Protect[IT] Breaker protection terminal

REB 551*2.5

1MRK 505 098-BEN
Page 1
Revision: A
Issued: November 2003
Data subject to change without notice

Industrial[IT] enabled

Features

- A terminal with extensive configuration possibilities and expandable hardware design to meet specific user requirements
- Breaker failure protection with 10 ms reset time
- Complete autoreclosing function for one or two circuit breakers
- Syncrocheck with phasing and energizing check
- Versatile local human-machine interface (LED-HMI)
- Extensive self-supervision with internal event recorder
- Time synchronization with 1 ms resolution
- Four independent groups of complete setting parameters
- Powerful software PC ‘tool-box’ for monitoring, evalution and user configuration

Functions

- Current
  - Pole discordance protection, current and contact based (PD)
  - Breaker failure protection (BFP)
- Power system supervision
  - Loss of voltage check (LOV)
  - Overload supervision (OVLD)
  - Dead line detection (DLD)
- System protection and control
  - Pole slip protection (PSP)
- Secondary system supervision
  - Current circuit supervision, current based (CTSU)
  - Fuse failure supervision, negative sequence (FUSEns)
  - Fuse failure supervision, zero sequence (FUSEzs)
  - Fuse failure supervision, du/dt and di/dt based (FUSEdb)
  - Voltage transformer supervision (TCT)
- Control
  - Single command, 16 signals (CD)
  - Synchro-check and energizing-check, single circuit breaker (SYN1)
  - Synchro-check and energizing-check, double circuit breakers (SYN12)
  - Synchro-check and energizing-check, 1 1/2 breaker arrangement, per breaker (SYN 1 1/2)
  - Synchro-check with synchronizing and energizing-check, double circuit breaker (SYNsy1)
  - Synchro-check with synchronizing and energizing-check, double circuit breaker (SYNsy12)
  - Autorecloser - 1- and/or 3-phase, single circuit breaker (AR1-1/3)
  - Autorecloser - 1- and/or 3-phase, double circuit breakers (AR12-1/3)
  - Autorecloser - 3-phase, single circuit breaker (AR1-3)
  - Autorecloser- 3-phase, double circuit breaker (AR12-3)
- Logic
  - Single, two or three pole tripping logic (TR01-1/2/3)
  - Additional single, two or three pole tripping logic (TR02-1/2/3)
  - Pole discordance logic (PDc)
  - Additional configurable logic blocks (CL2)

- Communication channel test logic (CCHT)
- Binary signal transfer to remote end (RTC12)
- Multiple command, one fast block with 16 signals (CM1)
- Multiple command, 79 medium speed blocks each with 16 signals (CM79)

• Monitoring
  - Disturbance recorder (DR)
  - Event recorder (ER)
  - Trip value recorder (TVR)
  - Increased accuracy of AC input quatities (IMA)
  - Supervision of AC input quantities (DA)
  - Supervision of mA input quantities (MI)

• Metering capabilities
  - Pulse counter logic for metering (PC)
  - Six event counters (CN)

• Hardware
  - 18 LEDs for extended indication capabilities

• Several input/output module options including measuring mA input module (for transducers)

Application

The main purpose of the REB 551 terminal is the protection, control and monitoring of circuit breaker related applications in all networks. It provides for one-, two-, and/or three-pole tripping. It is specially suitable for application on circuit breakers in 1 1/2 and double breaker configurations.

Design

Type tested software and hardware that comply with international standards and ABB´s internal design rules together with extensive self monitoring functionality, ensure high reliability of the complete terminal

The terminal’s closed and partly welded steel case makes it possible to fulfill the stringent EMC requirements.

Serial data communication is via optical connections or galvanic RS485.

An extensive library of protection, control and monitoring functions is available. This library of functions, together with the flexible hardware design, allows this terminal to be configured to each user´s own specific requirements. This wide application flexibility makes this product an excellent choice for both new installations and the refurbishment of existing installations.

Platform

Application

The platform hardware and common software functions are included in all REx 5xx terminals. It is the foundation on which all terminals are built. Application specific modules and functions are added to create a specific terminal type or family.

Design

The REx 5xx platform consists of a case, hardware modules and a set of common functions.

The closed and partly welded steel case makes it possible to fulfill stringent EMC requirements. Three different sizes of the case are available to fulfill the space requirements of different terminals. The degree of protection is IP 40 according to IEC 529 for cases with the widths 1/2x19” and 3/4x19”. IP 54 can be obtained for the front area in flush and semiflush applications. Mounting kits are available for rack, flush, semiflush or wall mounting.

All connections are made on the rear of the case. Screw compression type terminal blocks are used for electrical connections. Serial communication connections are made by optical fibre connectors type Hewlett Packard (HFBR) for plastic fibres or bayonet type ST for glass fibres.

A set of hardware modules are always included in a terminal. Application specific modules are added to create a specific terminal type or family.

The common functions provide a terminal with basic functionality such as self supervision, I/O-system configurator, real time clock and other functions to support the protection and control system of a terminal.

Common functions

Description

Common functions are the software functions always included in the terminals.

Self supervision with internal event recorder (INT)

Application

Use the local HMI, SMS or SCS to view the status of the self-supervision function. The self-supervision operates continuously and includes:

- Normal micro-processor watchdog function
- Checking of digitized measuring signals
- Checksum verification of PROM contents and all types of signal communication

Real-time clock with external time synchronization (TIME)

Application

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

Functionality

Two main alternatives of external time synchronization are available. Either the synchronization message is applied via any of the communication ports of the terminal as a telegram message including date and time, or as a minute pulse, connected to a binary input. The minute pulse is used to fine tune already existing time in the terminals.

The REx 5xx terminal has its own internal clock with date, hour, minute, second and millisecond. It has a resolution of 1 ms.

The clock has a built-in calendar that handles leap years through 2098. Any change between summer and winter time must be handled manually or through external time synchronization. The clock is powered by a capacitor, to bridge interruptions in power supply without malfunction.

The internal clock is used for time-tagging disturbances, events in Substation monitoring system (SMS) and Substation control system (SCS), and internal events.

Four parameter setting groups (GRP)

Application

Use the four sets of settings to optimize the terminals operation for different system conditions. By creating and switching between fine tuned setting sets, either from the human-machine interface or configurable binary inputs, results in a highly adaptable terminal that can cope with a variety of system scenarios.

Functionality

The GRP function block has four functional inputs, each corresponding to one of the setting groups stored within the terminal. Activation of any of these inputs changes the active setting group. Four functional output signals are available for configuration purposes, so that continuous information on active setting group is available.

Configurable logic blocks (CL1)

Application

The user can with the available logic function blocks build logic functions and configure the terminal to meet application specific requirements.

Different protection, control, and monitoring functions within the REx 5xx terminals are quite independent as far as their configuration in the terminal is concerned. The user can not change the basic algorithms for different functions. But these functions combined with the logic function blocks can be used to create application specific functionality.

Invert function block (INV)

The inverter function block INV has one input and one output, where the output is in inverse ratio to the input.

OR function block (OR)

The OR function is used to form general combinatory expressions with boolean variables. The OR function block has six inputs and two outputs. One of the outputs is inverted.

AND function block (AND)

The AND function is used to form general combinatory expressions with boolean variables.The AND function block has four inputs and two outputs. One of the inputs and one of the outputs are inverted.

Timer function block (TM)
The function block TM timer has drop-out and pick-up delayed outputs related to the input signal. The timer has a settable time delay (parameter T).

Timer long fuction block (TL)
The function block TL timer with extended maximum time delay at pick-up and at drop-out, is identical with the TM timer. The difference is the longer time delay.

Pulse timer function block (TP)
The pulse function can be used, for example, for pulse extensions or limiting of operation of outputs. The pulse timer TP has a settable length.

Extended length pulse function block (TQ)
The function block TQ pulse timer with extended maximum pulse length, is identical with the TP pulse timer. The difference is the longer pulse length.

Exclusive OR function block (XOR)
The exclusive OR function XOR is used to generate combinatory expressions with boolean variables. The function block XOR has two inputs and two outputs. One of the outputs is inverted. The output signal is 1 if the input signals are different and 0 if they are equal.

Set-reset function block (SR)
The Set-Reset (SR) function is a flip-flop that can set or reset an output from two inputs respectively. Each SR function block has two outputs, where one is inverted.

Set-reset with memory function block (SM)
The Set-Reset function SM is a flip-flop with memory that can set or reset an output from two inputs respectively. Each SM function block has two outputs, where one is inverted. The memory setting controls if the flip-flop after a power interruption will return the state it had before or if it will be reset.

Controllable gate function block (GT)
The GT function block is used for controlling if a signal should be able to pass from the input to the output or not depending on a setting.

Settable timer function block (TS)
The function block TS timer has outputs for delayed input signal at drop-out and at pick-up. The timer has a settable time delay. It also has an Operation setting On, Off that controls the operation of the timer.

Move first function (MOF)
The Move function block MOF is put first in the slow logic and is used for signals coming from fast logic into the slow logic. The MOF function block is only a temporary storage for the signals and does not change any value between input and output.

Move last function block (MOL)
The Move function block MOL is put last in the slow logic and is used for signals going out from the slow logic to the fast logic. The MOL function block is only a temporary storage for the signals and does not change any value between input and output.

Event function (EV)

Application
When using a Substation Automation system, events can be spontaneously sent or polled from the terminal to the station level. These events are created from any available signal in the terminal that is connected to the event function block. The event function block can also handle double indication, that is normally used to indicate positions of high-voltage apparatuses. With this event function block, data also can be sent to other terminals over the interbay bus.

Functionality
As basic, 12 event function blocks EV01-EV12 running with a fast cyclicity, are available in REx 5xx. When the function Apparatus control is used in the terminal, additional 32 event function blocks EV13-EV44, running with a slower cyclicity, are available.

Each event function block has 16 connectables corresponding to 16 inputs INPUT1 to INPUT16. Every input can be given a name with up to 19 characters from the CAP 540 configuration tool.

The inputs can be used as individual events or can be defined as double indication events.

The inputs can be set individually, from the Parameter Setting Tool (PST) under the Mask-Event function, to create an event at pick-up, drop-out or at both pick-up and drop-out of the signal.

The event function blocks EV01-EV06 have inputs for information numbers and function type, which are used to define the events according to the communication standard IEC 60870-5-103.

Supervision of AC input quantities (DA)

Application
Use the AC monitoring function to provide three phase or single phase values of voltage and current. At three phase measurement, the values of apparent power, active power, reactive power, frequency and the RMS voltage and current for each phase are calculated. Also the average values of currents and voltages are calculated.

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

The software functions to support presentation of measured values are always present in the terminal. In order to retrieve actual values, however, the terminal must be equipped with the appropriate hardware measuring module(s), i.e. Transformer Input Module (TRM).

Supervision of mA input quantities (MI)

Application
Use the DC monitoring function to measure and process signals from different measuring transducers. Many devices used in process control uses low currents, usually in the range 4-20 mA or 0-20 mA to represent various parameters such as frequency, temperature and DC battery voltage.

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

The software functions to support presentation of measured values are always present in the terminal. In order to retrieve actual values, however, the terminal must be equipped with the mA Input Module (MIM).

I/O system configurator (IOP)

Application
The I/O system configurator must be used in order for the terminal’s software to recognize added modules and to create internal address mappings between modules and protections and other functions.

