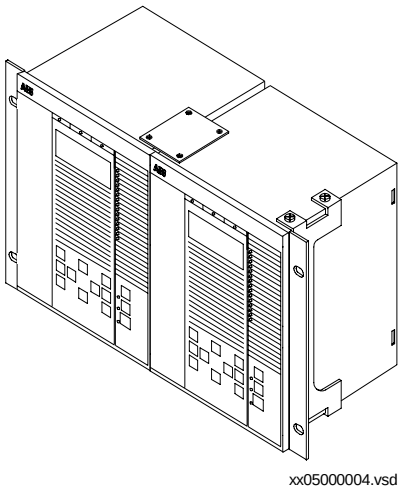


Figure 7: Side-by-side mounting

Case size	A	B	C	D	E	F
6U, 1/2 x 19”	265.9	223.7	201.1	242.1	252.9	205.7
6U, 3/4 x 19”	265.9	336.0	201.1	242.1	252.9	318.0
6U, 1/1 x 19”	265.9	448.1	201.1	242.1	252.9	430.3
						(mm)

Mounting alternatives

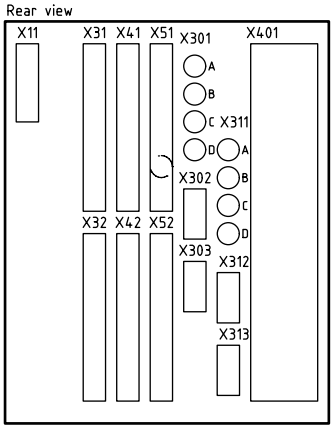
Following mounting alternatives (IP40 protection from the front) are available:

- 19” rack mounting kit
- Flush mounting kit with cut-out dimensions:
  - 1/2 case size (h) 254.3 mm (w) 210.1 mm
  - 3/4 case size (h) 254.3 mm (w) 322.4 mm
  - 1/1 case size (h) 254.3 mm (w) 434.7 mm
- Wall mounting kit

See ordering for details about available mounting alternatives.

Connection diagrams

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



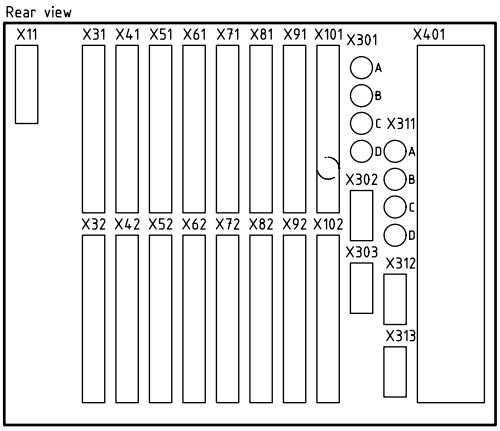
Module	Rear Positions
PSM	X11
BIM, BOM, SOM or IOM	X31 and X32 etc. to X51 and X52
BIM, BOM, SOM, IOM or GSM	X51, X52
SLM	X301:A, B, C, D
IRIG-B 1)	X302
OEM	X311:A, B, C, D
RS485 or LDCM 2) 3)	X312
LDCM 2)	X313
TRM	X401

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 3/4 x 19” casing with 1 TRM slot



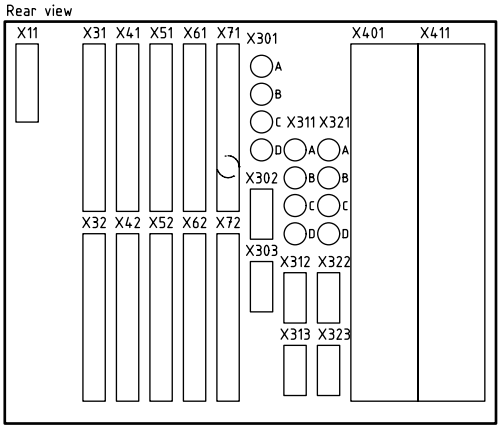
Module	Rear Positions
PSM	X11
BIM, BOM, SOM, IOM or MIM	X31 and X32 etc. to X101 and X102
BIM, BOM, SOM, IOM, MIM or GSM	X101, X102
SLM	X301:A, B, C, D
IRIG-B or LDCM 1) 2)	X302
LDCM 2)	X303
OEM	X311:A, B, C, D
RS485 or LDCM 2) 3)	X312
LDCM 2)	X313
TRM	X401

1) IRIG-B installation, when included in seat P30:2
2) LDCM installation sequence: P31:2, P31:3, P30:2 and P30:3
3) RS482 installation, when included in seat P31:2

Note!

2-4 LDCM can be included depending of availability of IRIG-B respective RS485 modules.

Table 3: Designations for 3/4 x 19” casing with 2 TRM slot



Module	Rear Positions
PSM	X11
BIM, BOM, SOM, IOM or MIM	X31 and X32 etc. to X71 and X72
BIM, BOM, SOM, IOM, MIM or GSM	X71, X72
SLM	X301:A, B, C, D
IRIG-B or LDCM 1,2)	X302
LDCM 2)	X303
OEM	X311:A, B, C, D
RS485 or LDCM 2) 3)	X312
LDCM 2)	X313
LDCM 2)	X322
LDCM 2)	X323
TRM 1	X401
TRM 2	X411

1) IRIG-B installation, when included in seat P30:2

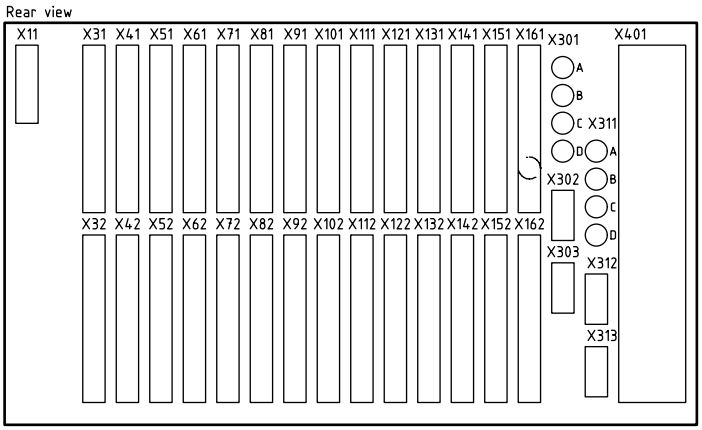
2) LDCM installation sequence: P31:2, P31:3, P32:2, P32:3, P30:2 and P30:3

3) RS485 installation, when included in seat P31:2

Note!

2-4 LDCM can be included depending of availability of IRIG-B respective RS485 modules.

Table 4: Designations for 1/1 x 19” casing with 1 TRM slot



Module	Rear Positions
PSM	X11
BIM, BOM, SOM, IOM or MIM	X31 and X32 etc. to X161 and X162
BIM, BOM, SOM, IOM, MIM or GSM	X161, X162
SLM	X301:A, B, C, D
IRIG-B or LDCM 1,2)	X302
LDCM 2)	X303
OEM	X311:A, B, C, D
RS485 or LDCM 2) 3)	X312
LDCM 2)	X313
TRM	X401

1) IRIG-B installation, when included in seat P30:2

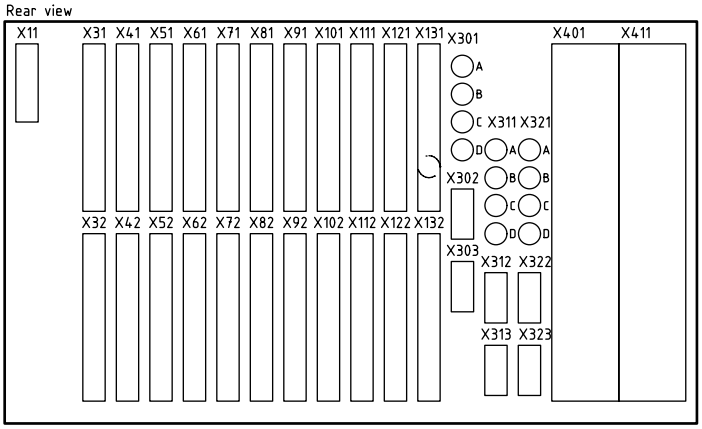
2) LDCM installation sequence: P31:2, P31:3, P30:2 and P30:3

3) RS485 installation, when included in seat P31:2

Note!

2-4 LDCM can be included depending of availability of IRIG-B respective RS485 modules.

Table 5: Designations for 1/1 x 19” casing with 2 TRM slots



Module	Rear Positions
PSM	X11
BIM, BOM, SOM, IOM or MIM	X31 and X32 etc. to X131 and X132
BIM, BOM, SOM, IOM, MIM or GSM	X131, X132
SLM	X301:A, B, C, D
IRIG-B or LDCM 1,2)	X302
LDCM 2)	X303
OEM	X311:A, B, C, D
RS485 or LDCM 2) 3)	X312
LDCM 2)	X313
LDCM 2)	X322
LDCM 2)	X323
TRM 1	X401
TRM 2	X411

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

Note!

2-4 LDCM can be included depending of availability of IRIG-B respective RS485 modules.

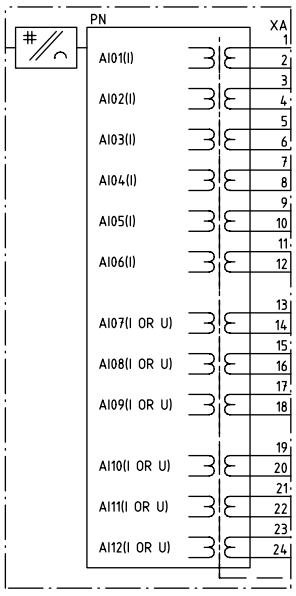


Figure 8: Transformer input module (TRM)

	CT/VT-input designation according to figure 8											
Current/voltage configuration (50/60 Hz)	AI01	AI02	AI03	AI04	AI05	AI06	AI07	AI08	AI09	AI10	AI11	AI12
12I, 1A	1A	1A	1A	1A	1A	1A	1A	1A	1A	1A	1A	1A
12I, 5A	5A	5A	5A	5A	5A	5A	5A	5A	5A	5A	5A	5A
9I and 3U, 1A	1A	1A	1A	1A	1A	1A	1A	1A	1A	110-220V	110-220V	110-220V
9I and 3U, 5A	5A	5A	5A	5A	5A	5A	5A	5A	5A	110-220V	110-220V	110-220V
5I, 1A and 4I, 5A and 3U	1A	1A	1A	1A	1A	5A	5A	5A	5A	110-220V	110-220V	110-220V
7I and 5U, 1A	1A	1A	1A	1A	1A	1A	1A	110-220V	110-220V	110-220V	110-220V	110-220V
7I and 5U, 5A	5A	5A	5A	5A	5A	5A	5A	110-220V	110-220V	110-220V	110-220V	110-220V
6I and 6U, 1A	1A	1A	1A	1A	1A	1A	110-220V	110-220V	110-220V	110-220V	110-220V	110-220V
6I and 6U, 5A	5A	5A	5A	5A	5A	5A	110-220V	110-220V	110-220V	110-220V	110-220V	110-220V
5I+1I+6U	5A	5A	5A	5A	5A	5A	110-220V	110-220V	110-220V	110-220V	110-220V	110-220V
6I, 1A	1A	1A	1A	1A	1A	1A	-	-	-	-	-	-
6I, 5A	5A	5A	5A	5A	5A	5A	-	-	-	-	-	-

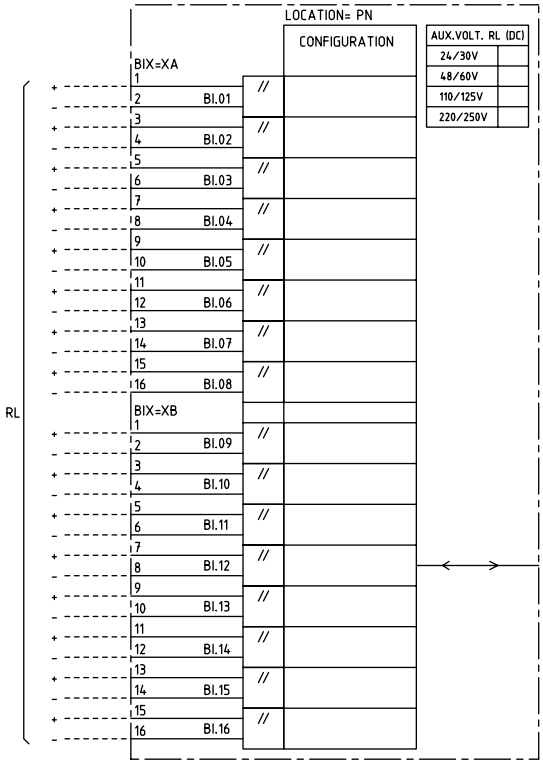


Figure 9: Binary input module (BIM). Input contacts named XA corresponds to rear position X31, X41, etc. and input contacts named XB to rear position X32, X42, etc.

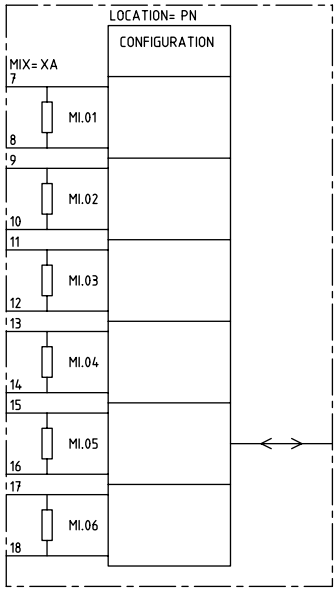


Figure 10: mA input module (MIM)

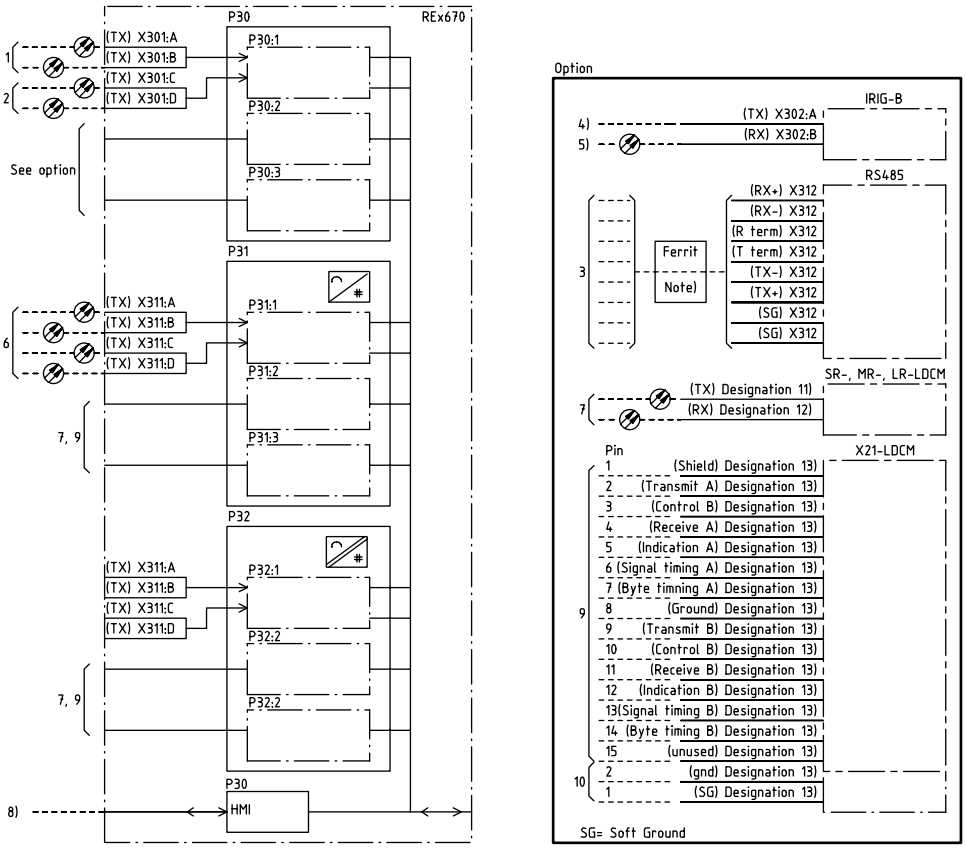


Figure 11: Communication interfaces (OEM, LDCM, SLM and HMI)

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 prot IEC 61850, ST-connector
7) Rear communication port C37.94, ST-connector
8) Front communication port Ethernet, RJ45 connector
9) Rear communication port 15-pole female mini D-sub
10) Rear communication port, terminal block

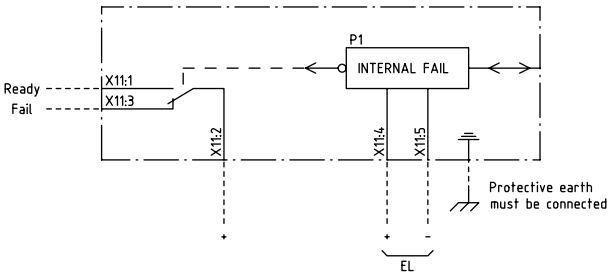


Figure 12: Power supply module (PSM)

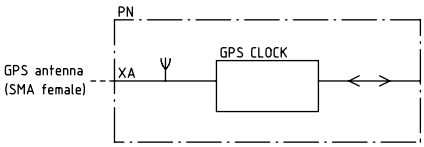


Figure 13: GPS time synchronization module (GSM)

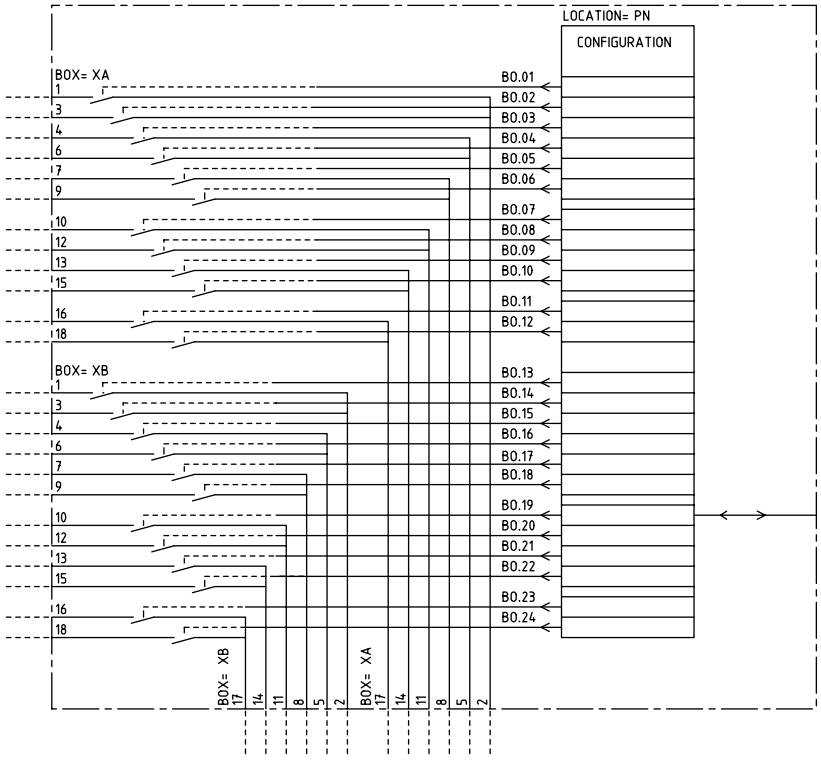


Figure 14: Binary output module (BOM). Output contacts named XA corresponds to rear position X31, X41, etc. and output contacts named XB to rear position X32, X42, etc.

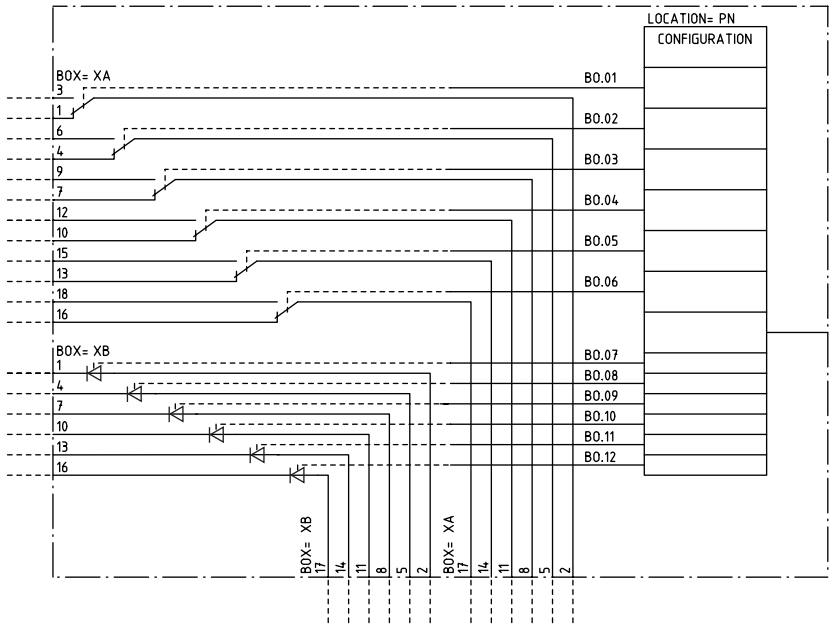


Figure 15: Static output module (SOM)

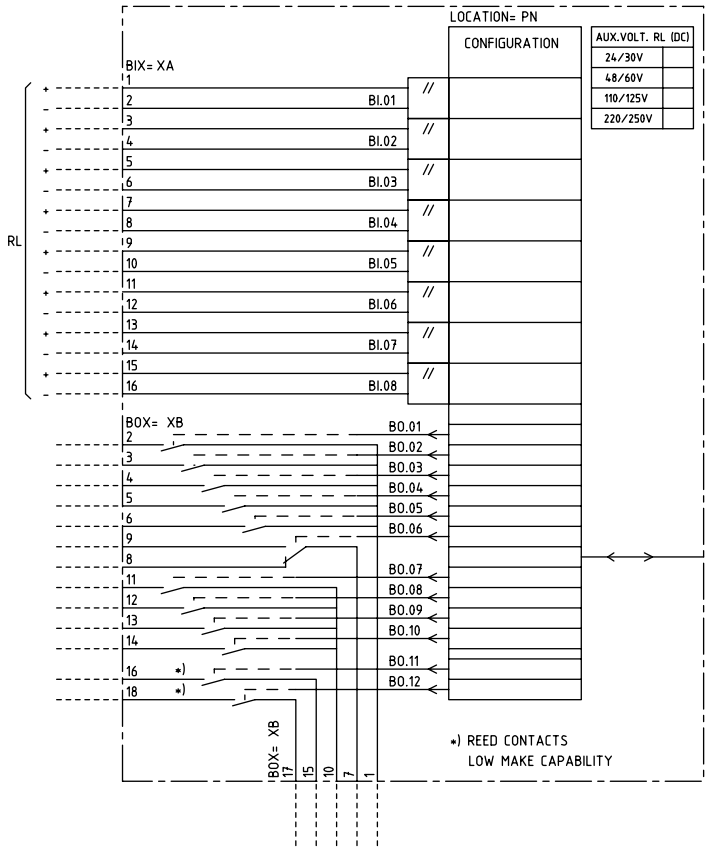


Figure 16: Binary in/out module (IOM). Input contacts named XA corresponds to rear position X31, X41, etc. and output contacts named XB to rear position X32, X42, etc.

Technical data

General

Definitions

Reference value:

The specified value of an influencing factor to which are referred the characteristics of the equipment.

Nominal range:

The range of values of an influencing quantity (factor) within which, under specified conditions, the equipment meets the specified requirements.

Operative range:

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.

Energizing quantities, rated values and limits

Analog inputs

Table 6: TRM - Energizing quantities, rated values and limits

Quantity	Rated value	Nominal range
Current	I_r = 1 or 5 A	(0.2-40) × I_r
Operative range	(0-100) x I_r	
Permissive overload	4 × I_r cont.	
	100 × I_r for 1 s *)	
Burden	< 150 mVA at I_r = 5 A	
	< 20 mVa at I_r = 1 A	
Ac voltage	U_r = 110 V	0.5–288 V
Operative range	(0–340) V	
Permissive overload	420 V cont.	
	450 V 10 s	
Burden	< 0.1 VA at 110 V	
Frequency	f_r = 50/60 Hz	± 5%
*) max. 350 A for 1 s when COMBITEST test switch is included.		

Table 7: MIM - mA input module

Quantity:	Rated value:	Nominal range:
Input range	± 5, ± 10, ± 20mA	-
	0-5, 0-10, 0-20, 4-20mA	
Input resistance	R_{in} = 194 Ohm	-
Power consumption		-
each mA-board	≤ 4 W	
each mA input	≤ 0.1 W	

Table 8: OEM - Optical ethernet module

Quantity	Rated value
Number of channels	1 or 2
Standard	IEEE 802.3u 100BASE-FX
Type of fiber	62.5/125 μm multimode fibre
Wave length	1300 nm
Optical connector	Type ST
Communication speed	Fast Ethernet 100 MB

Auxiliary DC voltage

Table 9: PSM - Power supply module

Quantity	Rated value	Nominal range
Auxiliary dc voltage, EL (input)	EL = (24 - 60) V	EL ± 20%
	EL = (90 - 250) V	EL ± 20%
Power consumption	50 W typically	-
Auxiliary DC power in-rush	< 5 A during 0.1 s	-

Binary inputs and outputs

Table 10: BIM - Binary input module

Quantity	Rated value	Nominal range
Binary inputs	16	-
DC voltage, RL	24/40 V	RL ± 20%
	48/60 V	RL ± 20%
	110/125 V	RL ± 20%
	220/250 V	RL ± 20%
Power consumption		
24/40 V	max. 0.05 W/input	-
48/60 V	max. 0.1 W/input	
110/125 V	max. 0.2 W/input	
220/250 V	max. 0.4 W/input	
Counter input frequency	10 pulses/s max	-
Oscillating signal discriminator	Blocking settable 1–40 Hz	
	Release settable 1–30 Hz	

Table 11: BIM - Binary input module with enhanced pulse counting capabilities

Quantity	Rated value	Nominal range
Binary inputs	16	-
DC voltage, RL	24/40 V	RL ± 20%
	48/60 V	RL ± 20%
	110/125 V	RL ± 20%
	220/250 V	RL ± 20%
Power consumption		
24/40 V	max. 0.05 W/input	-
48/60 V	max. 0.1 W/input	
110/125 V	max. 0.2 W/input	
220/250 V	max. 0.4 W/input	
Counter input frequency	10 pulses/s max	-
Balanced counter input frequency	40 pulses/s max	-
Oscillating signal discriminator	Blocking settable 1–40 Hz	
	Release settable 1–30 Hz	