Setting restriction of HMI (SRH)

Application
Use the setting restriction function to prevent unauthorized setting changes and to control when setting changes are allowed. Unpermitted or uncoordinated changes by unauthorized personnel may influence the security of people and cause severe damage to primary and secondary power circuits.

By adding a key switch connected to a binary input a simple setting change control circuit can be built simply allowing only authorized keyholders to make setting changes from the built-in HMI.

Functionality
The restriction of setting via the local HMI can be activated from the local HMI only. Activating the local HMI setting restriction prevent unauthorized changes of the terminal settings or configuration.

The function permits remote changes of settings and reconfiguration through the serial communication ports.   for SPA communication parameters.

All other functions of the local human-machine communication remain intact. This means that an operator can read disturbance reports, setting values, the configuration of different logic circuits and other available information.

Blocking of signals during test (BST)

Application
The protection and control terminals have a complex configuration with many included functions. To make the testing procedure easier, the terminals include the feature to individually block a single, several or all functions.

This means that it is possible to see when a function is activated or trips. It also enables the user to follow the operation of several related functions to check correct functionality and to check parts of the configuration etc.

The Release Local for line differential function is only possible to operate if the terminal has been set in test mode from the HMI.

Current

Pole discordance protection, current and contact based (PD)

Application

Breaker pole position discordance can occur on the operation of a breaker with independent operating gears for the three poles. The reason may be an interruption in the closing or trip coil circuit, or a mechanical failure resulting in a stuck breaker pole. A pole discordance can be tolerated for a limited time, for instance during a single-phase trip-reclose cycle. The pole discordance function detects a breaker pole discordancy not generated by auto-reclose cycle and issues a trip signal for the circuit breaker.

Functionality

The operation of the pole discordance logic, PD, is based on checking the position of the breaker auxiliary contacts. Three parallel normally open contacts in series with three normally closed contacts in parallel of the respective breaker poles form a condition of pole discordance, connected to a binary input dedicated for the purpose.

In addition, there is an automatic detection criterion based on comparison of currents in the breaker poles. This function is enabled for just a few seconds after close or trip commands to the breaker in order to avoid unwanted operation in unsymmetrical load conditions.

Breaker failure protection (BFP)

Application

In many protection applications local redundancy is used. One part of the fault clearance system is however never duplicated, namely the circuit breaker. Therefore a breaker failure protection can be used.

The breaker failure protection is initiated by trip signals from different protection functions within or outside the protection terminal. When a trip signal is sent to the breaker failure protection first, with no or a very short delay, a re-trip signal can be sent to the protected breaker. If fault current is flowing through the breaker still after a setting time a back-up trip signal is sent to the adjacent breakers. This will ensure fault clearance also if the circuit breaker is out of order.

Functionality

Breaker failure protection, BFP, provides backup protection for the primary circuit breaker if it fails to clear a system fault. It is obtained by checking that fault current persists after a brief time from the operation of the object protection and issuing then a three phase trip command to the adjacent circuit breakers (back-up trip).

Correct operation at evolving faults is ensured by phase segregated starting command, phase segregated current check and phase segregated settable timers.

Additionally, the retrip of the faulty circuit breaker after a settable time is possible. The retrip can be controlled by current check or carried out as direct retrip.

Power system supervision

Loss of voltage check (LOV)

Application

The loss of voltage detection, LOV, is suitable for use in networks with an automatic restoration function. The LOV 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 than 7 seconds, and the circuit breaker remains closed.

Functionality

The operation of LOV function is based on line voltage measurement. The function is provided with a logic, which automatically recognises if the line was restored for at least three seconds before starting the seven seconds timer. Additionally, the function is automatically blocked if only one or two phase voltages have been detected low for more than 10 seconds. The LOV function operates again only if the line has been fully energised.

Operation of LOV function is also inhibited by fuse failure and open circuit breaker information signals, by their connection to dedicated inputs of the function block.

The operation of the function is supervised by the fuse-failure function and the information about the closed position of the associated circuit breaker.

Overload supervision (OVLD)

Application

The overload protection, OVLD, prevents excessive loading of power transformers, lines and cables.

Alternative application is the detection of primary current transformer overload, as they usually can withstand a very small current beyond the rated value.

Functionality

The function continuously measures the three phase currents flowing through the terminal. If any of the three currents is beyond the preset overcurrent threshold for a time longer than the preset value, a trip signal is activated.

Dead line detection (DLD)

Application

The main purpose of the dead line detection is to provide different protection, control and monitoring functions with the status of the line, i.e whether or not it is connected to the rest of the power system.

Functionality

The dead line detection function continuously measures all three phase currents and phase voltages of a protected power line. The line is declared as dead (not energized) if all three measured currents and voltages fall below the preset values for more than 200 ms.

System protection and control

Pole slip protection (PSP)

Application

Sudden events in an electrical power system such as large jumps in load, fault occurrence or fault clearance, can cause oscillations referred to as power swings. In a recoverable situation, the power swings will decay and stable operation will be resumed; in a non-recoverable situation, the power swings become so severe that the synchronism is lost, a condition referred to as pole slipping. The main purpose of the PSP pole slip protection is to detect, evaluate, and take the required action for pole slipping occurrences in the power system.

Functionality

The PSP function comprises an inner and an outer quadrilateral measurement characteristic. It detects oscillations in the power system by measuring the time it takes the transient impedance to pass through the impedance area between the outer and the inner characteristics. Oscillations are identified by transition times longer than timer settings. The impedance measuring principle is the same as that used for the distance protection zones. The impedance and the transient impedance time are measured in all three phases separately. One-out-of-three or two-out-of-three operating modes can be selected permanently or adaptively according to the specific system operating conditions.

Oscillations with an oscillation period as low as 200 ms (i.e. with a slip frequency as high as 10% of the rated frequency on a 50 Hz basis) can be detected for normal system operating conditions, as well as during the dead time of a single-pole automatic reclosing cycle. Different timers are used for initial and consecutive pole slips, securing a high degree of differentiation between oscillation and fault conditions.

It is possible to inhibit the ocsillation detected output on detection of earth fault current. This can be used to release the operation of the distance protection function for earth faults during power oscillation conditions.

The PSP function has two tripping areas. These are located within the operating area, which is located within the inner characteristic. On detection of a new oscillation, the activation of a trip output will depend on the applied settings. These determine the direction of the transition for which tripping is permitted, whether tripping will occur on entry of the measured impedance into a tripping area, or on its exit from the tripping area, and through which tripping area the transition must be measured for tripping to occur. The applied settings also determine the number of pole slips required before the trip output is issued.

Secondary system supervision

Current circuit supervision, current based (CTSU)

Application

Faulty information about current flows in a protected element might influence the security (line differential protection) or dependability (line distance protection) of a complete protection system.

The main purpose of the current circuit supervision function is to detect different faults in the current secondary circuits and influence the operation of corresponding main protection functions.

The signal can be configured to block different protection functions or initiate an alarm.

Functionality

The function compares the sum of the three phase currents from one current transformer core with a reference zero sequence current from another current transformer core.

The function issues an output signal when the difference is greater than the set value.

Fuse failure supervision (FUSE)

Application

The fuse failure supervision function, FUSE, continuously supervises the ac voltage circuits between the voltage instrument transformers and the terminal. Different output signals can be used to block, in case of faults in the ac voltage secondary circuits, the operation of the distance protection and other voltage-dependent functions, such as the synchro-check function, undervoltage protection, etc.

Different measurement principles are available for the fuse failure supervision function.

The FUSE function based on zero sequence measurement principle, is recommended in directly or low impedance earthed systems.

The FUSE function based on the negative sequence measurement principle is recommended in isolated or high impedance earthed systems.

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

Functionality

The FUSE function based on the negative sequence measurement principle continuously measures the negative sequence voltage and current in all three phases. It operates if the measured negative sequence voltage increases over the preset operating value, and if the measured negative sequence current remains below the preset operating value.

The FUSE function based on the zero sequence measurement principle continuously measures the zero sequence current and voltage in all three phases. It operates if the measured zero sequence voltage increases over preset operating value, and if the measured zero sequence current remains below the preset operating value.

The di/dt and du/dt algorithm, detects a fuse failure if a sufficient negative change in voltage amplitude without a sufficient change in current amplitude is detected in each phase separately. This check is performed if the circuit breaker is closed. Information about the circuit breaker position is brought to the function input CBCLOSED through a binary input of the terminal.

Three output signals are available. The first depends directly on the voltage and current measurement. The second depends on the operation of the dead line detection function, to prevent unwanted operation of the distance protection if the line has been deenergised and energised under fuse failure conditions. The third depends on the loss of all three measured voltages. A special function input serves the connection to the auxiliary contact of a miniature circuit breaker, MCB (if used), to secure correct operation of the function on simultaneous interruption of all three measured phase voltages also when the additional delta current and delta voltage algorithm is not present in the function block.

Voltage transformer supervision (TCT)

Application

The main purpose of the voltage transformer supervision function is to indicate failure in the measuring voltage from a capacitive voltage transformer.

Functionality
The voltage transformer supervision function checks all of the three phase-phase voltages and the residual voltage. If the residual voltage exceeds the setpoint value and any of the phase-phase voltages is higher than 80% of the rated phase-phase voltage the output is activated after a settable time delay.

Control

Single command, 16 signals (CD)

Application
The terminals may be provided with a function to receive signals either from a substation automation system (SMS and/or SCS) or from the local human-machine interface, HMI. That receiving function block has 16 outputs that can be used, for example, to control high voltage apparatuses in switchyards. For local control functions, the local HMI can also be used. Together with the configuration logic circuits, the user can govern pulses or steady output signals for control purposes within the terminal or via binary outputs.

Functionality
The single command function consists of a function block CD for 16 binary output signals.

The output signals can be of the types Off, Steady, or Pulse. The setting is done on the MODE input, common for the whole block, from the CAP 531 configuration tool.

The outputs can be individually controlled from the operator station, remote-control gateway, or from the local HMI. Each output signal can be given a name with a maximum of 13 characters from the CAP 531 configuration tool.

The output signals, here OUT1 to OUT16, are then available for configuration to built-in functions or via the configuration logic circuits to the binary outputs of the terminal.

Synchrocheck and energizing check (SYN)

Application
The main purpose of the synchrocheck function is to provide controlled closing of circuit breakers in interconnected networks.

The main purpose of the energizing check function is to facilitate the controlled reconnection of a disconnected line or bus to, respectively, an energized bus or line.

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.

The synchronizing function is only available together with the synchrocheck and energizing check functions.

To meet the different application arrangements, a number of identical SYN function blocks may be provided within a single terminal. The number of these function blocks that may be included within any given terminal depends on the type of terminal. Therefore, the specific circuit breaker arrangements that can be catered for, or the number of bays of a specific arrangement that can be catered for, depends on the type of terminal.

Functionality
The synchrocheck function measures the conditions across the circuit breaker and compares them to set limits. The output is only given when all measured conditions are simultaneously within their set limits.

The energizing check function measures the bus and line voltages and compares them to both high and low threshold detectors. The output is only given when the actual measured conditions match the set conditions.

The synchronizing measures the conditions across the circuit breaker, and also determines the angle change during the closing delay of the circuit breaker from the measured slip frequency. The output is only given when all measured conditions are simultaneously within their set limits. The issue of the output is timed to give closure at the optimal time.