Table 12: IOM - Binary input/output module

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

Table 13: IOM - Binary input/output module contact data (reference standard: IEC 61810-2)

Function or quantity	Trip and signal relays	Fast signal relays (parallel reed relay)
Binary outputs	10	2
Max system voltage	250 V AC, DC	250 V AC, DC
Test voltage across open contact, 1 min	1000 V rms	800 V DC
Current carrying capacity		
Continuous	8 A	8 A
1 s	10 A	10 A
Making capacity at inductive load with L/R>10 ms		
0.2 s	30 A	0.4 A
1.0 s	10 A	0.4 A

Function or quantity	Trip and signal relays	Fast signal relays (parallel reed relay)
Breaking capacity for AC, cos φ > 0.4	250 V/8.0 A	250 V/8.0 A
Breaking capacity for DC with L/R < 40 ms	48 V/1 A 110 V/0.4 A 125 V/0.35 A 220 V/0.2 A 250 V/0.15 A	48 V/1 A 110 V/0.4 A 125 V/0.35 A 220 V/0.2 A 250 V/0.15 A
Maximum capacitive load	-	10 nF

Table 14: BOM - Binary output module contact data (reference standard: IEC 61810-2)

Function or quantity	Trip and Signal relays
Binary outputs	24
Max system voltage	250 V AC, DC
Test voltage across open contact, 1 min	1000 V rms
Current carrying capacity Continuous 1 s	 8 A 10 A
Making capacity at inductive load with L/R>10 ms 0.2 s 1.0 s	 30 A 10 A
Breaking capacity for AC, cos φ>0.4	250 V/8.0 A
Breaking capacity for DC with L/R < 40 ms	48 V/1 A 110 V/0.4 A 125 V/0.35 A 220 V/0.2 A 250 V/0.15 A

Influencing factors

Table 15: Temperature and humidity influence

Parameter	Reference value	Nominal range	Influence
Ambient temperature, operate value	+20 °C	-10 °C to +55 °C	0.02% /°C
Relative humidity Operative range	10%-90% 0%-95%	10%-90%	-
Storage temperature	-40 °C to +70 °C	-	-

Table 16: Auxiliary DC supply voltage influence on functionality during operation

Dependence on	Reference value	Within nominal range	Influence
Ripple, in DC auxiliary voltage Operative range	max. 2% Full wave rectified	12% of EL	0.01% /%
Auxiliary voltage dependence, operate value		± 20% of EL	0.01% /%
Interrupted auxiliary DC voltage Interruption interval 0–50 ms 0–∞ s Restart time		24-60 V DC ± 20% 90-250 V DC ± 20%	 No restart Correct behaviour at power down <180 s

Table 17: Frequency influence (reference standard: IEC 60255–6)

Dependence on	Within nominal range	Influence
Frequency dependence, operate value	f_r ± 2.5 Hz for 50 Hz f_r ± 3.0 Hz for 60 Hz	± 1.0% / Hz
Harmonic frequency dependence (20% content)	2nd, 3rd and 5th harmonic of f_r	± 1.0%
Harmonic frequency dependence for distance protection (10% content)	2nd, 3rd and 5th harmonic of f_r	± 6.0%

Type tests according to standards

Table 18: Electromagnetic compatibility

Test	Type test values	Reference standards
1 MHz burst disturbance	2.5 kV	IEC 60255-22-1, Class III
100 kHz disturbance	2.5 kV	IEC 61000-4-12, Class III
Surge withstand capability test	2.5 kV, oscillatory 4.0 kV, fast transient	ANSI/IEEE C37.90.1
Electrostatic discharge Direct applicaton Indirect application	15 kV air discharge 8 kV contact discharge 8 kV contact discharge	IEC 60255-22-2, Class IV IEC 61000-4-2, Class IV
Electrostatic discharge Direct application Indirect application	15 kV air discharge 8 kV contact discharge 8 kV contact discharge	ANSI/IEEE C37.90.1
Fast transient disturbance	4 kV	IEC 60255-22-4,Class A
Surge immunity test	1-2 kV, 1.2/50 μs high energy	IEC 60255-22-5
Power frequency immunity test	150-300 V, 50 Hz	IEC 60255-22-7, Class A
Power frequency magnetic field test	1000 A/m, 3 s	IEC 61000-4-8, Class V
Radiated electromagnetic field disturbance	20 V/m, 80-1000 MHz	IEC 60255-22-3
Radiated electromagnetic field disturbance	20 V/m, 80-2500 MHz	EN 61000-4-3
Radiated electromagnetic field disturbance	35 V/m 26-1000 MHz	IEEE/ANSI C37.90.2
Conducted electromagnetic field disturbance	10 V, 0.15-80 MHz	IEC 60255-22-6
Radiated emission	30-1000 MHz	IEC 60255-25
Conducted emission	0.15-30 MHz	IEC 60255-25

Table 19: Insulation

Test	Type test values	Reference standard
Dielectric test	2.0 kV AC, 1 min.	IEC 60255-5
Impulse voltage test	5 kV, 1.2/50 μs, 0.5 J	
Insulation resistance	>100 MΩ at 500 VDC	

Table 20: Environmental tests

Test	Type test value	Reference standard
Cold test	Test Ad for 16 h at -25°C	IEC 60068-2-1
Storage test	Test Ad for 16 h at -40°C	IEC 60068-2-1
Dry heat test	Test Bd for 16 h at +70°C	IEC 60068-2-2
Damp heat test, steady state	Test Ca for 4 days at +40 °C and humidity 93%	IEC 60068-2-78
Damp heat test, cyclic	Test Db for 6 cycles at +25 to +55 °C and humidity 93 to 95% (1 cycle = 24 hours)	IEC 60068-2-30

Table 21: CE compliance

Test	According to
Immunity	EN 50263
Emissivity	EN 50263
Low voltage directive	EN 50178

Table 22: Mechanical tests

Test	Type test values	Reference standards
Vibration	Class I	IEC 60255-21-1
Shock and bump	Class I	IEC 60255-21-2
Seismic	Class I	IEC 60255-21-3

Differential protection

Table 23: Transformer differential protection (PDIF, 87T)

Function	Range or value	Accuracy
Operating characteristic	Adaptable	± 2.0% of I_r for $I < I_r$ ± 2.0% of I for $I > I_r$
Reset ratio	> 95%	-
Unrestrained differential current limit	(100-5000)% of I_{base} on high voltage winding	± 2.0% of set value

Function	Range or value	Accuracy
Base sensitivity function	(10-60)% of I_{base}	± 2.0% of I_r
Second harmonic blocking	(5.0-100.0)% of fundamental	± 2.0% of I_r
Fifth harmonic blocking	(5.0-100.0)% of fundamental	± 5.0% of I_r
Connection type for each of the windings	Y-wye or D-delta	-
Phase displacement between high voltage winding, W1 and each of the windings, w2 and w3. Hour notation	0–11	-
Operate time, restrained function	25 ms typically at 0 to 2 x I_d	-
Reset time, restrained function	20 ms typically at 2 to 0 x I_d	-
Operate time, unrestrained function	12 ms typically at 0 to 5 x I_d	-
Reset time, unrestrained function	25 ms typically at 5 to 0 x I_d	-
Critical impulse time	2 ms typically at 0 to 5 x I_d	-

Table 24: Restricted earth fault protection, low impedance (PDIF, 87N)

Function	Range or value	Accuracy
Operate characteristic	Adaptable	± 2.0% of I_r for I < I_r ± 2.0% of I for I > I_r
Reset ratio	>95%	-
Base sensitivity function	(4.0-100.0)% of I_{base}	± 2.0% of I_r
Directional characteristic	Fixed 180 degrees or ± 60 to ± 90 degrees	± 2.0 degree
Operate time	20 ms typically at 0 to 10 x I_d	-
Reset time	25 ms typically at 10 to 0 x I_d	-
Second harmonic blocking	(5.0-100.0)% of fundamental	± 2.0% of I_r

Table 25: High impedance differential protection (PDIF, 87)

Function	Range or value	Accuracy
Operate voltage	(20-400) V	± 1.0% of U_r for U < U_r ± 1.0% of U for U > U_r
Reset ratio	>95%	-
Maximum continuous voltage	U>TripPickup^2/series resistor ≤200 W	-
Operate time	10 ms typically at 0 to 10 x U_d	-
Reset time	90 ms typically at 10 to 0 x U_d	-
Critical impulse time	2 ms typically at 0 to 10 x U_d	-

Impedance protection

Table 26: Distance measuring zone, Quad (PDIS, 21)

Function	Range or value	Accuracy
Number of zones	5 with selectable direction	-
Minimum operate current	(10-30)% of I_{base}	-
Positive sequence reactance	(0.50-3000.00) Ω/phase	± 2.0% static accuracy
Positive sequence resistance	(0.10-1000.00) Ω/phase	± 2.0 degrees static angular accuracy
Zero sequence reactance	(0.50-9000.00) Ω/phase	Conditions:
Zero sequence resistance	(0.50-3000.00) Ω/phase	Voltage range: (0.1-1.1) x U_r
Fault resistance, Ph-E	(1.00-9000.00) Ω/loop	Current range: (0.5-30) x I_r
Fault resistance, Ph-Ph	(1.00-3000.00) Ω/loop	Angle: at 0 degrees and 85 degrees
Dynamic overreach	<5% at 85 degrees measured with CCVT's and 0.5<SIR<30	-
Impedance zone timers	(0.000-60.000) s	± 0.5% ± 10 ms
Operate time	24 ms typically	-
Reset ratio	105% typically	-
Reset time	30 ms typically	-

Table 27: Full-scheme distance protection, Mho characteristic (PDIS, 21)

Function	Range or value	Accuracy
Number of zones with selectable directions	with selectable direction	-
Minimum operate current	(10–30)% of I_{Base}	-

Function	Range or value	Accuracy
Positive sequence impedance, phase–earth loop	(0.005–3000.000) Ω/phase	± 2.0% static accuracy 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
Positive sequence impedance angle, phase–earth loop	(10–90) degrees	
Reverse reach, phase–earth loop (Magnitude)	(0.005–3000.000) Ω/phase	
Impedance reach for phase–phase elements	(0.005–3000.000) Ω/phase	
Angle for positive sequence impedance, phase–phase elements	(10–90) degrees	
Reverse reach of phase–phase loop	(0.005–3000.000) Ω/phase	
Magnitude of earth return compensation factor KN	(0.00–3.00)	
Angle for earth compensation factor KN	(-180–180) degrees	
Dynamic overreach	<5% at 85 degrees measured with CVT's and 0.5<SIR<30	-
Timers	(0.000-60.000) s	± 0.5% ± 10 ms
Operate time	15 ms typically (with static outputs)	-
Reset ratio	105% typically	-
Reset time	30 ms typically	-

Table 28: Full-scheme distance protection, quadrilateral for mho

Function	Range or value	Accuracy
Number of zones	with selectable direction	-
Minimum operate current	(10-30)% of I_{base}	-
Positive sequence reactance	(0.50-3000.00) Ω/phase	± 2.0% static accuracy ± 2.0 degrees static angular accuracy 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
Positive sequence resistance	(0.10-1000.00) Ω/phase	
Zero sequence reactance	(0.50-9000.00) Ω/phase	
Zero sequence resistance	(0.50-3000.00) Ω/phase	
Fault resistance, Ph-E	(1.00-9000.00) Ω/loop	
Dynamic overreach	<5% at 85 degrees measured with CCVT's and 0.5<SIR<30	-
Impedance zone timers	(0.000-60.000) s	± 0.5% ± 10 ms
Operate time	24 ms typically	-
Reset ratio	105% typically	-
Reset time	30 ms typically	-

Table 29: Phase selection with load encroachment, quadrilateral characteristic (PDIS, 21)

Function	Range or value	Accuracy
Minimum operate current	(5-30)% of I_{base}	± 1.0% of I_r
Reactive reach, positive sequence, forward and reverse	(0.50–3000.00) Ω/phase	± 2.0% static accuracy ± 2.0 degrees static angular accuracy 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
Resistive reach, positive sequence	(0.10–1000.00) Ω/phase	
Reactive reach, zero sequence, forward and reverse	(0.50–9000.00) Ω/phase	
Resistive reach, zero sequence	(0.50–3000.00) Ω/phase	
Fault resistance, phase-earth faults, forward and reverse	(1.00–9000.00) Ω/loop	
Fault resistance, phase-phase faults, forward and reverse	(0.50–3000.00) Ω/loop	
Load encroachment criteria: Load resistance, forward and reverse Safety load impedance angle	 (1.00–3000.00) Ω/phase (5-70) degrees	
Reset ratio	105% typically	-

Table 30: Faulty phase identification with load encroachment (PDIS, 21)

Function	Range or value	Accuracy
Minimum operate current	(5-30)% of I_{base}	± 1.0% of I_r
Load encroachment criteria: Load resistance, forward and reverse	(0.5–3000) Ω/phase (5–70) degrees	± 2.0% static accuracy Conditions: Voltage range: (0.1–1.1) x V_n Current range: (0.5–30) x I_n Angle: at 0 degrees and 85 degrees

Table 31: Power swing detection (RPSB, 78)

Function	Range or value	Accuracy
Reactive reach	(0.10-3000.00) Ω/phase	± 2.0% static accuracy Conditions: Voltage range: (0.1-1.1) x U_r Current range: (0.5-30) x I_r
Resistive reach	(0.10–1000.00)Ω /loop	Angle: at 0 degrees and 85 degrees
Timers	(0.000-60.000) s	± 0.5% ± 10 ms

Current protection

Table 32: Instantaneous phase overcurrent protection (PIOC, 50)