Single breaker
For single circuit breaker arrangements, the SYN function blocks have the capability to make the necessary voltage selection. For single circuit breaker arrangements, selection of the correct voltage is made using auxiliary contacts of the bus disconnection.

1 1/2 breaker
For 1 1/2 circuit breaker arrangements, the SYN function blocks have the capability to make the necessary voltage selection. For 1 1/2 circuit breaker arrangements, correct voltage selections is made using auxiliary contacts of the bus disconnection as well as the circuit breakers (as well as binary output signals from the other terminals in the same diameter for 1 1/2 circuit breaker applications with a separate terminal per circuit breaker).

Autorecloser (AR)

Application
The majority of power line faults are transient in nature, i.e. they do not recur when the line is re-energized following disconnection. The main purpose of the AR automatic reclosing function is to automatically return power lines to service following their disconnection for fault conditions.

Especially at higher voltages, the majority of line faults are single-phase-to-earth. Faults involving all three phases are rare. The main purpose of the single- and two-pole automatic reclosing function, operating in conjunction with a single- and two-pole tripping capability, is to limit the effect to the system of faults involving less than all three phases. This is particularly valuable for maintaining system stability in systems with limited meshing or parallel routing.

Functionality
The AR function is a logical function built up from logical elements. It operates in conjunction with the trip output signals from the line protection functions, the OK to close output signals from the synchrocheck and energizing check function, and binary input signals. The binary input signals can be for circuit breaker position/status or from other external protection functions.

Of the six reclosing programs, one provides for three-pole reclosing only, while the others provide for single- and two-pole reclosing as well. For the latter, only the first shot may be single- or two-pole. All subsequent shots up to the maximum number will be three-pole. For some of the programs, depending on the initial trip, no shot, or only one shot, will be permitted irrespective of the number of shots selected.

Logic

Tripping logic (TR)

Application
The main purpose of the TR trip logic function is to serve as a single node through which all tripping for the entire terminal is routed.

The main purpose of the single- and two-pole extension to the basic three-pole tripping function is to cater for applications where, for reasons of system stability, single-pole tripping is required for single-phase faults, and/or two-pole tripping is required for two-phase faults, e.g. on double circuit parallel lines.

Functionality
The minimum duration of a trip output signal from the TR function is settable.

The TR function has a single input through which all trip output signals from the protection functions within the terminal, or from external protection functions via one or more of the terminal's binary inputs, are routed. It has a single trip output for connection to one or more of the terminal's binary outputs, as well as to other functions within the terminal requiring this signal.

The expanded TR function for single- and two-pole tripping has additional phase segregated inputs for this, as well as inputs for faulted phase selection. The latter inputs enable single- and two-pole tripping for those functions which do not have their own phase selection capability, and therefore which have just a single trip output and not phase segregated trip outputs for routing through the phase segregated trip inputs of the expanded TR function. The expanded TR function has two inputs for these functions, one for impedance tripping (e.g. carrier-aided tripping commands from the scheme communication logic), and one for earth fault tripping (e.g. tripping output from a residual overcurrent protection). Additional logic secures a three-pole final trip command for these protection functions in the absence of the required phase selection signals.

The expanded TR function has three trip outputs, one per phase, for connection to one or more of the terminal's binary outputs, as well as to other functions within the terminal requiring these signals.

The expanded TR function is equipped with logic which secures correct operation for evolving faults as well as for reclosing on to persistent faults. A special input is also provided which disables single- and two-pole tripping, forcing all tripping to be three-pole.

Pole discordance logic (PDc)

Application

Breaker pole position discordance can occur on the operation of a breaker with independent operating gears for the three poles. The reason may be an interruption in the closing or trip coil circuit, or a mechanical failure resulting in a stuck breaker pole. A pole discordance can be tolerated for a limited time, for instance during a single-phase trip-reclose cycle. The pole discordance function detects a breaker pole discordancy not generated by auto-reclose cycle and issues a trip signal for the circuit breaker.

Functionality

The operation of the pole discordance logic, PDc, is based on checking the position of the breaker auxiliary contacts. Three parallel normally open contacts in series with three normally closed contacts in parallel of the respective breaker poles form a condition of pole discordance, connected to a binary input dedicated for the purpose.

Additional configurable logic blocks (CL2)

Application

Additional configurable logic means that an extended number of logic circuits are available. Also Move function blocks (MOF, MOL), used for synchronization of boolean signals sent between logics with slow and fast execution, are among the additional configurable logic circuits.

Functionality

The functionality of the additional logic function blocks are the same as for the basic logic functions, but with an extended number of blocks.

Communication channel test logic (CCHT)

Application

Many secondary system applications require testing of different functions with confirmed information about the result of the test. The main purpose of the CCHT communication channel test logic is to perform testing of communication channels (power line carrier) in applications where continuous monitoring by some other means is not possible due to technical or economic reasons, and to indicate the result of the test.

Functionality

Starting of a communications channel test may be performed manually (by means of an external pushbutton) or automatically (by means of an included timer). When started, the CCHT logic initiates the sending of an impulse (carrier send signal) to the remote end. This action starts the operation of the applicable external functions. On receipt of the sent signal at the remote end terminal, a return signal is immediately sent back to the initiating end by the identical CCHT logic function within that terminal. The initiating end waits for this returned signal. It reports a successful or an unsuccessful response to the initiated test based on the receipt or not of this signal. An input is provided through which it is possible to abort the test by means of an external signal.

Binary signal transfer to remote end (RTC)

General

In this function, there are two function blocks, RTC1-, and RTC2-. They are identical in all aspects.

Application

The main purpose of the RTC binary signal transfer to remote end function is the exchange of communication scheme related signals, trip signals and/or other binary signals between opposite ends of the line.

Functionality

The RTC function comprises two identical function blocks, each able to handle up to 16 inputs and 16 outputs, giving a total of 32 signals that can be transmitted in each direction.

The updated status of the selected binary signals is packaged within a data message which is sent once every computation loop.

Event counter (CN)

Application

The function consists of six counters which are used for storing the number of times each counter has been activated. It is also provided with a common blocking function for all six counters, to be used for example at testing.

Every counter can separately be set on or off by a parameter setting.

Functionality

The function block has six inputs for increasing the counter values for each of the six counters respectively. The content of the counters are stepped one step for each positive edge of the input respectively.

The function block also has an input BLOCK. At activation of this input all six counters are blocked.

Multiple command (CM)

Application

The terminals may be provided with a function to receive signals either from a substation automation system or from other terminals via the interbay bus. That receiving function block has 16 outputs that can be used, together with the configuration logic circuits, for control purposes within the terminal or via binary outputs. When it is used to communicate with other terminals, these terminals must have a corresponding event function block to send the information.

Functionality

One multiple command function block CM01 with fast execution time also named *Binary signal interbay communication, high speed* and/or 79 multiple command function blocks CM02-CM80 with slower execution time are available in the REx 5xx terminals as options.

The output signals can be of the types Off, Steady, or Pulse. The setting is done on the MODE input, common for the whole block, from the CAP 531 configuration tool.

The multiple command function block has 16 outputs combined in one block, which can be controlled from the operator station or from other terminals. One common name for the block, with a maximum of 19 characters, is set from the configuration tool CAP 531.

The output signals, here OUT1 to OUT16, are then available for configuration to built-in functions or via the configuration logic circuits to the binary outputs of the terminal.

The command function also has a supervision function, which sets the output VALID to 0 if the block did not receive data within a configured INTERVAL time.

Monitoring

Disturbance report (DRP)

Application

Use the disturbance report to provide the network operator with proper information about disturbances in the primary network. The function comprises several subfunctions enabling different types of users to access relevant information in a structured way.

Select appropriate binary signals to trigger the red HMI LED to indicate trips or other important alerts.

Functionality

The disturbance report collects data from each subsystem for up to ten disturbances. The data is stored in nonvolatile memory, used as a cyclic buffer, always storing the latest occurring disturbances. Data is collected during an adjustable time frame, the collection window. This window allows for data collection before, during and after the fault.

The collection is started by a trigger. Any binary input signal or function block output signal can be used as a trigger. The analog signals can also be set to trigger the data collection. Both over levels and under levels are available. The trigger is common for all subsystems, hence it activates them all simultaneously.

A triggered report cycle is indicated by the yellow HMI LED, which will be lit. Binary signals may also be used to activate the red HMI LED for additional alerting of fault conditions. A disturbance report summary can be viewed on the local HMI.

Indications

Application

Use the indications list to view the state of binary signals during the fault. All binary input signals to the disturbance report function are listed.

Functionality

The indications list tracks zero-to-one changes of binary signals during the fault period of the collection window. This means that constant logic zero, constant logic one or state changes from logic one to logic zero will not be visible in the indications list. Signals are not time tagged. In order to be listed in the indications list the:

1. signal must be connected to the DRP function blocks, (DRP1, DRP2, DRP3).
2. setting parameter, IndicationMask, for the input must be set to Show.

Output signals of other function blocks of the configuration will be listed by the signal name listed in the corresponding signal list. Binary input signals are listed by the name defined in the configuration.

The indications can be viewed on the local HMI and via SMS.

Disturbance recorder (DR)

Application

Use the disturbance recorder to record analog and binary signals during fault conditions in order to analyze disturbances. The analysis may include fault severity, fault duration and protection performance. Replay the recorded data in a test set to verify protection performance.

Functionality

The disturbance recorder records both analog and binary signal information and up to ten disturbances can be recorded.

Analog and digital signals can be used as triggers. A trigger signal does not need to be recorded.

A trigger is generated when the analog signal moves under and/or over set limit values. The trig level is compared to the signal’s average peak-to-peak value, making the function insensible to DC offset. The trig condition must occur during at least one full period, that is, 20 ms for a 50 Hz network.

The recorder continuously records data in a cyclic buffer capable of storing the amount of data generated during the set pre-fault time of the collection window. When triggered, the pre-fault data is saved and the data for the fault and post-fault parts of the collection window is recorded.

The RAM area for temporary storage of recorded data is divided into subareas, one for each recording. The size of a subarea depends on the set recording times. There is sufficient memory for four consecutive recordings with a maximum number of analog channels recorded and with maximum time settings. Should no subarea be free at a new disturbance, the oldest recording is overwritten.

When a recording is completed, the post recording process:

- merges the data for analog channels with corresponding data for binary signals stored in an event buffer
- compresses the data without loosing any data accuracy
- stores the compressed data in a non-volatile memory

The disturbance recordings can be viewed via SMS or SCS.

Event recorder (ER)

Application

Use the event recorder to obtain a list of binary signal events that occurred during the disturbance.

Functionality

When a trigger condition for the disturbance report is activated, the event recorder collects time tagged events from the 48 binary signals that are connected to disturbance report and lists the changes in status in chronological order. Each list can contain up to 150 time tagged events that can come from both internal logic signals and binary input channels and up to ten disturbances can be recorded. Events are recorded during the total recording time which depends on the set recording times and the actual fault time.

Events can be viewed via SMS and SCS.

Trip value recorder (TVR)

Application

Use the trip value recorder to record fault and prefault phasor values of voltages and currents to be used in detailed analysis of the severity of the fault and the phases that are involved. The recorded values can also be used to simulate the fault with a test set.