Function	Range or value	Accuracy
Operate current	(1-2500)% of I_{base}	± 1.0% of I_r at $I \leq I_r$ ± 1.0% of I at $I > I_r$
Reset ratio	> 95%	-
Operate time	25 ms typically at 0 to 2 x I_{set}	-
Reset time	25 ms typically at 2 to 0 x I_{set}	-
Critical impulse time	10 ms typically at 0 to 2 x I_{set}	-
Operate time	10 ms typically at 0 to 10 x I_{set}	-
Reset time	35 ms typically at 10 to 0 x I_{set}	-
Critical impulse time	2 ms typically at 0 to 10 x I_{set}	-
Dynamic overreach	< 5% at τ = 100 ms	-

Table 33: Four step phase overcurrent protection (POCM, 51/67)

Function	Setting range	Accuracy
Operate current	(1-2500)% of I_{base}	± 1.0% of I_r at $I \leq I_r$ ± 1.0% of I at $I > I_r$
Reset ratio	> 95%	-
Min. operating current	(1-100)% of I_{base}	± 1.0% of I_r
Relay characteristic angle (RCA)	(-70.0– -50.0) degrees	± 2.0 degrees
Maximum forward angle	(40.0–70.0) degrees	± 2.0 degrees
Minimum forward angle	(75.0–90.0) degrees	± 2.0 degrees
Second harmonic blocking	(5–100)% of fundamental	± 2.0% of I_r
Independent time delay	(0.000-60.000) s	± 0.5% ± 10 ms
Minimum operate time	(0.000-60.000) s	± 0.5% ± 10 ms
Inverse characteristics, see table 90 and table 91	19 curve types	See table 90 and table 91
Operate time, start function	25 ms typically at 0 to 2 x I_{set}	-
Reset time, start function	25 ms typically at 2 to 0 x I_{set}	-
Critical impulse time	10 ms typically at 0 to 2 x I_{set}	-
Impulse margin time	15 ms typically	-

Table 34: Instantaneous residual overcurrent protection (PIOC, 50N)

Function	Range or value	Accuracy
Operate current	(1-2500)% of I_{base}	± 1.0% of I_r at $I \leq I_r$ ± 1.0% of I at $I > I_r$
Reset ratio	> 95%	-
Operate time	25 ms typically at 0 to 2 x I_{set}	-
Reset time	25 ms typically at 2 to 0 x I_{set}	-
Critical impulse time	10 ms typically at 0 to 2 x I_{set}	-
Operate time	10 ms typically at 0 to 10 x I_{set}	-
Reset time	35 ms typically at 10 to 0 x I_{set}	-
Critical impulse time	2 ms typically at 0 to 10 x I_{set}	-
Dynamic overreach	< 5% at τ = 100 ms	-

Table 35: Four step residual overcurrent protection (PEFM, 51N/67N)

Function	Range or value	Accuracy
Operate current	(1-2500)% of I_{base}	± 1.0% of I_r at $I \leq I_r$ ± 1.0% of I at $I > I_r$
Reset ratio	> 95%	-
Operate current for directional comparison	(1–100)% of I_{base}	± 1.0% of I_r

Function	Range or value	Accuracy
Timers	(0.000-60.000) s	± 0.5% ± 10 ms
Inverse characteristics, see table 90 and table 91	19 curve types	See table 90 and table 91
Second harmonic restrain operation	(5–100)% of fundamental	± 2.0% of I_r
Relay characteristic angle	(-180 to 180) degrees	± 2.0 degrees
Minimum polarizing voltage	(1–100)% of U_{base}	± 0.5% of U_r
Minimum polarizing current	(1–30)% of I_{base}	± 0.25% of I_r
RNS, XNS	(0.50–3000.00) Ω/phase	-
Operate time, start function	25 ms typically at 0 to 2 x I_{set}	-
Reset time, start function	25 ms typically at 2 to 0 x I_{set}	-
Critical impulse time	10 ms typically at 0 to 2 x I_{set}	-
Impulse margin time	15 ms typically	-

Table 36: Sensitive directional residual overcurrent and power protection (PSDE, 67N)

Function	Range or value	Accuracy
Operate level for 3I0 cosφ directional residual overcurrent	(0.25-200.00)% of I_{base}	± 1.0% of I_r at I ≤ I_r ± 1.0% of I at I > I_r
	At low setting:	
	(2.5-10) mA	± 1.0 mA
	(10-50) mA	± 0.5 mA
Operate level for 3I03U0 cosφ directional residual power	(0.25-200.00)% of S_{base}	± 1.0% of S_r at S ≤ S_r ± 1.0% of S at S > S_r
	At low setting:	
	(0.25-5.00)% of S_{base}	± 10% of set value
Operate level for 3I0 and φ residual overcurrent	(0.25-200.00)% of I_{base}	± 1.0% of I_r at ≤ I_r ± 1.0% of I at I > I_r
	At low setting:	
	(2.5-10) mA	± 1.0 mA
	(10-50) mA	± 0.5 mA
Operate level for non directional overcurrent	(1.00-400.00)% of I_{base}	± 1.0% of I_r at I ≤ I_r ± 1.0% of I at I > I_r
	At low setting:	
	(10-50) mA	± 1.0 mA
Operate level for non directional residual overvoltage	(1.00-200.00)% of U_{base}	± 0.5% of U_r at U ≤ U_r ± 0.5% of U at U > U_r
Residual release current for all directional modes	(0.25-200.00)% of I_{base}	± 1.0% of I_r at I ≤ I_r ± 1.0% of I at I > I_r
	At low setting:	
	(2.5-10) mA	± 1.0 mA
	(10-50) mA	± 0.5 mA
Residual release voltage for all directional modes	(0.01-200.00)% of U_{base}	± 0.5% of U_r at U ≤ U_r ± 0.5% of U at > U_r
Reset ratio	> 95%	-
Timers	(0.000-60.000) s	± 0.5% ± 10 ms
Inverse characteristics, see table 90 and table 91	19 curve types	See table 90 and table 91
Relay characteristic angle RCA	(-179 to 180) degrees	± 2.0 degrees
Relay open angle ROA	(0-90) degrees	± 2.0 degrees
Operate time, non directional residual over current	60 ms typically at 0 to 2 x I_{set}	-
Reset time, non directinal residual over current	60 ms typically at 2 to 0 x I_{set}	-
Operate time, start function	150 ms typically at 0 to 2 x I_{set}	-
Reset time, start function	50 ms typically at 2 to 0 x I_{set}	-

Table 37: Thermal overload protection, two time constants (PTTR, 49)

Function	Range or value	Accuracy
Base current 1 and 2	(30–250)% of I_{base}	± 1.0% of I_r
Operate time: $t = \tau \cdot \ln\left(\frac{I^2 - I_p^{\,2}}{I^2 - I_b^{\,2}}\right)$ $I = I_{measured}$	I_p = load current before overload occurs Time constant τ = (1–500) minutes	IEC 60255–8, class 5 + 200 ms
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 38: Breaker failure protection (RBRF, 50BF)

Function	Range or value	Accuracy
Operate phase current	(5-200)% of I_{base}	± 1.0% of I_r at $I \le I_r$ ± 1.0% of I at $I > I_r$
Reset ratio, phase current	> 95%	-
Operate residual current	(2-200)% of I_{base}	± 1.0% of I_r at $I \le I_r$ ± 1.0% of I at $I > I_r$
Reset ratio, residual current	> 95%	-
Phase current level for blocking of contact function	(5-200)% of I_{base}	± 1.0% of I_r at $I \le I_r$ ± 1.0% of I at $I > I_r$
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 39: Pole discordance protection (RPLD, 52PD)

Function	Range or value	Accuracy
Operate current	(0–100)% of I_{base}	± 1.0% of I_r
Time delay	(0.000-60.000) s	± 0.5% ± 10 ms

Table 40: Directional underpower protection (PDUP)

Function	Range or value	Accuracy
Power level	(0.0–500.0)% of S_{base} At low setting: (0.5-2.0)% of S_{base} (2.0-10)% of S_{base}	± 1.0% of S_r at $S < S_r$ ± 1.0% of S at $S > S_r$ < ± 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 41: Directional overpower protection (PDOP)

Function	Range or value	Accuracy
Power level	(0.0–500.0)% of S_{base} At low setting: (0.5-2.0)% of S_{base} (2.0-10)% of S_{base}	± 1.0% of S_r at $S < S_r$ ± 1.0% of S at $S > S_r$ < ± 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 42: Broken conductor check (PTOC, 46)

Function	Range or value	Accuracy
Minimum phase current for operation	(5–100)% of I_{base}	± 0.1% of I_r
Unbalance current operation	(0–100)% of maximum current	± 0.1% of I_r
Timers	(0.00-6000.00) s	± 0.5% ± 10 ms

Voltage protection

Table 43: Two step undervoltage protection (PUVM, 27)

Function	Range or value	Accuracy
Operate voltage, low and high step	(1–100)% of U_{base}	± 1.0% of U_r
Absolute hysteresis	(0–100)% of U_{base}	± 1.0% of U_r
Internal blocking level, low and high step	(1–100)% of U_{base}	± 1.0% of U_r
Inverse time characteristics for low and high step, see table 92	-	See table 92
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 2 to 0 x U_{set}	-
Reset time, start function	25 ms typically at 0 to 2 x U_{set}	-
Critical impulse time	10 ms typically at 2 to 0 x U_{set}	-
Impulse margin time	15 ms typically	-

Table 44: Two step overvoltage protection (POVM, 59)

Function	Range or value	Accuracy
Operate voltage, low and high step	(1-200)% of U_{base}	± 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 93	-	See table 93
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 45: Two step residual overvoltage protection (PTOV, 59N)

Function	Range or value	Accuracy
Operate voltage, low and high step	(1-200)% of U_{base}	± 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 94	-	See table 94
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 46: Overexcitation protection (PVPH, 24)

Function	Range or value	Accuracy
Operate value, start	(100–180)% of (U_{base}/f_{rated})	± 1.0% of U
Operate value, alarm	(50–120)% of start level	± 1.0% of U_r at U ≤ U_r ± 1.0% of U at U > U_r
Operate value, high level	(100–200)% of (U_{base}/f_{rated})	± 1.0% of U
Curve type	IEEE or customer defined $IEEE : t = \frac{(0.18 \cdot k)}{(M-1)^2}$ where M = relative (V/Hz) = (E/f)/(Ur/fr)	Class 5 + 40 ms
Minimum time delay for inverse function	(0.000–60.000) s	± 0.5% ± 10 ms
Maximum time delay for inverse function	(0.00–9000.00) s	± 0.5% ± 10 ms
Alarm time delay	(0.000–60.000) s	± 0.5% ± 10 ms

Table 47: Voltage differential protection (PTOV)

Function	Range or value	Accuracy
Voltage difference for alarm and trip	(0.0–100.0) % of U_{base}	± 0.5 % of U_r
Under voltage level	(0.0–100.0) % of U_{base}	± 0.5% of U_r
Timers	(0.000–60.000)s	± 0.5% ± 10 ms

Table 48: Loss of voltage (PDIS, 40)

Function	Range or value	Accuracy
Operate voltage	(0–100)% of U_{base}	± 0.5% of U_r
Pulse timer	(0.050–60.000) s	± 0.5% ± 10 ms
Timer	(0.000–60.000) s	± 0.5% ± 10 ms

Frequency protection

Table 49: Underfrequency protection (PTUF, 81)

Function	Range or value	Accuracy
Operate value, start function	(35.00-75.00) Hz	± 2.0 mHz
Operate time, start function	100 ms typically	-
Reset time, start function	100 ms typically	-
Operate time, definite time function	(0.000-60.000)s	± 0.5% + 10 ms
Reset time, definite time function	(0.000-60.000)s	± 0.5% + 10 ms
Voltage dependent time delay $t = \left[\frac{U - UMin}{UNom - UMin}\right]^{Exponent} \cdot (tMax - tMin) + tMin$ $U=U_{measured}$	Settings: UNom=(50-150)% of U_{base} UMin=(50-150)% of U_{base} Exponent=0.0-5.0 tMax=(0.000-60.000)s tMin=(0.000-60.000)s	Class 5 + 200 ms

Table 50: Overfrequency protection (PTOF, 81)

Function	Range or value	Accuracy
Operate value, start function	(35.00-75.00) Hz	± 2.0 mHz
Operate time, start function	100 ms typically	-
Reset time, start function	100 ms typically	-
Operate time, definite time function	(0.000-60.000)s	± 0.5% + 10 ms
Reset time, definite time function	(0.000-60.000)s	± 0.5% + 10 ms

Table 51: Rate-of-change frequency protection (PFRC, 81)

Function	Range or value	Accuracy
Operate value, start function	(-10.00-10.00) Hz/s	± 10.0 mHz/s
Operate value, internal blocking level	(0-100)% of U_{base}	± 1.0% of U_r
Operate time, start function	100 ms typically	-

Multipurpose protection

Table 52: General current and voltage protection (GAPC)