Functionality

Pre-fault and fault phasors of currents and voltages are filtered from disturbance data stored in digital sample buffers.

When the disturbance report function is triggered, the function looks for non-periodic change in the analog channels. Once the fault interception is found, the function calculates the pre-fault RMS values during one period starting 1,5 period before the fault interception. The fault values are calculated starting a few samples after the fault interception and uses samples during 1/2 - 2 periods depending on the waveform.

If no error sample is found the trigger sample is used as the start sample for the calculations. The estimation is based on samples one period before the trigger sample. In this case the calculated values are used both as prefault and fault values.

The recording can be viewed on the local HMI or via SMS.

Increased accuracy of AC input quantities (IMA)

Application

Select the increased accuracy option to increase the measuring accuracy of analog input channels, thus also increasing the accuracy of calculated quantities such as frequency, active and reactive power.

Functionality

The increased accuracy is reached by a factory calibration of the hardware. Calibration factors are stored in the terminal. If the transformer input module, A/D conversion module or the main processing module is replaced, the terminal must be factory calibrated again to retain the increased accuracy.

Metering

Pulse counter logic for metering (PC)

Application

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. The number of pulses in the counter is then reported via LON to the station control system or read via SPA from the station monitoring system as a service value.

Functionality

Up to 12 inputs located on binary input modules can be used for counting of pulses with a frequency of up to 40 Hz. The registration of pulses is done for positive transitions (0 to 1) on any of the 16 binary input channels on the input module.

Pulse counter values are read from the operator workplace with predefined cyclicity without reset. The integration time period can be set in the range from 30 seconds to 60 minutes and is synchronized with absolute system time.

The counter value is a 32-bit, signed integer with a range 0...+2147483647. The reported value over the communication bus contains Identity, Value, Time and Pulse Counter Quality.

Data communication

Remote end data communication modules

Application

The remote terminal communication modules can be used either for differential line protection applications or for binary signal transfer of up to 32 signals in both directions between for example distance protections. The following hardware modules are available:

- V35/36 contra-directional and co-directional
- X.21
- RS530/422 contra-directional and co-directional
- G.703
- Short-range galvanic module
- Fibre optical communication module
- Short-range fibre optical module

Fibre optical module

The fibre optical communication module DCM-FOM can be used both with multi-mode and single-mode fibres.The communication distance can typically be 30 km for single mode fibre and 15 km for multi-mode fibre, with high quality fibres even longer. This interface can also be used for direct connection to communication equipment of type FOX from ABB.

Galvanic interface

The galvanic data communication modules according to V35/36 DCM-V36 contra, DCM-V36 co, X.21 DCM-X21, RS530/422 DCM-RS 530 contra, DCM-RS 530 co can be used for galvanic short range communication covering distances up to 100 m in low noise environment. Only contra-directional operation is recommended in order to get best system performance. These modules are designed for 64 kbit/s operation but can also be used at 56 kbit/s.

Short range galvanic module

The short-range galvanic module DCM-SGM can be used for communication over galvanic pilot wires and can operate for distances typically between 0,5 and 3 km depending on pilot wire cable. Twisted-pair, double-screened cable is recommended.

Short range fibre optical module

The short-range fibre optical module DCM-SFOM can only be used with multi-mode fibre .The communication distance can normally be up to 5 km. This module can also be used for direct connection to optical/electrical communication converters of type 21-15xx and 21-16xx from FIBERDATA

Physically the DCM module is inserted in slot position S19 for 1/2 19” rack.

Physically the DCM module is inserted in slot position S29 for 3/4 19” rack.

Co-directional G.703 galvanic interface

The galvanic data communication module DCM-G.703 according to G.703 is not recommended for distances above 10 m. Special attention must be paid to avoid problems due to noise interference. This module is designed only for 64 kbit/s operation.