Function	Range or value	Accuracy
Measuring current input	phase1, phase2, phase3, PosSeq, NegSeq, 3*ZeroSeq, MaxPh, MinPh, UnbalancePh, phase1-phase2, phase2-phase3, phase3-phase1, MaxPh-Ph, MinPh-Ph, UnbalancePh-Ph	-
Base current	(1 - 99999) A	-
Measuring voltage input	phase1, phase2, phase3, PosSeq, -NegSeq, -3*ZeroSeq, MaxPh, MinPh, UnbalancePh, phase1-phase2, phase2-phase3, phase3-phase1, MaxPh-Ph, MinPh-Ph, UnbalancePh-Ph	-
Base voltage	(0.05 - 2000.00) kV	-
Start overcurrent, step 1 and 2	(2 - 5000)% of I_{base}	± 1.0% of I_r for I<I_r ± 1.0% of I for I>I_r
Start undercurrent, step 1 and 2	(2 - 150)% of I_{base}	± 1.0% of I_r for I<I_r ± 1.0% of I for I>I_r
Definite time delay	(0.00 - 6000.00) s	± 0.5% ± 10 ms
Operate time start overcurrent	25 ms typically at 0 to 2 x I_{set}	-
Reset time start overcurrent	25 ms typically at 2 to 0 x I_{set}	-

Function	Range or value	Accuracy
Operate time start undercurrent	25 ms typically at 2 to 0 x I_{set}	-
Reset time start undercurrent	25 ms typically at 0 to 2 x I_{set}	-
See table 90 and table 91	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	See table 90 and table 91
Voltage level where voltage memory takes over	(0.0 - 5.0)% of U_{base}	± 1.0% of U_r
Start overvoltage, step 1 and 2	(2.0 - 200.0)% of U_{base}	± 1.0% of U_r for U<U_r ± 1.0% of U for U>U_r
Start undervoltage, step 1 and 2	(2.0 - 150.0)% of U_{base}	± 1.0% of U_r for U<U_r ± 1.0% of U for U>U_r
Operate time, start overvoltage	25 ms typically at 0 to 2 x U_{set}	-
Reset time, start overvoltage	25 ms typically at 2 to 0 x U_{set}	-
Operate time start undervoltage	25 ms typically 2 to 0 x U_{set}	-
Reset time start undervoltage	25 ms typically at 0 to 2 x U_{set}	-
High and low voltage limit, voltage dependent operation	(1.0 - 200.0)% of U_{base}	± 1.0% of U_r for U<U_r ± 1.0% of U for U>U_r
Directional function	Settable: NonDir, forward and reverse	-
Relay characteristic angle	(-180 to +180) degrees	± 2.0 degrees
Relay operate angle	(1 to 90) degrees	± 2.0 degrees
Reset ratio, overcurrent	> 95%	-
Reset ratio, undercurrent	< 105%	-
Reset ratio, overvoltage	> 95%	-
Reset ratio, undervoltage	< 105%	-
Overcurrent: Critical impulse time Impulse margin time	 10 ms typically at 0 to 2 x I_{set} 15 ms typically	 - -
Undercurrent: Critical impulse time Impulse margin time	 10 ms typically at 2 to 0 x I_{set} 15 ms typically	 - -
Overvoltage: Critical impulse time Impulse margin time	 10 ms typically at 0 to 2 x U_{set} 15 ms typically	 - -
Undervoltage: Critical impulse time Impulse margin time	 10 ms typically at 2 to 0 x U_{set} 15 ms typically	 - -

Secondary system supervision

Table 53: Current circuit supervision (RDIF)

Function	Range or value	Accuracy
Operate current	(5-200)% of I_r	± 10.0% of I_r at I ≤ I_r ± 10.0% of I at I > I_r
Block current	(5-500)% of I_r	± 5.0% of I_r at I ≤ I_r ± 5.0% of I at I > I_r

Table 54: Fuse failure supervision (RFUF)

Function	Range or value	Accuracy
Operate voltage, zero sequence	(1-100)% of U_{base}	± 1.0% of U_r
Operate current, zero sequence	(1–100)% of I_{base}	± 1.0% of I_r
Operate voltage, negative sequence	(1–100)% of U_{base}	± 1.0% of U_r
Operate current, negative sequence	(1–100)% of I_{base}	± 1.0% of I_r
Operate voltage change level	(1–100)% of U_{base}	± 5.0% of U_r
Operate current change level	(1–100)% of I_{base}	± 5.0% of I_r

Control

Table 55: Synchronizing, synchrocheck check and energizing check (RSYN, 25)

Function	Range or value	Accuracy
Phase shift, φ_{line} - φ_{bus}	(-180 to 180) degrees	-
Voltage ratio, U_{bus}/U_{line}	(0.20-5.00)% of U_{base}	-
Voltage high limit for synchrocheck	(50.0-120.0)% of U_{base}	± 1.0% of U_r at $U \leq U_r$ ± 1.0% of U at $U > U_r$
Reset ratio, synchrocheck	> 95%	-
Frequency difference limit between bus and line	(0.003-1.000) Hz	± 2.0 mHz
Phase angle difference limit between bus and line	(5.0-90.0) degrees	± 2.0 degrees
Voltage difference limit between bus and line	(2.0-50.0)% of U_{base}	± 1.0% of U_r
Time delay output for synchrocheck	(0.000-60.000) s	± 0.5% ± 10 ms
Voltage high limit for energizing check	(50.0-120.0)% of U_{base}	± 1.0% of U_r at $U \leq U_r$ ± 1.0% of U at $U > U_r$
Reset ratio, voltage high limit	> 95%	-
Voltage low limit for energizing check	(10.0-80.0)% of U_{base}	± 1.0% of U_r
Reset ratio, voltage low limit	< 105%	-
Maximum voltage for energizing	(80.0-140.0)% of U_{base}	± 1.0% of U_r at $U \leq U_r$ ± 1.0% of U at $U > U_r$
Time delay for energizing check	(0.000-60.000) s	± 0.5% ± 10 ms
Operate time for synchrocheck function	160 ms typically	-
Operate time for energizing function	80 ms typically	-

Table 56: Voltage control (VCTR)

Function	Range or value	Accuracy
Transformer reactance	(0.1–200.0)Ω, primary	-
Time delay for lower command when FSD is activated	(1.0–100.0) s	-
Voltage control set voltage	(85.0–120.0)% of U_{base}	±0.25% of U_r
Outer voltage deadband	(0.2–9.0)% of U_{base}	-
Inner voltage deadband	(0.1–9.0)% of U_{base}	-
Upper limit of busbar voltage	(80–180)% of U_{base}	± 1.0% of U_r
Lower limit of busbar voltage	(70–120)% of U_{base}	± 1.0% of U_r
Undervoltage block level	(0–120)% of U_{base}	± 1.0% of U_r
Time delay (long) for automatic control commands	(3–1000) s	± 0.5% ± 10 ms
Time delay (short) for automatic control commands	(1–1000) s	± 0.5% ± 10 ms
Minimum operating time in inverse mode	(3–120) s	± 0.5% ± 10 ms
Line resistance	(0.00–150.00)Ω, primary	-
Line resistance	(-150.00–150.00)Ω, primary	-
Load voltage adjustment constants	(-20.0–20.0)% of U_{base}	-
Load voltage auto correction	(-20.0–20.0)% of U_{base}	-
Duration time for the reverse action block signal	(30–6000) s	± 0.5% ± 10 ms
Current limit for reverse action block	(0–100)% of $I1_{base}$	-
Overcurrent block level	(0–250)% of $I1_{base}$	± 1.0% of I_r at $I \leq I_r$ ± 1.0% of I at $I > I_r$
Level for number of counted raise/lower within one hour	(0–30) operations/hour	-
Level for number of counted raise/lower within 24 hours	(0–100) operations/day	-
Time window for hunting alarm	(1–120) minutes	-
Hunting detection alarm, max operations/window	(3–30) operations/window	-
Alarm level of active power in forward and reverse direction	(-9999.99–9999.99) MW	± 1.0% of S_r
Alarm level of reactive power in forward and reverse direction	(-9999.99–9999.99) MVAr	± 1.0% of S_r
Time delay for alarms from power supervision	(1–6000) s	± 0.5% ± 10 ms

Function	Range or value	Accuracy
Tap position for lowest and highest voltage	(1–63)	-
mA for lowest and highest voltage tap position	(0.000–25.000) mA	-
Type of code conversion	BIN, BCD, GRAY, SINGLE, mA	-
Time after position change before the value is accepted	(1–60) s	± 0.5% ± 10 ms
Tap changer constant time-out	(1–120) s	± 0.5% ± 10 ms
Raise/lower command output pulse duration	(0.5–10.0) s	± 0.5% ± 10 ms

Scheme communication

Table 57: Scheme communication logic for residual overcurrent protection (PSCH, 85)

Function	Range or value	Accuracy
Communication scheme coordination time	(0.000-60.000) s	± 0.5% ± 10 ms
Scheme type	Permissive UR Permissive OR Blocking	-

Table 58: Current reversal and weak-end infeed logic for residual overcurrent protection (PSCH, 85)

Function	Range or value	Accuracy
Operate voltage $3U_o$ for WEI trip	(5-70)% of U_{base}	± 1.0% of U_r
Reset ratio	>95%	-
Operate time for current reversal	(0.000-60.000) s	± 0.5% ± 10 ms
Delay time for current reversal	(0.000-60.000) s	± 0.5% ± 10 ms
Coordination time for weak-end infeed logic	(0.000–60.000) s	± 0.5% ± 10 ms

Logic

Table 59: Tripping logic (PTRC, 94)

Function	Range or value	Accuracy
Trip action	3-ph, 1/3-ph, 1/2/3-ph	-
Minimum trip pulse length	(0.000-60.000) s	± 0.5% ± 10 ms
Timers	(0.000-60.000) s	± 0.5% ± 10 ms

Table 60: Configurable logic blocks

Logic block	Quantity with update rate			Range or value	Accuracy
	fast	medium	normal		
LogicAND	60	60	160	-	-
LogicOR	60	60	160	-	-
LogicXOR	10	10	20	-	-
LogicInverter	30	30	80	-	-
LogicSRMemory	10	10	20	-	-
LogicGate	10	10	20	-	-
LogicTimer	10	10	20	(0.000–90000.000) s	± 0.5% ± 10 ms
LogicPulseTimer	10	10	20	(0.000–90000.000) s	± 0.5% ± 10 ms
LogicTimerSet	10	10	20	(0.000–90000.000) s	± 0.5% ± 10 ms
LogicLoopDelay	10	10	20	(0.000–90000.000) s	± 0.5% ± 10 ms

Monitoring

Table 61: Measurements (MMXU)

Function	Range or value	Accuracy
Frequency	(0.95-1.05) × f_r	± 2.0 mHz
Voltage	(0.1-1.5) × U_r	± 0.5% of U_r at $U \le U_r$ ± 0.5% of U at $U > U_r$
Connected current	(0.2-4.0) × I_r	± 0.5% of I_r at $I \le I_r$ ± 0.5% of I at $I > I_r$
Active power, P	$0.1 \times U_r < U < 1.5 \times U_r$ $0.2 \times I_r < I < 4.0 \times I_r$	± 1.0% of S_r at $S \le S_r$ ± 1.0% of S at $S > S_r$

Function	Range or value	Accuracy
Reactive power, Q	0.1 x U_r < U < 1.5 x U_r 0.2 x I_r < I < 4.0 x I_r	± 1.0% of S_r at S ≤ S_r ± 1.0% of S at S > S_r
Apparent power, S	0.1 x U_r < U < 1.5 x U_r 0.2 x I < I < 4.0 x I_r	± 1.0% of S_r at S ≤ S_r ± 1.0% of S at S > S_r
Power factor, cos (φ)	0.1 x U_r < U < 1.5 x U_r 0.2 x I_r < I < 4.0 x I_r	± 0.02

Table 62: Supervision of mA input signals (MVGGIO)

Function	Range or value	Accuracy
mA measuring function	± 5, ± 10, ± 20 mA 0-5, 0-10, 0-20, 4-20 mA	± 0.1 % of set value ± 0.005 mA
Max current of transducer to input	(-20.00 to +20.00) mA	
Min current of transducer to input	(-20.00 to +20.00) mA	
Alarm level for input	(-20.00 to +20.00) mA	
Warning level for input	(-20.00 to +20.00) mA	
Alarm hysteresis for input	(0.0-20.0) mA	

Table 63: Event counter (GGIO)

Function	Range or value	Accuracy
Counter value	0-10000	-
Max. count up speed	10 pulses/s	-

Table 64: Disturbance report (RDRE)

Function	Range or value	Accuracy
Pre-fault time	(0.05–0.30) s	-
Post-fault time	(0.1–5.0) s	-
Limit time	(0.5–6.0) s	-
Maximum number of recordings	100	-
Time tagging resolution	1 ms	See Table 86: "Time synchronization, time tagging".
Maximum number of analog inputs	30 + 10 (external + internally derived)	-
Maximum number of binary inputs	96	-
Maximum number of phasors in the Trip Value recorder per recording	30	-
Maximum number of indications in a disturbance report	96	-
Maximum number of events in the Event recording per recording	150	-
Maximum number of events in the Event list	1000, first in - first out	-
Maximum total recording time (3.4 s recording time and maximum number of channels, typical value)	340 seconds (100 recordings) at 50 Hz, 280 seconds (80 recordings) at 60 Hz	-
Sampling rate	1 kHz at 50 Hz 1.2 kHz at 60 Hz	-
Recording bandwidth	(5-300) Hz	-

Table 65: Event list (RDRE)

Function		Value
Buffer capacity	Maximum number of events in the list	1000
Resolution		1 ms
Accuracy		Depending on time synchronizing

Table 66: Indications

Function		Value
Buffer capacity	Maximum number of indications presented for single disturbance	96
	Maximum number of recorded disturbances	100

Table 67: Event recorder (RDRE)

Function		Value
Buffer capacity	Maximum number of events in disturbance report	150
	Maximum number of disturbance reports	100
Resolution		1 ms
Accuracy		Depending on time synchro-nizing