Communication alternatives

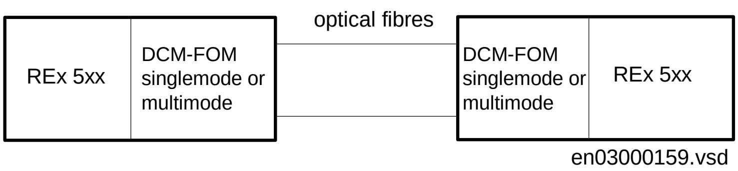


Figure 1: Dedicated link, optical fibre connection

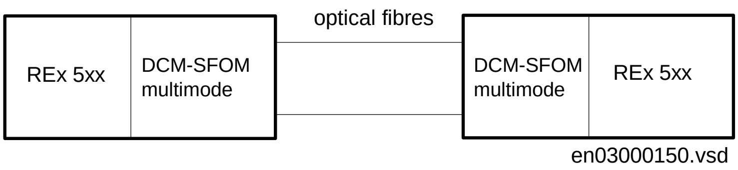


Figure 2: Dedicated link, short range optical fibre connection

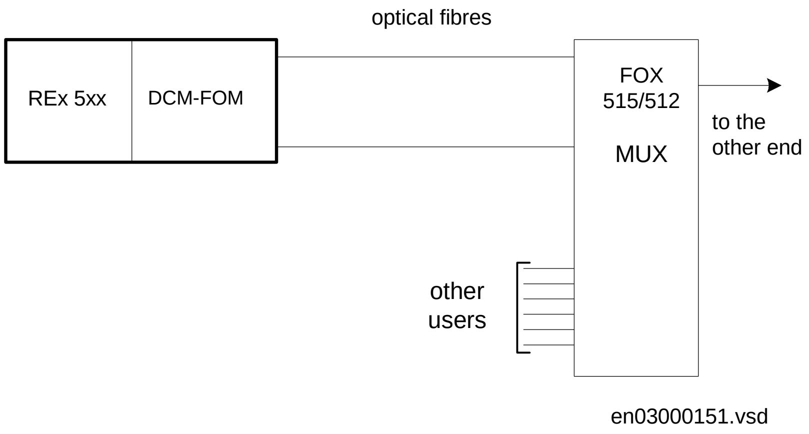


Figure 3: Multiplexed link, optical fibre connection

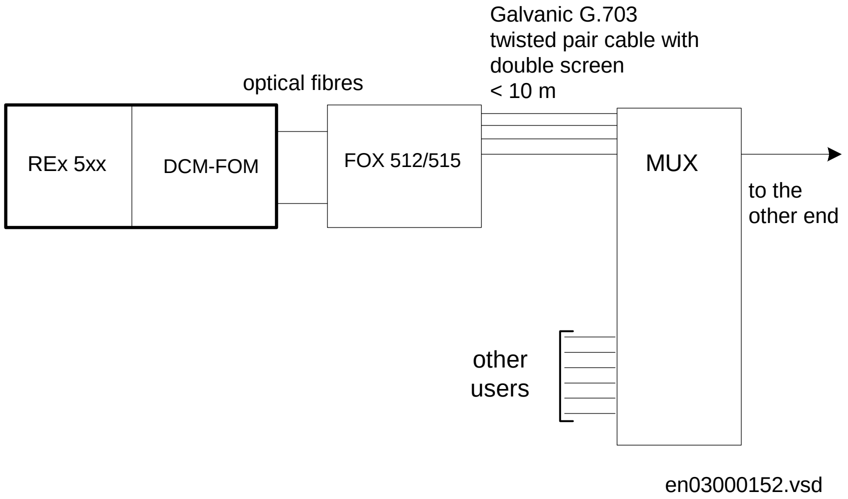


Figure 4: Multiplexed link, fibre optical-galvanic connection with FOX 515

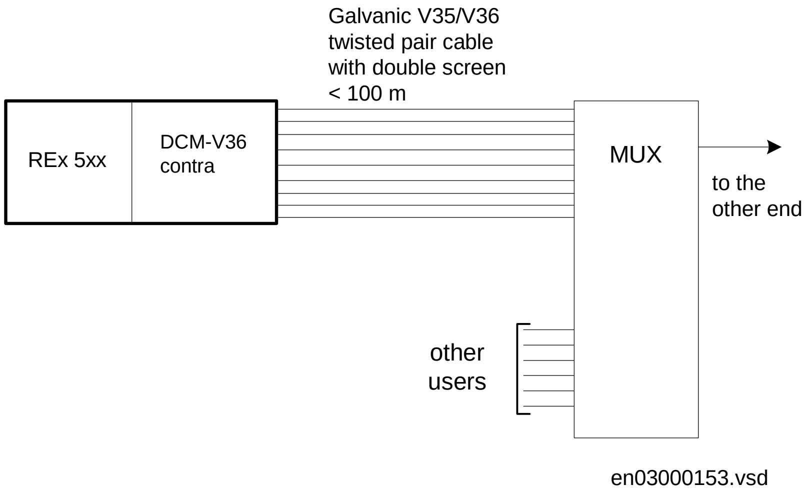


Figure 5: Multiplexed link, galvanic connection, V35/V36 contra directional

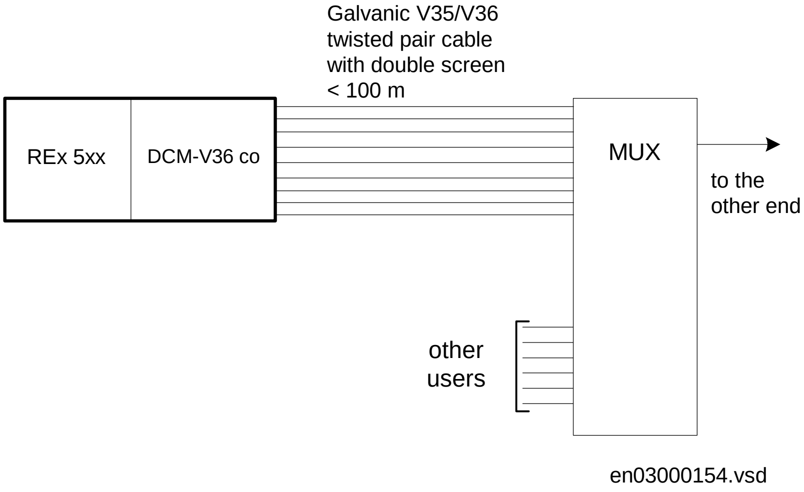


Figure 6: Multiplexed link, galvanic connection V35/V36 co-directional

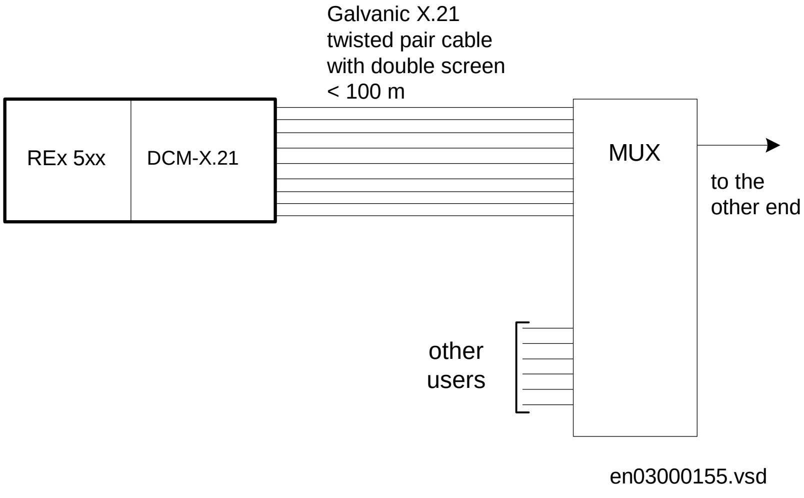


Figure 7: Multiplexed link, galvanic connection, X.21

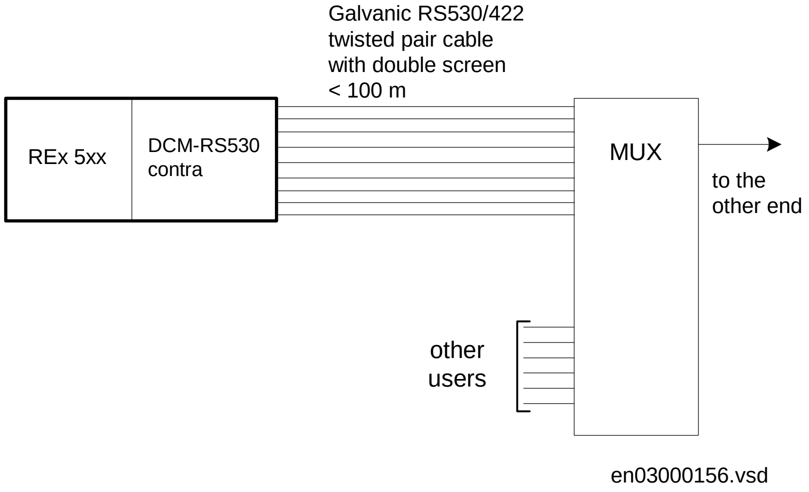


Figure 8: Multiplexed link, galvanic connection, RS530/422

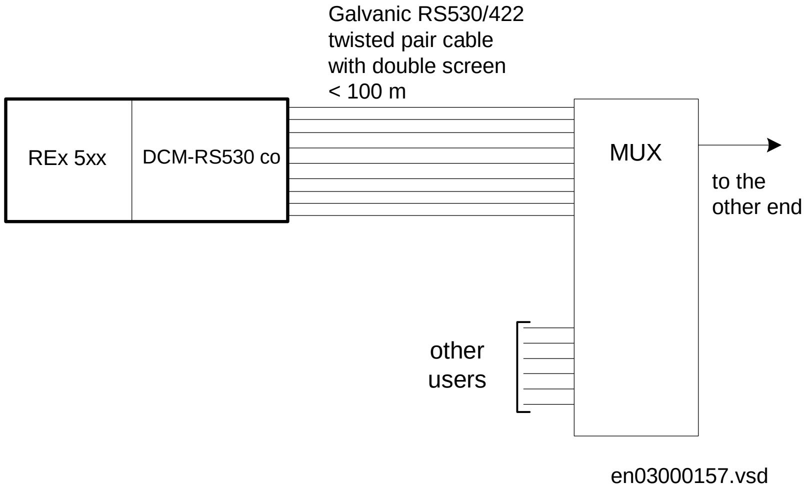


Figure 9: Multiplexed link, galvanic connection, RS530/422 co-directional

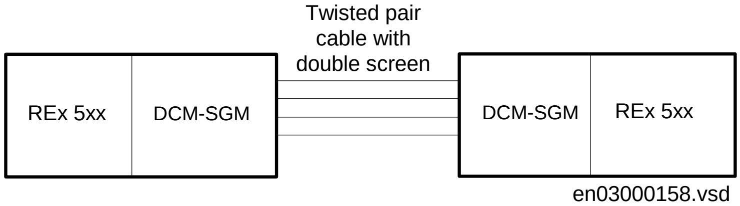


Figure 10:Dedicated link, short range galvanic modem

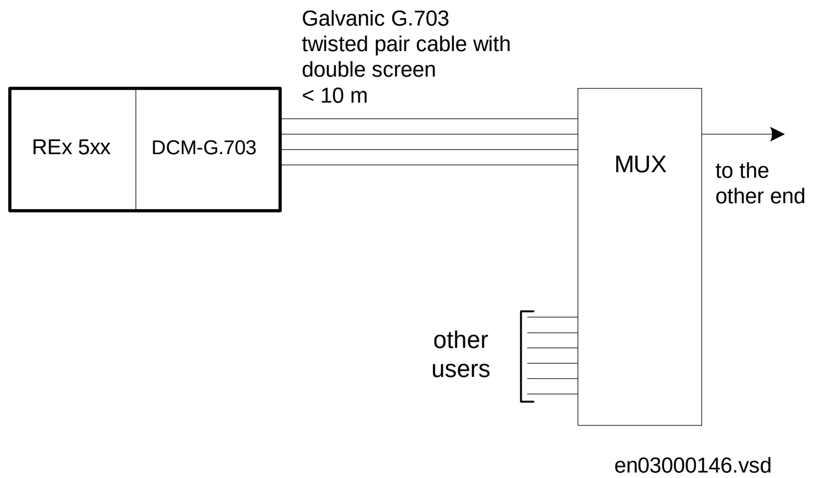


Figure 11:Multiplexed link, galvanic connection, G.703

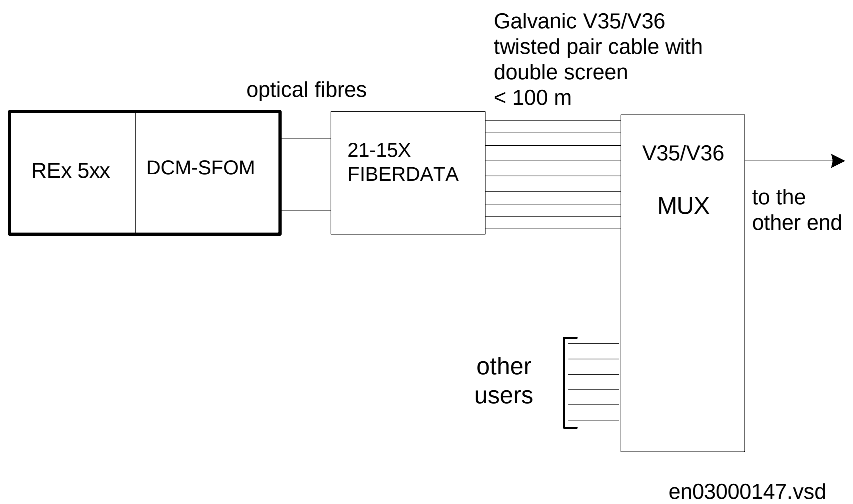


Figure 12:Multiplexed link, optical fiber - galvanic connection V35/V36 with 21 - 15X

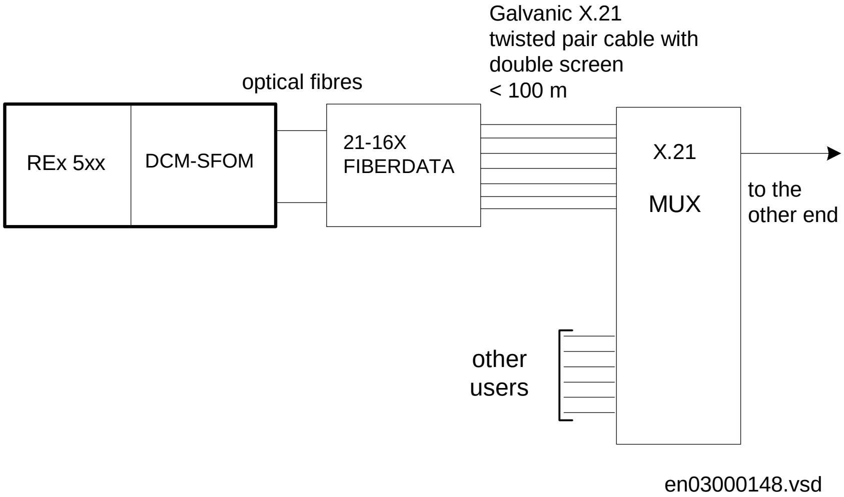


Figure 13:Multiplexed link, optical fibre - galvanic connection X.21 with 21-16X

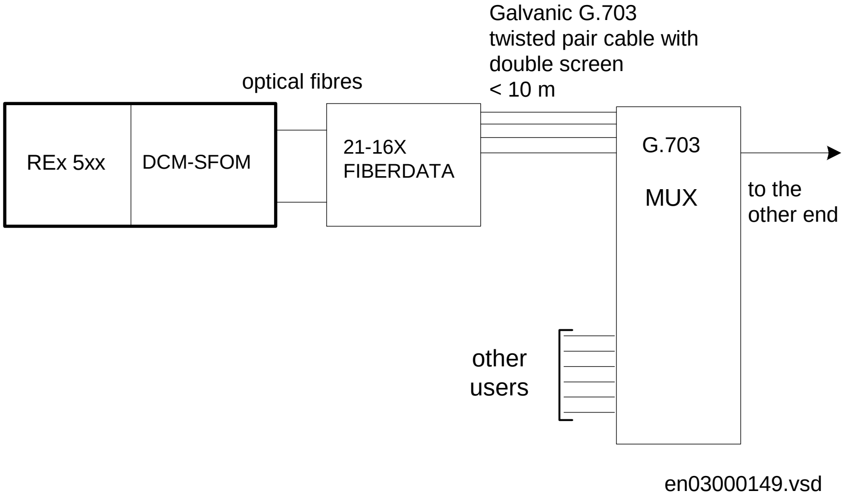


Figure 14:Multiplexed link, optical fibre - galvanic connection G.703 with 21-16X

Serial communication

Application

One or two optional optical serial interfaces with LON protocol, SPA protocol or IEC 60870-5-103 protocol, for remote communication, enables the terminal to be part of a Substation Automation (SA) system. These interfaces with terminal designations X13 and X15 are located at the rear of the terminal. The two interfaces can be configured independent of each other, each with different functionalities regarding monitoring and setting of the functions in the terminal.

One RS485 interface can be inserted replacing one of the optical interfaces. The RS485 interface is ordered as terminated for last terminal in a multidrop connection. The RS485 interface is alternatively ordered as unterminated for point to point connection, or for intermediate location in a multidrop connection. A selection between SPA and IEC 60870-5-103 is made in software at setting of the terminal.

Serial communication protocols - possible combinations of interface and connectors			
	Alt 1	Alt 2	Alt 3
X13	SPA/IEC fibre optic	SPA/IEC RS485	SPA fibre optic
X15	LON fibre optic	LON fibre optic	IEC fibre optic

Serial communication, SPA

Application
This communication bus is mainly used for SMS. It can include different numerical relays/terminals with remote communication possibilities. Connection to a personal computer (PC) can be made directly (if the PC is located in the substation) or by telephone modem through a telephone network with ITU (former CCITT) characteristics.

Functionality
When communicating with a PC, using the rear SPA port, the only hardware needed for a station monitoring system is:

- Optical fibres
- Opto/electrical converter for the PC
- PC

or

- An RS485 network installation according to EIA
- PC

Remote communication over the telephone network also requires a telephone modem.

The software needed in the PC, either local or remote, is CAP 540.

SPA communication is applied when using the front communication port, but for this purpose, no special serial communication function is required in the terminal. Only the software in the PC and a special cable for front connection is needed.

Serial communication, IEC (IEC 60870-5-103 protocol)

Application
This communication protocol is mainly used when a protection terminal communicates with a third party control system. This system must have a program that can interpret the IEC 60870-5-103 communication messages.

Functionality
The IEC protocol may be used alternatively on a fibre optic or on an RS485 network. The fibre optic network is point to point only, while the RS485 network may be used by multiple terminals in a multidrop configuration.

The IEC 60870-5-103 protocol implementation in REx 5xx consists of these functions:

- Event handling
- Report of analog service values (measurements)
- Fault location
- Command handling
  -Autorecloser ON/OFF
  -Teleprotection ON/OFF
  -Protection ON/OFF
  -LED reset
  -Characteristics 1 - 4 (Setting groups)
- File transfer (disturbance files)
- Time synchronization

The events created in the terminal available for the IEC protocol are based on the event function blocks EV01 - EV06 and disturbance function blocks DRP1 - DRP3. The commands are represented in a dedicated function block ICOM. This block has output signals according to the IEC protocol for all commands.

Serial communication, LON

Application
An optical network can be used within the Substation Automation system. This enables communication with the terminal through the LON bus from the operator’s workplace, from the control center and also from other terminals.

Functionality
An optical serial interface with LON protocol enables the terminal to be part of a Substation Control System (SCS) and/or Substation Monitoring System (SMS). This interface is located at the rear of the terminal. The hard-

ware needed for applying LON communication depends on the application, but one very central unit needed is the LON Star Coupler and optic fibres connecting the star coupler to the terminals. To communicate with the terminals from a Personal Computer (PC), the SMS 510, software or/and the application library LIB 520 together with MicroSCADA is needed.

Serial communication modules (SCM)

Functionality, SPA/IEC
The serial communication module for SPA/IEC is placed in a slot at the rear part of the main processing module. The serial communication module can have connectors for either:

- two plastic fibre cables; (Rx, Tx) or
- two glass fibre cables; (Rx, Tx) or
- galvanic RS485

The type of connection is chosen when ordering the terminal.

Functionality, LON
The serial communication module for LON is placed in a slot at the rear part of the Main processing module. The serial communication module can have connectors for either:

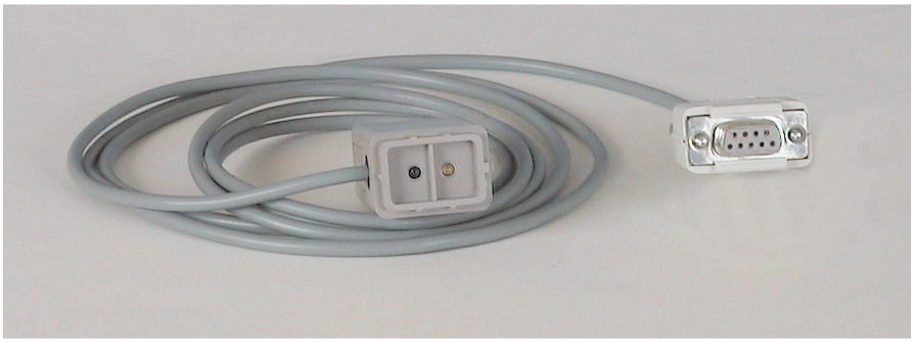
- two plastic fibre cables; (Rx, Tx) or
- two glass fibre cables; (Rx, Tx)

The type of connection is chosen when ordering the terminal.

Front communication

Application
The special front connection cable is used to connect a PC COM-port to to the optical contact on the left side of the local HMI.

Functionality
The cable includes an optical contact, an opto/electrical converter and an electrical cable with a standard 9-pole D-sub contact. This ensures a disturbance immune and safe communication with the terminal.



xx01000039

Figure 15:Front connection cable

Hardware modules

Modules

Table 1: Basic, always included, modules

Module	Description
Backplane module (BPM)	Carries all internal signals between modules in a terminal. The size of the module depends on the size of the case.
Main processing module (MPM)	Module for overall application control. All information is processed or passed through this module, such as configuration, settings and communication. Carries up to 12 digital signal processors, performing all measuring functions.
Human machine interface (LCD-HMI)	The module consist of LED:s, a LCD, push buttons and an optical connector for a front connected PC

Table 2: Application specific modules

Module	Description
Milliampere input module (MIM)	Analog input module with 6 independent, galvanically separated channels.
Binary input module (BIM)	Module with 16 optically isolated binary inputs
Binary output module (BOM)	Module with 24 single outputs or 12 double-pole command outputs including supervision function
Binary I/O module (IOM)	Module with 8 optically isolated binary inputs, 10 outputs and 2 fast signalling outputs.
Data communication modules (DCMs)	Modules used for digital communication to remote terminal.
Transformer input module (TRM)	Used for galvanic separation of voltage and/or current process signals and the internal circuitry.
A/D conversion module (ADM)	Used for analog to digital conversion of analog process signals galvanically separated by the TRM.
Serial communication module (SCM)	Used for SPA/LON/IEC communication
LED module (LED-HMI)	Module with 18 user configurable LEDs for indication purposes

Power supply module (PSM)

Application
The power supply module, PSM, with built in binary I/O is used in 1/2 and 3/4 of full width 19” units. It has four optically isolated binary inputs and five binary outputs, out of which one binary output is dedicated for internal fail.

Functionality
The power supply modules contain a built-in, self-regulated DC/DC converter that provides full isolation between the terminal and the battery system.

A/D module (ADM)

Functionality
The inputs of the A/D-conversion module (ADM) are fed with voltage and current sig-

nals from the transformer module. The current signals are adapted to the electronic voltage level with shunts. To gain dynamic range for the current inputs, two shunts with separate A/D channels are used for each input current. By that a 16-bit dynamic range is obtained with a 12 bits A/D converter.

The input signals passes an anti aliasing filter with a cut-off frequency of 500 Hz.

Each input signal (5 voltages and 5 currents) is sampled with a sampling frequency of 2 kHz.

The A/D-converted signals are low-pass filtered with a cut-off frequency of 250 Hz and down-sampled to 1 kHz in a digital signal processor (DSP) before transmitted to the main processing module.

Transformer module (TRM)

Functionality

A transformer input module can have up to 10 input transformers. The actual number depends on the type of terminal. Terminals including only current measuring functions only have current inputs. Fully equipped the transformer module consists of:

- Five voltage transformers
- Five current transformers

The inputs are mainly used for:

- Phase currents
- Residual current of the protected line
- Residual current of the parallel circuit (if any) for compensation of the effect of the zero sequence mutual impedance on the fault locator measurement or residual current of the protected line but from a parallel core used for CT circuit supervision function or independent earth fault function.
- Phase voltages
- Open delta voltage for the protected line (for an optional directional earth-fault protection)
- Phase voltage for an optional synchronism and energizing check.

Binary I/O capabilities

Application

Input channels with high EMI immunity can be used as binary input signals to any function. Signals can also be used in disturbance or event recording. This enables extensive monitoring and evaluation of the operation of the terminal and associated electrical circuits.

Functionality

Inputs are designed to allow oxide burn-off from connected contacts, and increase the disturbance immunity during normal protection operate times. This is achieved with a high peak inrush current while having a low steady-state current. Inputs are debounced by software.

Well defined input high and input low voltages ensures normal operation at battery supply earth faults.

The voltage level of the inputs is selected when ordering.

I/O events are time stamped locally on each module for minimum time deviance and stored by the event recorder if present.

Binary input module (BIM)

Application

Use the binary input module, BIM, when a large amount of inputs are needed. The BIM is available in two versions, one standard and one with enhanced pulse counting inputs to be used with the pulse counter function.

Functionality

The binary input module, BIM, has 16 optically isolated binary inputs.

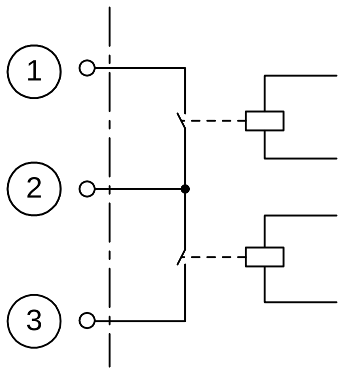
A signal discriminator detects and blocks oscillating signals. When blocked, a hysteresis function may be set to release the input at a chosen frequency, making it possible to use the input for pulse counting. The blocking frequency may also be set.

Binary output module (BOM)

Application

Use the binary output module, BOM, for trip output or any signalling purpose when a large amount of outputs is needed.

Functionality
The binary output module, BOM, has 24 software supervised output relays, pairwise connected to be used as single-output channels with a common connection or as command output channels.



xx00000299.vsd

1	Output connection from relay 1
2	Common input connection
3	Output connection from relay 2

Figure 16:Relay pair example

Binary input/output module (IOM)

Application
Use the binary I/O module, IOM, when few input and output channels are needed. The ten 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.

Functionality
The binary I/O module, IOM, has eight optically isolated inputs and ten output relays. One of the outputs has a change-over contact. The nine remaining output contacts are connected in two groups. One group has five contacts with a common and the other group has four contacts with a common, to be used as single-output channels.

The binary I/O module also has two high speed output channels where a reed relay is connected in parallel to the standard output relay.

Note: The making capacity of the reed relays are limited.

mA input module (MIM)

Application
Use the milliampere input module, MIM, to interface transducer signals in the ± 20 mA range from for example temperature and pressure transducers.

Functionality
The milliampere input module has six input channels, each with a separate protection and filter circuit, A/D converter and optically isolated connection to the backplane.

The digital filter circuits have individually programmable cut-off frequencies, and all parameters for filtering and calibration are stored in a nonvolatile memory on the module. The calibration circuitry monitors the module temperature and commences an automatical calibration procedure if the temperature drift increase outside the allowed range. The module uses the serial CAN bus for backplane communication.

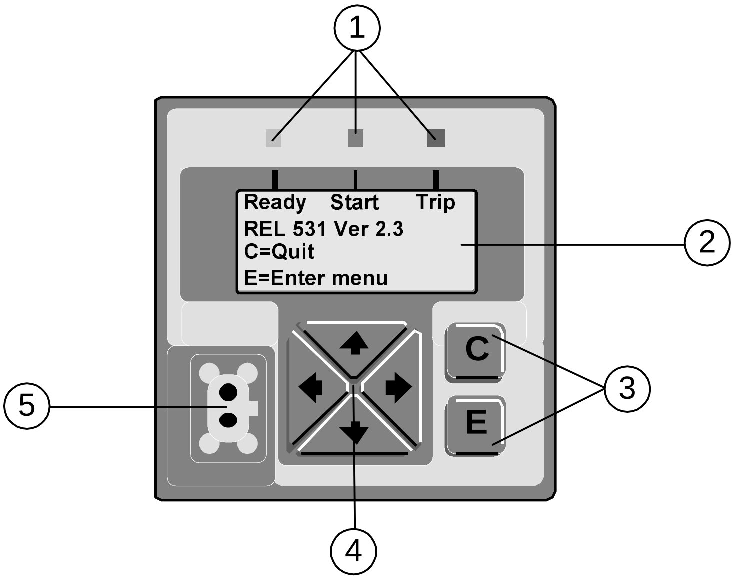
Signal events are time stamped locally for minimum time deviance and stored by the event recorder if present.

Human machine interface module (LCD-HMI)

Application
The human machine interface is used to monitor and in certain aspects affect the way the product operates. The configuration designer can add functions for alerting in case of important events that needs special attention from you as an operator.