Table 68: Trip value recorder (RDRE)

Function		Value
Buffer capacity	Maximum number of analog inputs	30
	Maximum number of disturbance reports	100

Table 69: Disturbance recorder (RDRE)

Function		Value
Buffer capacity	Maximum number of analog inputs	40
	Maximum number of binary inputs	96
	Maximum number of disturbance reports	100
Maximum total recording time (3.4 s recording time and maximum number of channels, typical value)		340 seconds (100 recordings) at 50 Hz 280 seconds (80 recordings) at 60 Hz

Metering

Table 70: Pulse counter logic (GGIO)

Function	Setting range	Accuracy
Input frequency	See Binary Input Module (BIM)	-
Cycle time for report of counter value	(0–3600) s	-

Table 71: Energy metering (MMTR)

Function	Range or value	Accuracy
Energy metering	kWh Export/Import, kvarh Export/Import	Input from MMXU. No extra error at steady load

Station communication

Table 72: IEC 61850-8-1 communication protocol

Function	Value
Protocol	IEC 61850-8-1
Communication speed for the IEDs	100BASE-FX

Table 73: LON communication protocol

Function	Value
Protocol	LON
Communication speed	1.25 Mbit/s

Table 74: SPA communication protocol

Function	Value
Protocol	SPA
Communication speed	300, 1200, 2400, 4800, 9600, 19200 or 38400 Bd
Slave number	1 to 899

Table 75: IEC 60870-5-103 communication protocol

Function	Value
Protocol	IEC 60870-5-103
Communication speed	9600, 19200 Bd

Table 76: SLM – LON port

Quantity	Range or value
Optical connector	Glass fibre: type ST Plastic fibre: type HFBR snap-in
Fibre, optical budget	Glass fibre: 11 dB (1000 m typically *) Plastic fibre: 7 dB (10 m typically *)
Fibre diameter	Glass fibre: 62.5/125 μm Plastic fibre: 1 mm
*) depending on optical budget calculation	

Table 77: SLM – SPA/IEC 60870-5-103 port

Quantity	Range or value
Optical connector	Glass fibre: type ST Plastic fibre: type HFBR snap-in
Fibre, optical budget	Glass fibre: 11 dB (3000ft/1000 m typically *) Plastic fibre: 7 dB (80ft/25 m typically *)
Fibre diameter	Glass fibre: 62.5/125 μm Plastic fibre: 1 mm
*) depending on optical budget calculation	

Table 78: Galvanic RS485 communication module

Quantity	Range or value
Communication speed	2400–19200 bauds
External connectors	RS-485 6-pole connector Soft ground 2-pole connector

Remote communication

Table 79: Line data communication modules (LDCM)

Characteristic	Range or value		
Type of LDCM	**Short range (SR)**	**Medium range (MR)**	**Long range (LR)**
Type of fibre	Graded-index multimode 62.5/125 μm or 50/125 μm	Singlemode 8/125 μm	Singlemode 8/125 μm
Wave length	820 nm	1310 nm	1550 nm
Optical budget Graded-index multimode 62.5/125 μm, Graded-index multimode 50/125 μm	 11 dB (typical distance about 3 km *) 7 dB (typical distance about 2 km *)	20 dB (typical distance 80 km *)	26 dB (typical distance 120 km *)
Optical connector	Type ST	Type FC	Type FC
Protocol	C37.94	C37.94 implementation **)	C37.94 implementation **)
Data transmission	Synchronous	Synchronous	Synchronous
Transmission rate / Data rate	2 Mb/s / 64 kbit/s	2 Mb/s / 64 kbit/s	2 Mb/s / 64 kbit/s
Clock source	Internal or derived from received signal	Internal or derived from received signal	Internal or derived from received signal
*) 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 80: Case

Material	Steel sheet
Front plate	Steel sheet profile with cut-out for HMI
Surface treatment	Aluzink preplated steel
Finish	Light grey (RAL 7035)

Table 81: Water and dust protection level according to IEC 60529

Front	IP40 (IP54 with sealing strip)
Rear, sides, top and bottom	IP20

Table 82: Weight

Case size	Weight
6U, 1/2 x 19”	≤ 10 kg
6U, 3/4 x 19”	≤ 15 kg
6U, 1/1 x 19”	≤ 18 kg

Connection system

Table 83: CT and VT circuit connectors

Connector type	Rated voltage and current	Maximum conductor area
Terminal blocks of feed through type	250 V AC, 20 A	4mm^2
Terminal blocks suitable for ring lug terminals	250 V AC, 20 A	4 mm^2

Table 84: Binary I/O connection system

Connector type	Rated voltage	Maximum conductor area
Screw compression type	250 V AC	2.5 mm^2 2 × 1 mm^2
Terminal blocks suitable for ring lug terminals	300 V AC	3 mm^2

Basic IED functions

Table 85: Self supervision with internal event list

Data	Value
Recording manner	Continuous, event controlled
List size	1000 events, first in-first out

Table 86: Time synchronization, time tagging

Function	Value
Time tagging resolution, Events and Sampled Measurement Values	1 ms
Time tagging error with synchronization once/min (minute pulse synchronization), Events and Sampled Measurement Values	± 1.0 ms typically
Time tagging error with SNTP synchronization, Sampled Measurement Values	± 1.0 ms typically

Table 87: GPS time synchronization module (GSM)

Function	Range or value	Accuracy
Receiver	–	±1μs relative UTC
Time to reliable time reference with antenna in new position or after power loss longer than 1 month	<30 minutes	–
Time to reliable time reference after a power loss longer than 48 hours	<15 minutes	–
Time to reliable time reference after a power loss shorter than 48 hours	<5 minutes	–

Table 88: GPS – Antenna and cable

Function	Value
Max antenna cable attenuation	26 db @ 1.6 GHz
Antenna cable impedance	50 ohm
Lightning protection	Must be provided externally
Antenna cable connector	SMA in receiver end TNC in antenna end

Table 89: IRIG-B

Quantity	Rated value
Number of channels IRIG-B	1
Number of channels PPS	1
Electrical connector IRIG-B	BNC
Optical connector PPS	Type ST
Type of fibre	62.5/125 μm multimode fibre

Inverse characteristics

Table 90: Inverse time characteristics ANSI

Function	Range or value	Accuracy
Operate characteristic: $t = \left(\frac{A}{\left(I^{P} - 1 \right)} + B \right) \cdot k$ Reset characteristic: $t = \frac{t_r}{\left(I^{2} - 1 \right)} \cdot k$ I = $I_{measured}/I_{set}$	k = 0.05-999 in steps of 0.01 unless otherwise stated	-
ANSI Extremely Inverse no 1	A=28.2, B=0.1217, P=2.0, tr=29.1	ANSI/IEEE C37.112, class 5 + 30 ms
ANSI Very inverse no 2	A=19.61, B=0.491, P=2.0, tr=21.6	
ANSI Normal Inverse no 3	A=0.0086, B=0.0185, P=0.02, tr=0.46	
ANSI Moderately Inverse no 4	A=0.0515, B=0.1140, P=0.02, tr=4.85	
ANSI Long Time Extremely Inverse no 6	A=64.07, B=0.250, P=2.0, tr=30	
ANSI Long Time Very Inverse no 7	A=28.55, B=0.712, P=2.0, tr=13.46	
ANSI Long Time Inverse no 8	k=(0.01-1.20) in steps of 0.01 A=0.086, B=0.185, P=0.02, tr=4.6	

Table 91: Inverse time characteristics IEC

Function	Range or value	Accuracy
Operate characteristic: $t = \left(\frac{A}{\left(I^{P} - 1 \right)} \right) \cdot k$ I = $I_{measured}/I_{set}$	k = (0.05-1.10) in steps of 0.01	-
Time delay to reset, IEC inverse time	(0.000-60.000) s	± 0.5% of set time ± 10 ms
IEC Normal Inverse no 9	A=0.14, P=0.02	IEC 60255-3, class 5 + 40 ms
IEC Very inverse no 10	A=13.5, P=1.0	
IEC Inverse no 11	A=0.14, P=0.02	
IEC Extremely inverse no 12	A=80.0, P=2.0	
IEC Short-time inverse no 13	A=0.05, P=0.04	
IEC Long-time inverse no 14	A=120, P=1.0	

Function	Range or value	Accuracy
Customer defined characteristic no 17 Operate characteristic: $t = \left(\frac{A}{\left(I^{P} - C \right)} + B \right) \cdot k$ Reset characteristic: $t = \frac{TR}{\left(I^{PR} - CR \right)} \cdot k$ $I = I_{measured}/I_{set}$	k=0.5-999 in steps of 0.1 A=(0.005-200.000) in steps of 0.001 B=(0.00-20.00) in steps of 0.01 C=(0.1-10.0) in steps of 0.1 P=(0.005-3.000) in steps of 0.001 TR=(0.005-100.000) in steps of 0.001 CR=(0.1-10.0) in steps of 0.1 PR=(0.005-3.000) in steps of 0.001	IEC 60255, class 5 + 40 ms
RI inverse characteristic no 18 $t = \frac{1}{0.339 - \frac{0.236}{I}} \cdot k$ $I = I_{measured}/I_{set}$	k=(0.05-999) in steps of 0.01	IEC 60255-3, class 5 + 40 ms
Logarithmic inverse characteristic no 19 $t = 5.8 - \left(1.35 \cdot In \frac{I}{k} \right)$ $I = I_{measured}/I_{set}$	k=(0.05-1.10) in steps of 0.01	IEC 60255-3, class 5 + 40 ms

Table 92: Inverse time characteristics for Two step undervoltage protection (PUVM, 27)

Function	Range or value	Accuracy
Type A curve: $t = \frac{k}{\left(\frac{U < -U}{U <} \right)}$ $U< = U_{set}$ $U = UV_{measured}$	k = (0.05-1.10) in steps of 0.01	Class 5 +40 ms
Type B curve: $t = \frac{k \cdot 480}{\left(32 \cdot \frac{U < -U}{U <} - 0.5 \right)^{2.0}} + 0.055$ $U< = U_{set}$ $U = U_{measured}$	k = (0.05-1.10) in steps of 0.01	
Programmable curve: $t = \left[\frac{k \cdot A}{\left(B \cdot \frac{U < -U}{U <} - C \right)^{P}} \right] + D$ $U< = U_{set}$ $U = U_{measured}$	k = (0.05-1.10) in steps of 0.01 A = (0.005-200.000) in steps of 0.001 B = (0.50-100.00) in steps of 0.01 C = (0.0-1.0) in steps of 0.1 D = (0.000-60.000) in steps of 0.001 P = (0.000-3.000) in steps of 0.001	

Table 93: Inverse time characteristics for Two step overvoltage protection (POVM, 59)

Function	Range or value	Accuracy
Type A curve: $t = \frac{k}{\left(\frac{U - U>}{U>}\right)}$ U> = U_{set} U = $U_{measured}$	k = (0.05-1.10) in steps of 0.01	Class 5 +40 ms
Type B curve: $t = \frac{k \cdot 480}{\left(32 \cdot \frac{U - U>}{U>} - 0.5\right)^{2.0} - 0.035}$	k = (0.05-1.10) in steps of 0.01	
Type C curve: $t = \frac{k \cdot 480}{\left(32 \cdot \frac{U - U>}{U>} - 0.5\right)^{3.0} - 0.035}$	k = (0.05-1.10) in steps of 0.01	
Programmable curve: $t = \frac{k \cdot A}{\left(B \cdot \frac{U - U>}{U>} - C\right)^{P}} + D$	k = (0.05-1.10) in steps of 0.01 A = (0.005-200.000) in steps of 0.001 B = (0.50-100.00) in steps of 0.01 C = (0.0-1.0) in steps of 0.1 D = (0.000-60.000) in steps of 0.001 P = (0.000-3.000) in steps of 0.001	

Table 94: Inverse time characteristics for Two step residual overvoltage protection (POVM, 59N)

Function	Range or value	Accuracy
Type A curve: $t = \frac{k}{\left(\frac{U - U>}{U>}\right)}$ U> = U_{set} U = $U_{measured}$	k = (0.05-1.10) in steps of 0.01	Class 5 +40 ms
Type B curve: $t = \frac{k \cdot 480}{\left(32 \cdot \frac{U - U>}{U>} - 0.5\right)^{2.0} - 0.035}$	k = (0.05-1.10) in steps of 0.01	
Type C curve: $t = \frac{k \cdot 480}{\left(32 \cdot \frac{U - U>}{U>} - 0.5\right)^{3.0} - 0.035}$	k = (0.05-1.10) in steps of 0.01	
Programmable curve: $t = \frac{k \cdot A}{\left(B \cdot \frac{U - U>}{U>} - C\right)^{P}} + D$	k = (0.05-1.10) in steps of 0.01 A = (0.005-200.000) in steps of 0.001 B = (0.50-100.00) in steps of 0.01 C = (0.0-1.0) in steps of 0.1 D = (0.000-60.000) in steps of 0.001 P = (0.000-3.000) in steps of 0.001	

Ordering

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

Platform and basic functionality

Basic IED 670 platform and common functions housed in selected casing

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

Impedance protection

Phase selection with load enchroachment, quadrilateral characteristic
Faulty phase identification with load enchroachment

Current protection

Broken conductor check *(PTOC)*

Voltage protection

Loss of voltage check *(PTUV, 27)*

Control

Logic Rotating Switch for function selection and LHMI presentation *(SLGGIO)*
Selector mini switch *(VSGGIO)*
IEC 618850 generic communication I/O functions *(DPGGIO)*
Single point generic control 8 signals

Logic

Tripping logic *(PTRC, 94)*
Trip matrix logic *(GGIO)*
Configurable logic blocks
Fixed signal function block
Boolean 16 to Integer conversion with logic node representation
Integer to Boolean 16 conversion with logic node representation

Monitoring

Measurements *(MMXU, MSQI)*
Function block for service values presentation of the analog inputs
Event counter
Event function
Disturbance report *(RDRE)*
IEC 61850 generic communication I/O functions *(SPGGIO, SP16GGIO, MVGGIO)*
Logical signal status report
Measured value expander block

Metering

Pulse counter logic *(GGIO)*
Energy metering and demand handling *(MMTR)*

Station communication

SPA communication protocool
LON communication protocool
IEC 60870-5-103 communication protocool
Operation selection between SPA and IEC 60870-5-103 for SLM
DNP3.0 for TCP/IP communication protocol
DNP3.0 for EIA-485 communication protocol
Parameter setting function for IEC 61850
Horizontal communication via GOOSE for interlocking
Horizontal communication via GOOSE for VCTR
Goose Binary recieve
Single command, 16 signals
AutomationBits, command function for DNP3.0
Multiple command and transmit
Ethernet configuration of links

Remote communication

Binary signal transfer to remote end, 32 signals
Binary signal transfer to remote end, 8 signals
Transmission of analog data from LDCM
Receive analog data from remote LDCM
Receive binary status from remote LDCM, 8 signals
Receive binary status from remote LDCM, 32 signals

Hardware

Numeric processing module

Product specification

RET 670 Quantity: ☐ 1MRK 002 816-AB

Default:
The IED is delivered with pre-configured loaded configuration.
Use the configuration and programming tool (PCM 600) to create or modify the configuration. The same tool can also be used for adaptation of an included example configuration.