Use the terminals built-in communication functionality to establish SMS communication with a PC with suitable software tool. Connect the PC to the optical connector on the local HMI with the special front communication cable including an opto-electrical converter for disturbance free and safe communication.

Design



1. Status indication LEDs	
2. LCD display	
3. *Cancel* and *Enter* buttons	
4. Navigation buttons	
5. Optical connector	

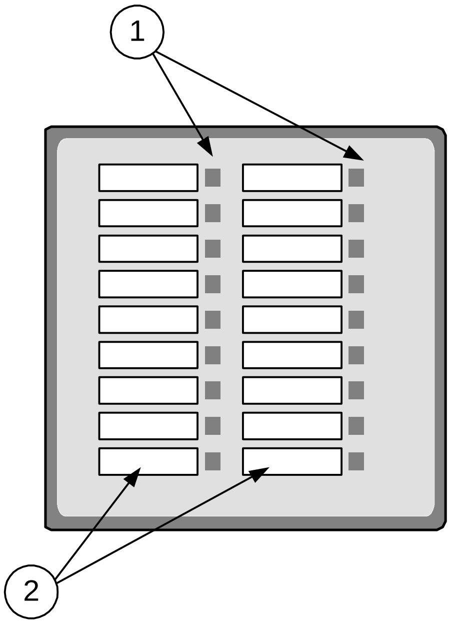
Figure 17:The LCD-HMI module

The number of buttons used on the HMI module is reduced to a minimum to allow a communication as simple as possible for the user. The buttons normally have more than one function, depending on actual dialogue.

18 LED Indication module (LED-HMI)

Application
The LED indication module is an option for the feature for the REx 5xx terminals for protection and control and consists totally of 18 LEDs (Light Emitting Diodes). The main purpose is to present on site an immediate visual information such as protection indications or alarm signals. It is located on the front of the protection and control terminals.

Functionality
The 18 LED indication module is equipped with 18 LEDs, which can light or flash in either red, yellow or green color. A description text can be added for each of the LEDs.



xx00000406.vsd

1	Three-color LEDs
2	Descriptive label, user exchangeable

Figure 18:The 18 LED indication module (LED-HMI)

The information on the LEDs is stored at loss of the auxiliary power for the terminal, so that the latest LED picture appears immediately after the terminal has restarted succesfully.

LED indication function (HL,HLED)

Each LED indication on the HMI LED module can be set individually to operate in six different sequences; two as follow type and four as latch type. Two of the latching types are intended to be used as a protection indication system, either in collecting or re-starting mode, with reset functionality. The other two are intended to be used as a signaling system in collecting mode with an acknowledgment functionality. See Application manual for more detailed information.

Hardware design

Layouts and dimensions

Design

Dimensions, case without rear cover

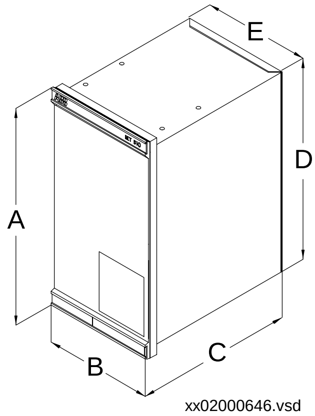


Figure 19:Case without rear cover

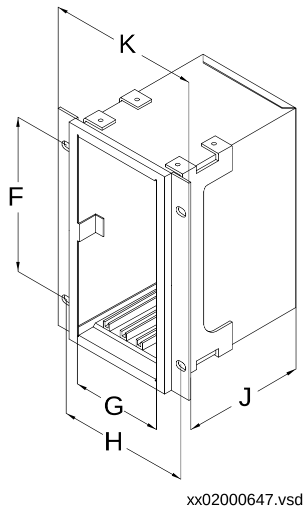


Figure 20:Case without rear cover with 19” rack mounting kit

Case size	A	B	C	D	E	F	G	H	J	K
6U, 1/2 x 19”	265.9	223.7	204.1	252.9	205.7	190.5	203.7	-	186.6	-
6U, 3/4 x 19”	256.9	336	204.1	252.9	318	190.5	316	-	186.6	-

(mm)

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

Dimensions, case with rear cover

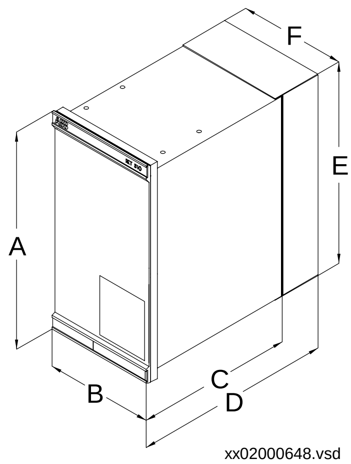


Figure 21:Case with rear cover

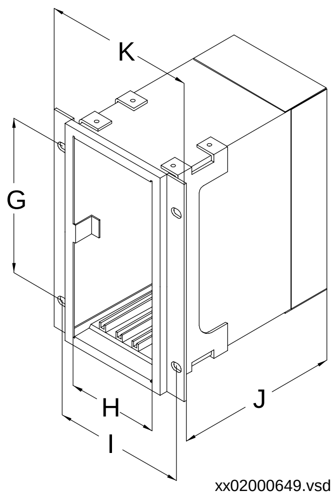


Figure 22:Case with rear cover and 19” rack mounting kit

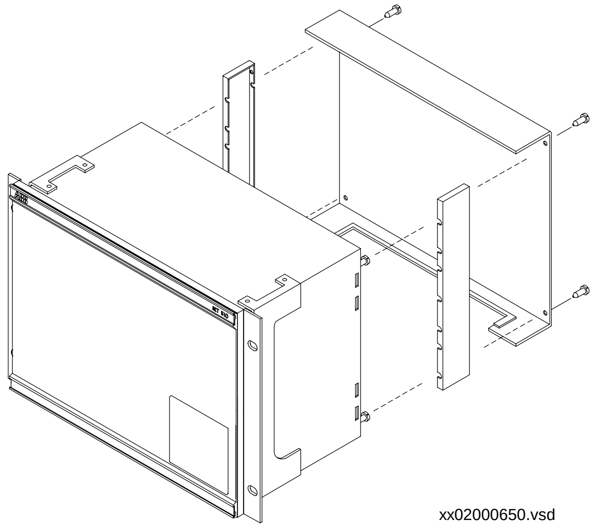


Figure 23:Case with rear cover

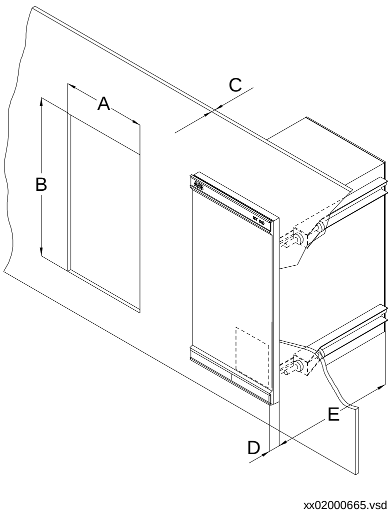
Case size	A	B	C	D	E	F	G	H	I	J	K
6U, 1/2 x 19”	265.9	223.7	204.1	245.1	255.8	205.7	190.5	203.7	-	227.6	-
6U, 3/4 x 19”	265.9	336	204.1	245.1	255.8	318	190.5	316	-	227.6	-

(mm)

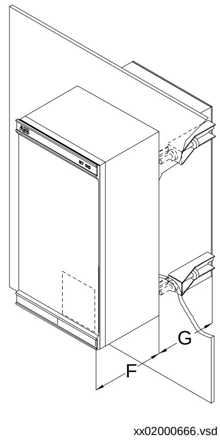
The I and K dimensions are defined by the 19” rack mounting kit.

Panel cut-outs for REx 500 series, single case

Flush mounting



Semi-flush mounting



Case size	Cut-out dimensions (mm)	
	A+/-1	B+/-1
6U, 1/2 x 19”	210.1	254.3
6U, 3/4 x 19”	322.4	254.3

C = 4-10 mm

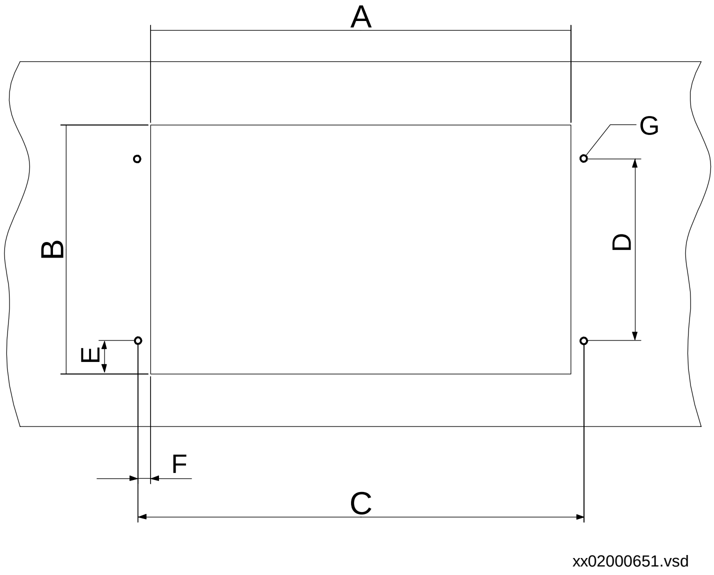
D = 16.5 mm

E = 187.6 mm without rear protection cover, 228.6 mm with rear protection cover

F = 106.5 mm

G = 97.6 mm without rear protection cover, 138.6 mm with rear protection cover

Panel cut-out for REx 500 series, side by side cases



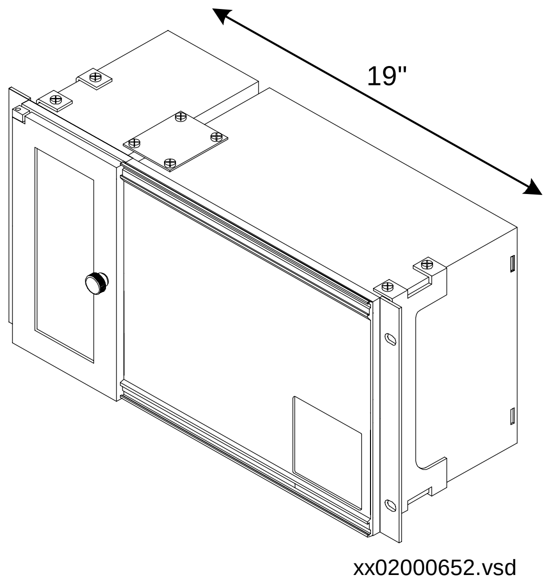
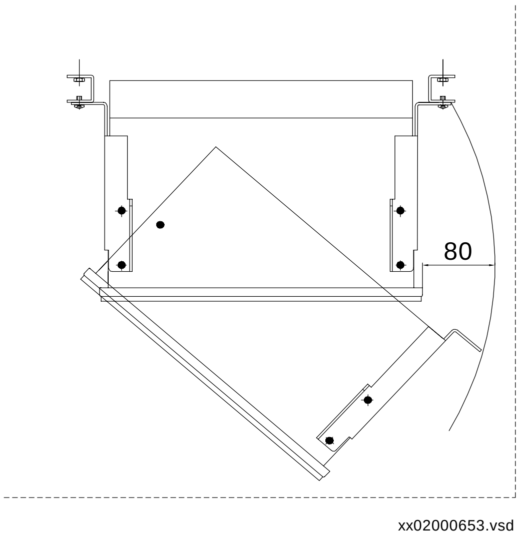