Option:
Customer specific configuration On request

Connection type for Power supply modules and I/O modules

Rule: Same connection type for Power supply modules and I/O modules must be ordered

Standard compression connection terminals	☐ 1MRK 002 960-AA
Ring lug terminals	☐ 1MRK 002 960-BA

Power supply module

Rule: One Power supply module must be specified

Power supply module *(PSM)*	24-60 VDC	☐ 1MRK 002 239-AB
	90-250 VDC	☐ 1MRK 002 239-BB

Differential protection

Rule: One of Differential protection must be ordered

		1	2	
Transformer differential protection, two winding *(PDIF, 87T)*	Qty:	☐	☐	1MRK 002 901-AB
Transformer differential protection, three winding *(PDIF, 87T)*	Qty:	☐	☐	1MRK 002 901-CB

Optional functions

Differential protection

		1	2	3	4	5	6	
1Ph High impedance differential protection *(PDIF, 87)*	Qty:	☐	☐	☐	☐	☐	☐	1MRK 002 901-HA

		1	2	3	
Restricted earth fault protection, low impedance *(PDIF, 87N)*	Qty:	☐	☐	☐	1MRK 002 901-EA

Impedance protection

Rule: One and only one of the alternatives (Alt. 1-3) can be ordered

Alternative 1:
Rule: Distance protection and Directional impedance must be ordered together

		1	2	3	4	5	
Distance protection zones, quadrilateral characteristic *(PDIS, 21)*	Qty:	☐	☐	☐	☐	☐	1MRK 002 904-XA

		1	2	
Directional impedance quadrilateral *(RDIR, 21)*	Qty:	☐	☐	1MRK 002 904-YA

Alternative 3:
Rule: All functions within the alternative must be ordered

		1	2	3	4	5	
Full scheme distance protection, mho characteristic *(PDIS, 21)*	Qty:	☐	☐	☐	☐	☐	1MRK 002 925-EA
Full scheme distance protection, quadrilateral for mho *(PDIS, 21)*	Qty:	☐	☐	☐	☐	☐	1MRK 002 925-GA

		1	2	
Directional impedance element for mho characteristic *(RDIR)*	Qty:	☐	☐	1MRK 002 924-PA

Additional distance protection directional function for earth faults*(RDIR)*	Qty:	☐ 1MRK 002 908-VA
Mho impedance supervision logic *(GAPC)*	Qty:	☐ 1MRK 002 908-UA

Power swing detection *(RPSB, 78)*	Qty:	☐ 1MRK 002 904-NA
Power swing logic *(RPSL)*	Qty:	☐ 1MRK 002 924-RA

Current protection

		1	2	3	
Instantaneous phase overcurrent protection *(PIOC, 50)*	Qty:	☐	☐	☐	1MRK 002 906-AB
Four step phase overcurrent protection *(PTOC, 51/67)*	Qty:	☐	☐	☐	1MRK 002 906-BB
Instantaneous residual overcurrent protection *(PIOC, 50N)*	Qty:	☐	☐	☐	1MRK 002 906-CB

Four step residual overcurrent protection *(PTOC, 51N/67N)*	Qty:	1 2 3 ☐ ☐ ☐	1MRK 002 906-DB
Sensitive directional residual overcurrent and power protection *(PSDE, 67N)*	Qty:	1 2 3 ☐ ☐ ☐	1MRK 002 907-DA
Thermal overload protection, two time constants *(PTTR, 49)*	Qty:	1 2 3 ☐ ☐ ☐	1MRK 002 906-NA
Breaker failure protection *(RBRF, 50BF)*	Qty:	1 2 3 4 5 6 ☐ ☐ ☐ ☐ ☐ ☐	1MRK 002 906-RB
Pole discordance protection *(RPLD, 52PD)*	Qty:	1 2 ☐ ☐	1MRK 002 907-AB
Directional underpower protection *(PDUP, 37)*	Qty:	1 2 ☐ ☐	1MRK 002 902-FA
Directional overpower protection *(PDOP, 32)*	Qty:	1 2 ☐ ☐	1MRK 002 902-GA

Voltage protection

Two step undervoltage protection *(PVUM, 27)*	Qty:	1 2 3 ☐ ☐ ☐	1MRK 002 908-AB
Two step overvoltage protection *(POVM, 59)*	Qty:	1 2 3 ☐ ☐ ☐	1MRK 002 908-DB
Two step residual overvoltage protection *(POVM, 59N)*	Qty:	1 2 3 ☐ ☐ ☐	1MRK 002 908-GB
Overexcitation protection *(PVPH, 24)*	Qty:	1 2 ☐ ☐	1MRK 002 908-MB
Voltage differential protection *(PTOV, 60)*	Qty:	1 2 ☐ ☐	1MRK 002 924-TA

Frequency protection

Underfrequency protection *(PTUF, 81)*	Qty:	1 2 3 4 5 6 ☐ ☐ ☐ ☐ ☐ ☐	1MRK 002 908-NB
Overfrequency protection *(PTOF, 81)*	Qty:	1 2 3 4 5 6 ☐ ☐ ☐ ☐ ☐ ☐	1MRK 002 908-RB
Rate-of-change frequency protection *(PFRC, 81)*	Qty:	1 2 3 4 5 6 ☐ ☐ ☐ ☐ ☐ ☐	1MRK 002 908-SA

Multipurpose protection

General current and voltage protection *(GAPC)*	Qty:	1 2 3 4 5 6 ☐ ☐ ☐ ☐ ☐ ☐ 7 8 9 10 11 12 ☐ ☐ ☐ ☐ ☐ ☐	1MRK 002 902-AA

Secondary system supervision

Current circuit supervision *(RDIF)*	Qty:	1 2 3 4 5 ☐ ☐ ☐ ☐ ☐	1MRK 002 914-AA
Fuse failure supervision *(RFUF)*	Qty:	1 2 3 4 ☐ ☐ ☐ ☐	1MRK 002 914-GB

Control

		1	2	3	4	5	6	
Synchrocheck, energizing check and synchronizin *(RSYN, 25)*	Qty:	☐	☐	☐	☐	☐	☐	1MRK 002 916-SB
Rule: Can only be ordered when APC30 is selected.								
Apparatus control for up to 6 bays, max 30 apparatuses (6CBs) incl. interlocking							☐	1MRK 002 916-RA
Rule: Only one of (ATCC, 90) can be ordered								
				1	2	3	4	
Automatic voltage control for tapchanger, single transformer *(ATCC, 90)*	Qty:			☐	☐	☐	☐	1MRK 002 916-YA
				1	2	3	4	
Automatic voltage control for tapchanger, parallel control *(ATCC, 90)*	Qty:			☐	☐	☐	☐	1MRK 002 916-ZA
				1	2	3	4	
Tap changer control and supervision, 6 binary inputs *(YLTC, 84)*	Qty:			☐	☐	☐	☐	1MRK 002 925-PA
				1	2	3	4	
Tap changer control and supervision, 32 binary inputs *(YLTC, 84)*	Qty:			☐	☐	☐	☐	1MRK 002 924-UA

Scheme communication

Scheme communication logic for residual overcurrent protection *(ECPSCH, 85)*	☐	1MRK 002 906-GA
Current reversal and weak end infeed logic for residual overcurrent protection *(ECRWPSCH, 85)*	☐	1MRK 002 906-HA

Logic

		2	3	4	5	6		
Rule: One is included as basic	Qty:							
Tripping logic *(PTRC 94)*		☐	☐	☐	☐	☐		1MRK 002 917-AA

First HMI language

Rule: One must be ordered

HMI language, English IEC	☐	1MRK 002 930-AA
HMI language, English ANSI	☐	1MRK 002 930-BA

Additional HMI language

Rule: Maximum one alternative can be selected

HMI language, german	☐	1MRK 002 920-AA
HMI language, russian	☐	1MRK 002 920-BA
HMI language, french	☐	1MRK 002 920-CA
HMI language, spanish	☐	1MRK 002 920-DA
HMI language, italian	☐	1MRK 002 920-EA
HMI language, polish	☐	1MRK 002 920-GA
HMI language, hungarian	☐	1MRK 002 920-FA
HMI language, czech	☐	1MRK 002 920-HA
HMI language, swedish	☐	1MRK 002 920-KA

Optional hardware

Human machine interface

Rule: One must be ordered

Small size – text only, IEC symbols, 1/2 19”	☐	1MRK 000 008-HB
Small size – text, IEC symbols, 3/4 19”	☐	1MRK 000 008-PB
Small size – text, IEC symbols, 1/1 19”	☐	1MRK 000 008-KB
Medium size – graphic display, IEC symbols, 1/2 19”	☐	1MRK 000 008-LB
Medium size – graphic display, IEC symbols, 3/4 19”	☐	1MRK 000 008-NB
Medium size – graphic display, IEC symbols, 1/1 19”	☐	1MRK 000 008-MB

Medium size – graphic display, ANSI symbols, 1/2 19”	☐ 1MRK 000 008-LC
Medium size – graphic display, ANSI symbols, 3/4 19”	☐ 1MRK 000 008-NC
Medium size – graphic display, ANSI symbols, 1/1 19”	☐ 1MRK 000 008-MC

Analog system

Rule: One Transformer input module must be ordered

Note: The same type of connection terminals has to be ordered for both TRMs

			1	2	
Transformer input module, compression connection terminals	12I, 1A, 50/60 Hz	Qty:	☐	☐	1MRK 002 247-CG
Transformer input module, compression connection terminals	12I, 5A, 50/60 Hz	Qty:	☐	☐	1MRK 002 247-CH
Transformer input module, compression connection terminals	9I+3U, 1A, 50/60 Hz	Qty:	☐	☐	1MRK 002 247-BG
Transformer input module, compression connection terminals	9I+3U, 5A, 50/60 Hz	Qty:	☐	☐	1MRK 002 247-BH
Transformer input module, compression connection terminals	5I, 1A+4I, 5A+3U, 50/60 Hz	Qty:	☐	☐	1MRK 002 247-BK
Transformer input module, compression connection terminals	7I+5U, 1A, 50/60 Hz	Qty:	☐	☐	1MRK 002 247-AP
Transformer input module, compression connection terminals	7I+5U, 5A, 50/60 Hz	Qty:	☐	☐	1MRK 002 247-AR
Transformer input module, compression connection terminals	6I+6U, 1A, 50/60 Hz	Qty:	☐	☐	1MRK 002 247-AG
Transformer input module, compression connection terminals	6I+6U, 5A, 50/60 Hz	Qty:	☐	☐	1MRK 002 247-AH
Transformer input module, compression connection terminals	6I, 1A, 50/60 Hz	Qty:		☐	1MRK 002 247-DG
Transformer input module, compression connection terminals	6I, 5A, 50/60 Hz	Qty:		☐	1MRK 002 247-DH
Transformer input module, ring lug terminals	12I, 1A, 50/60 Hz	Qty:	☐	☐	1MRK 002 247-CC
Transformer input module, ring lug terminals	12I, 5A, 50/60 Hz	Qty:	☐	☐	1MRK 002 247-CD
Transformer input module, ring lug terminals	9I+3U, 1A, 50/60 Hz	Qty:	☐	☐	1MRK 002 247-BC
Transformer input module, ring lug terminals	91+3U, 5A, 50/60 Hz	Qty:	☐	☐	1MRK 002 247-BD
Transformer input module, ring lug terminals	5+4I+3U, 50/60 Hz	Qty:	☐	☐	1MRK 002 247-BF
Transformer input module, ring lug terminals	7I+5U, 1A, 50/60 Hz	Qty:	☐	☐	1MRK 002 247-AS
Transformer input module, ring lug terminals	71I+5U, 5A, 50/60 Hz	Qty:	☐	☐	1MRK 002 247-AT
Transformer input module, ring lug terminals	6I+6U, 1A, 50/60 Hz	Qty:	☐	☐	1MRK 002 247-AC
Transformer input module, ring lug terminals	6I+6U, 5A, 50/60 Hz	Qty:	☐	☐	1MRK 002 247-AD

Transformer input module, ring lug terminals	6I, 1A, 50/60 Hz	Qty:	☐ 1MRK 002 247-DC
Transformer input module, ring lug terminals	6I, 5A, 50/60 Hz	Qty:	☐ 1MRK 002 247-DD

Note: One Analog digital conversion module, with time synchronization is always delivered with each Transformer input module.

Case size

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

Note: Standard order of location for I/O modules is BIM-BOM-SOM-IOM-MIM-GSM from left to right as seen from the rear side of the IED, but can also be freely placed. Only the GSM (GPS time synchronization module) has a specific slot designation, depending on case size.

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

	Maximum quantity of I/O modules							
Case sizes	BIM	IOM	BOM/ SOM	MIM	GSM	Maximum in case		
1/1 x 19”, one (1) TRM	14	6	4	4	1	14 (max 4 BOM+SOM+MIM)	☐	1MRK 000 151-NC
1/1 x 19”, two (2) TRM	11	6	4	4	1	11 (max 4 BOM+SOM+MIM)	☐	1MRK 000 151-ND
3/4 x 19”, one (1) TRM	8	6	4	1	1	8 (max 4 BOM+SOM+1 MIM)	☐	1MRK 000 151-NB
3/4 x 19”, two (2) TRM	5	5	4	1	1	5 (max 4 BOM+SOM+1 MIM)	☐	1MRK 000 151-NE
1/2 x 19”, one (1) TRM	3	3	3	0	1	3	☐	1MRK 000 151-NA

	Maximum quantity of I/O modules, with ring lug terminals, module limits see above			
Case sizes	Maximum in case	Possible locations for I/O modules with ringlugs		
1/1 x 19”, one (1) TRM	7	P3, P5, P7, P9, P11, P13, P15 *Note: No ringlugs in P15 if GSM is ordered*	☐	1MRK 000 151-NC
1/1 x 19”, two (2) TRM	5	P3, P5, P7, P9, P11	☐	1MRK 000 151-ND
3/4 x 19”, one (1) TRM	4	P3, P5, P7, P9 *Note: No ringlugs in P9 if GSM is ordered*	☐	1MRK 000 151-NB
3/4 x 19”, two (2) TRM	2	P3, P5	☐	1MRK 000 151-NE
1/2 x 19”, one (1) TRM	1	P3	☐	1MRK 000 151-NA

Binary input/output modules

Binary input module (BIM) 16 inputs

RL 24-30 VDC	Qty:	1 2 3 4 5 6 7 ☐ ☐ ☐ ☐ ☐ ☐ ☐ 8 9 10 11 12 13 14 ☐ ☐ ☐ ☐ ☐ ☐ ☐	1MRK 000 508-DB
RL 48-60 VDC	Qty:	1 2 3 4 5 6 7 ☐ ☐ ☐ ☐ ☐ ☐ ☐ 8 9 10 11 12 13 14 ☐ ☐ ☐ ☐ ☐ ☐ ☐	1MRK 000 508-AB
RL 110-125 VDC	Qty:	1 2 3 4 5 6 7 ☐ ☐ ☐ ☐ ☐ ☐ ☐ 8 9 10 11 12 13 14 ☐ ☐ ☐ ☐ ☐ ☐ ☐	1MRK 000 508-BB
RL 220-250 VDC	Qty:	1 2 3 4 5 6 7 ☐ ☐ ☐ ☐ ☐ ☐ ☐ 8 9 10 11 12 13 14 ☐ ☐ ☐ ☐ ☐ ☐ ☐	1MRK 000 508-CB

Binary input module (BIMp) with enhanced pulse counting capabilities, 16 inputs

RL 24-30 VDC Qty: 1 2 3 4 5 6 7 ☐ ☐ ☐ ☐ ☐ ☐ ☐ 8 9 10 11 12 13 14 ☐ ☐ ☐ ☐ ☐ ☐ ☐ 1MRK 000 508-HA

RL 48-60 VDC Qty: 1 2 3 4 5 6 7 ☐ ☐ ☐ ☐ ☐ ☐ ☐ 8 9 10 11 12 13 14 ☐ ☐ ☐ ☐ ☐ ☐ ☐ 1MRK 000 508-EA

RL 110-125 VDC Qty: 1 2 3 4 5 6 7 ☐ ☐ ☐ ☐ ☐ ☐ ☐ 8 9 10 11 12 13 14 ☐ ☐ ☐ ☐ ☐ ☐ ☐ 1MRK 000 508-FA

RL 220-250 VDC Qty: 1 2 3 4 5 6 7 ☐ ☐ ☐ ☐ ☐ ☐ ☐ 8 9 10 11 12 13 14 ☐ ☐ ☐ ☐ ☐ ☐ ☐ 1MRK 000 508-GA

Binary output module 24 output relays (BOM) Qty: 1 2 3 4 ☐ ☐ ☐ ☐ 1MRK 000 614-AB

Static binary output module (SOM) Qty: 1 2 3 4 ☐ ☐ ☐ ☐ 1MRK 002 614-AA

Binary input/output module (IOM) 8 inputs, 10 outputs, 2 high-speed outputs

RL 24-30 VDC Qty: 1 2 3 4 5 6 ☐ ☐ ☐ ☐ ☐ ☐ 1MRK 000 173-GB

RL 48-60 VDC Qty: 1 2 3 4 5 6 ☐ ☐ ☐ ☐ ☐ ☐ 1MRK 000 173-AC

RL 110-125 VDC Qty: 1 2 3 4 5 6 ☐ ☐ ☐ ☐ ☐ ☐ 1MRK 000 173-BC

RL 220-250 VDC Qty: 1 2 3 4 5 6 ☐ ☐ ☐ ☐ ☐ ☐ 1MRK 000 173-CC

Binary input/output module (IOMwith MOV), 8 inputs, 10 outputs, 2 high-speed outputs

RL 24-30 VDC Qty: 1 2 3 4 5 6 ☐ ☐ ☐ ☐ ☐ ☐ 1MRK 000 173-GC

RL 48-60 VDC Qty: 1 2 3 4 5 6 ☐ ☐ ☐ ☐ ☐ ☐ 1MRK 000 173-AD

RL 110-125 VDC Qty: 1 2 3 4 5 6 ☐ ☐ ☐ ☐ ☐ ☐ 1MRK 000 173-BD

RL 220-250 VDC Qty: 1 2 3 4 5 6 ☐ ☐ ☐ ☐ ☐ ☐ 1MRK 000 173-CD

mA input module 6 channels (MIM) Qty: 1 2 3 4 ☐ ☐ ☐ ☐ 1MRK 000 284-AB

Station communication ports

Only one of Optical ethernet resp. SPA/LON/IEC-103 module can be ordered.

Optical ethernet module, 1 glass interface ☐ 1MRK 002 266-AA

Optical ethernet module, 2 glass interfaces ☐ 1MRK 002 266-BA

Serial SPA/IEC 60870-5-103 and LON module (plastic) ☐ 1MRK 001 608-AA

Serial SPA/IEC 60870-5-103 (plastic) and LON (glass) module			☐ 1MRK 001 608-BA
Serial SPA/IEC 60870-5-103 and LON module (glass)			☐ 1MRK 001 608-CA
Galvanic RS485 communication module for DNP 3.0			☐ 1MRK 002 309-AA

Remote end serial communication for C37.94

Rule: Max two LDCM can be ordered

Optical short range line data communication module (Multi mode 900 nm) *(SR LDCM)*	Qty:	1 ☐ 2 ☐	1MRK 002 122-AB
Optical medium range line data communication module (Single mode 1310 nm) *(MR LDCM)*	Qty:	1 ☐ 2 ☐	1MRK 002 311-AA

Time synchronization

Rule: Only one Time synchronization can be ordered.

GPS Time synchronization module			☐ 1MRK 002 282-AA
IRIG-B Time synchronization module			☐ 1MRK 002 305-AA

Engineering facilities

19” rack mounting kit for 1/2 x 19” IED or 2 x RHGS6 or RHGS12	Quantity:	☐	1MRK 002 420-BB
19” rack mounting kit for 3/4 x 19” IED or 3 x RHGS6	Quantity:	☐	1MRK 002 420-BA
19” rack mounting kit for 1/1 x 19” IED	Quantity:	☐	1MRK 002 420-CA
Wall mounting kit for all IED sizes	Quantity:	☐	1MRK 002 420-DA
Flush mounting kit for all IED sizes	Quantity:	☐	1MRK 000 020-Y
Flush mounting kit + IP54 sealing (factory mounted). Cannot be ordered separately thus must be specified when ordering an IED.	Quantity:	☐	1MRK 002 418-AA

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:	1 ☐ 2 ☐	1MRK 002 245-AA
External interface converter from C37.94 to G703.E1	Quantity:	1 ☐ 2 ☐	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 RHGS6, 6U, 1/4 x 19”	Quantity: ☐	1MRK 002 420-AE
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, 3/4 x 19”	Quantity: ☐	1MRK 002 420-AB
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 and voltage dependent resistor 20-100V	1 2 3 Quantity: ☐ ☐ ☐	RK795101-MA
High impedance resistor unit 3-ph with resistor and voltage dependent resistor 20-100V	Quantity: ☐	RK795101-MB
High impedance resistor unit 1-ph with resistor and voltage dependent resistor 100-400V	1 2 3 Quantity: ☐ ☐ ☐	RK795101-CB
High impedance resistor unit 3-ph with resistor and voltage dependent resistor 100-400V	Quantity: ☐	RK795101-DC

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
Protection and control IED manager PCM 600			
PCM 600 ver. 1.5, IED Manager	Quantity:	☐	1MRK 003 395-AB
PCM 600 ver. 1.5, Engineering, IED Manager + CAP 531	Quantity:	☐	1MRK 003 395-BB
PCM 600 Engineering – Company licence	Quantity:	☐	1MRK 003 395-BL
PCM 600 ver. 1.5, Engineering, IED Manager + CAP 531 + CCT for IEC 61850-8-1 configuration of IED	Quantity:	☐	1MRK 003 395-CB
PCM 600 Engineering Pro – 10 licences	Quantity:	☐	1MRK 003 395-CL

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.

User documentation		Quantity:	☐	1MRK 002 290-AB
Rule: Specify the number of printed manuals requested				
Operator's manual	IEC	Quantity:	☐	1MRK 504 087-UEN
	ANSI	Quantity:	☐	1MRK 504 087-UUS
Technical reference manual	IEC	Quantity:	☐	1MRK 504 086-UEN
	ANSI	Quantity:	☐	1MRK 504 086-UUS
Installation and commissioning manual	IEC	Quantity:	☐	1MRK 504 088-UEN
	ANSI	Quantity:	☐	1MRK 504 088-UUS
Application manual	IEC	Quantity:	☐	1MRK 504 089-UEN
	ANSI	Quantity:	☐	1MRK 504 089-UUS
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

Related documents

Documents related to RET 670	**Identity number**
Operator’s manual	1MRK 504 087-UEN
Installation and commissioning manual	1MRK 504 088-UEN
Technical reference manual	1MRK 504 086-UEN
Application manual	1MRK 504 089-UEN
Buyer’s guide	1MRK 504 091-BEN
Connection diagram, Two winding transf. Single breaker arrangements	1MRK 002 801-LA
Connection diagram, Two winding transf. Multi breaker arrangements	1MRK 002 801-HA
Connection diagram, Three winding transf. Single breaker arrangements	1MRK 002 801-KA
Connection diagram, Three winding transf. Multi breaker arrangements	1MRK 002 801-GA
Configuration diagram A, Two winding transf. with single or double busbar but with a single breaker arr. on both sides (A30)	1MRK 004 500-93
Configuration diagram B, Two winding transf. in multi breaker arr. on one or both sides (A40)	1MRK 004 500-94
Configuration diagram C, Three winding transf. with single or double busbar but with a single breaker arr. on both sides (B30)	1MRK 004 500-95
Configuration diagram D, Three winding transf. in multi breaker arr. on one or both sides (B40)	1MRK 004 500-96
Configuration diagram E, Two or three winding transf., back-up protection package (A10)	1MRK 004 500-135
Configuration diagram F. Tap changer control package for two parallel transformers. (A25)	1MRK 004 500-140
Configuration diagram F. Tap changer control package for four parallel transformers. (A25)	1MRK 004 500-140
Setting example 1, 400/230 kV 500 MVA Transformer, YNyn connected	1MRK 504 083-WEN
Setting example 2, 132/230 kV 40 MVA Transformer, YNd1 connected	1MRK 504 084-WEN
Connection and Installation components	1MRK 013 003-BEN
Test system, COMBITEST	1MRK 512 001-BEN
Accessories for IED 670	1MRK 514 012-BEN
Getting started guide IED 670	1MRK 500 080-UEN
SPA and LON signal list for IED 670, ver. 1.1	1MRK 500 083-WEN
IEC 61850 Data objects list for IED 670, ver. 1.1	1MRK 500 084-WEN
Generic IEC 61850 IED Connectivity package	1KHA001027-UEN
Protection and Control IED Manager PCM 600 Installation sheet	1MRS755552
Engineering guide IED 670 products	1MRK 511 179-UEN

Latest versions of the described documentation can be found on www.abb.com/substationautomation

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