Figure 24:Flush mounting of side by side cases

Case size	Cut-out dimensions						
	A	**B**	**C**	**D**	**E**	**F**	**G**
6U, 3/4 x 19”	326.4	259.3	352.8	190.5	34.4	13.2	ø 6.4
6U, 1/1 x 19”	438.7	259.3	465.1	190.5	34.4	13.2	ø 6.4
							(mm)

Dimensions, wall mounting



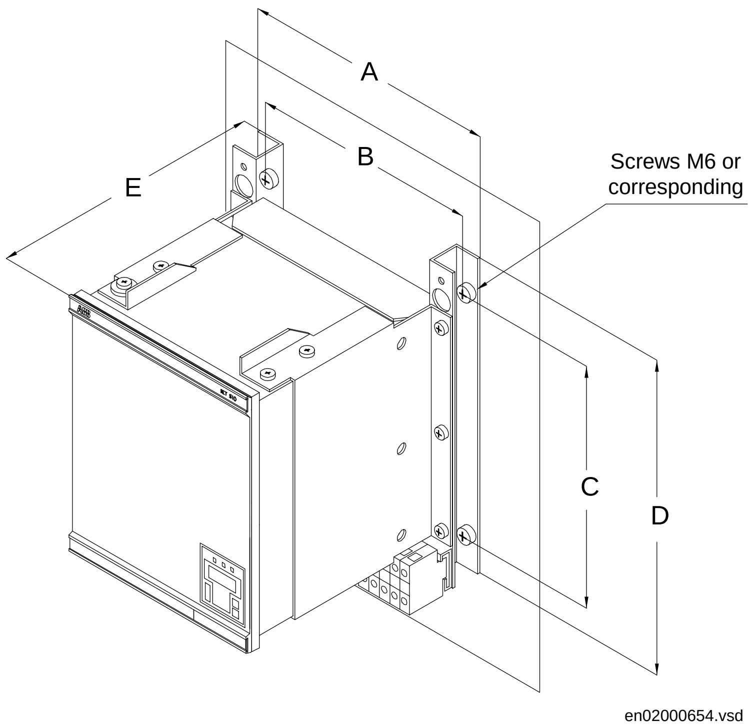
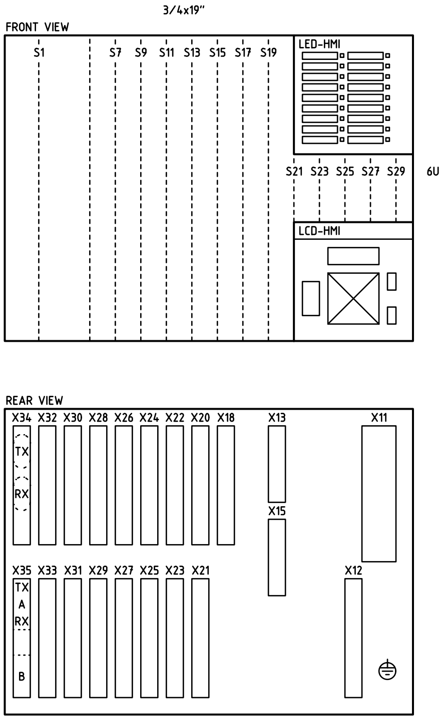


Figure 25:Wall mounting

Case size (mm)	A	B	C	D	E
6U, 1/2 x 19”	292	267.1	272.8	390	247
6U, 3/4 x 19”	404.3	379.4	272.8	390	247

Terminal diagram

Drawings



DESIGNATION CORRESPONDING TO CASING		
3/4x19"		
MODULE	FRONT	REAR
TRM 1)	S1	X11,12
ADM 1)	S7	-
MPM	S9	X13,15
PSM	S13	X18
2)	S15	X20,21
2)	S17	X22,23
2)	S19	X24,25
2)	S21	X26,27
2)	S23	X28,29
2)	S25	X30,31
2)	S27	X32,33
3)	S29	X34,35

TABLE 2

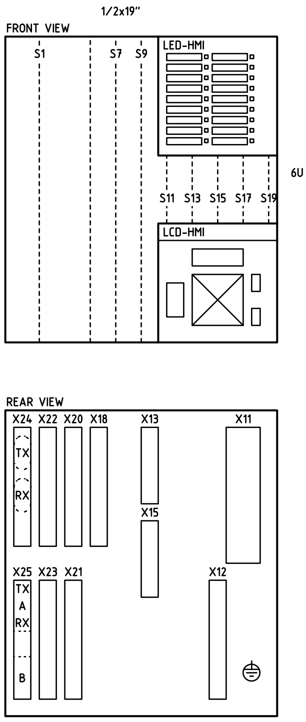
1) OPTION TRM AND ADM

2) BIM, BOM, IOM AND/OR MIM

3) BIM, BOM, IOM, MIM OR DCM

en03000144.eps

Figure 26:Hardware structure of the 3/4 of full width 19” case



DESIGNATION CORRESPONDING TO CASING		
1/2x19"		
MODULE	FRONT	REAR
TRM 1)	S1	X11,12
ADM 1)	S7	-
MPM	S9	X13,15
PSM	S13	X18
2)	S15	X20,21
2)	S17	X22,23
3)	S19	X24,25

TABLE 1

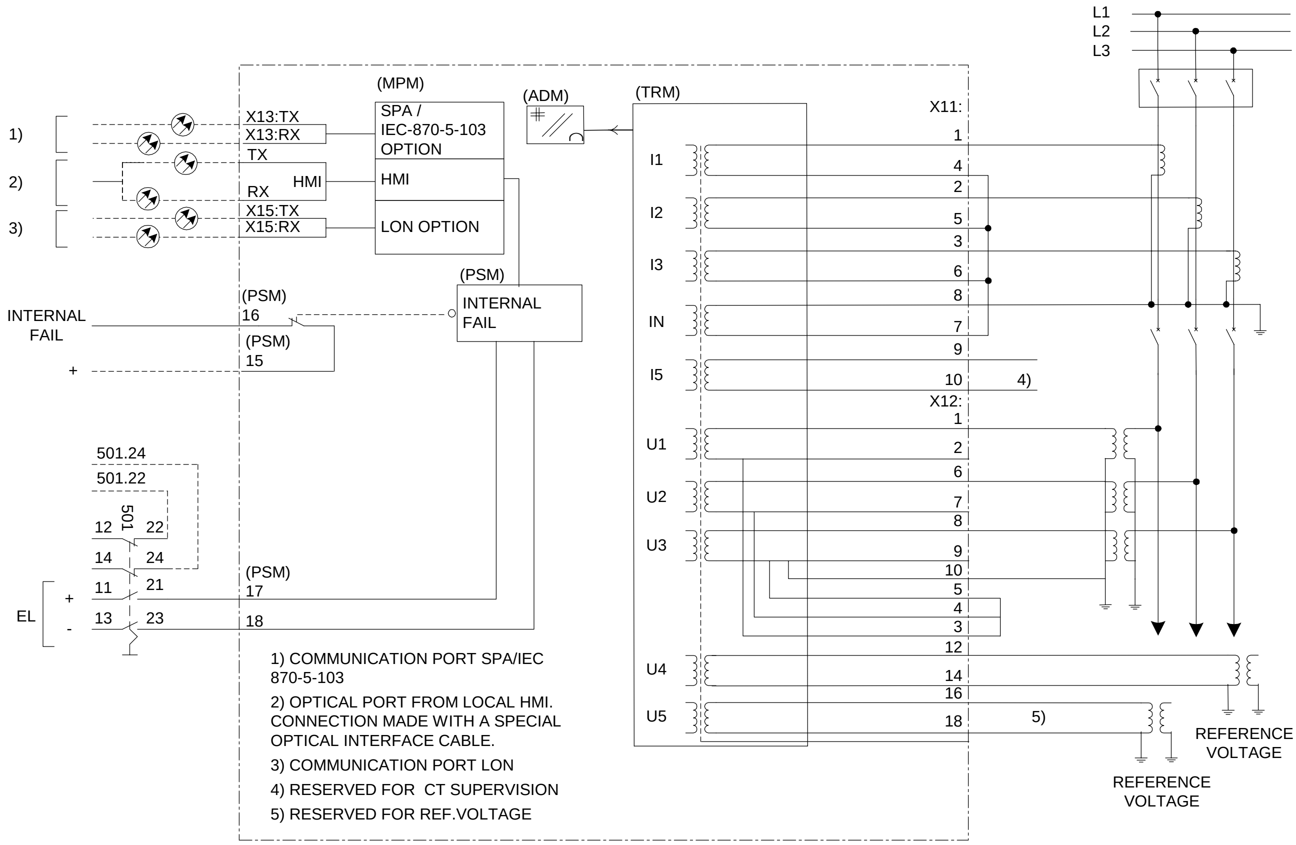
1) OPTION TRM AND ADM

2) BIM, BOM, IOM AND/OR MIM

3) BIM, BOM, IOM, MIM OR DCM

en03000143.eps

Figure 27:Hardware structure of the 1/2 of full width 19” case



xx00000441.vsd

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) whithin 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.

Table 3: Case

Material	Steel sheet
Front plate	Steel sheet profile with cut-out for HMI and for 18 LED when included
Surface treatment	Aluzink preplated steel
Finish	Light beige (NCS 1704-Y15R)
Degree of protection	Front side: IP40, optional IP54 with sealing strip. Rear side: IP20

Table 4: Weight

Case size	Weight
6U, 1/2 x 19”	≤ 8.5 kg
6U, 3/4 x 19”	≤ 11 kg

Table 5: PSM - Power Supply Module

Quantity	Rated value	Nominal range
Auxiliary dc voltage	EL = (48 - 250) V	± 20%

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

Quantity	Rated value	Nominal range
Current Operative range Permissive overload Burden	I_r = 1 or 5 A (0.004-100) x I_r 4 × I_r cont. 100 × I_r for 1 s *) < 0.25 VA at I_r = 1 or 5 A	(0.2-30) × I_r
Ac voltage for the terminal Operative range Permissive overload Burden	U_r = 110 V **) U_r = 220 V **) (0.001-1.5) x U_r 2.3 × U_r phase-earth, cont. 3.0 x U_r phase-earth, for 1 s < 0.2 VA at U_r	100/110/115/120 V 200/220/230/240 V
Frequency	f_r = 50/60 Hz	+/-10%
*) max. 350 A for 1 s when COMBITEST test switch is included. **) The rated voltage of each individual voltage input U1 to U5 is $U_r/\sqrt{3}$		

Table 7: Power consumption, basic terminal

Size of terminal	Typical value
1/2 of 19” rack	≤ 18 W
3/4 of 19” rack	≤ 26 W
1/1 of 19” rack	≤ 28 W

Table 8: Temperature and humidity influence

Parameter	Reference value	Nominal range	Influence
Ambient temperature Operative range	+20 °C -25 °C to +55°C	-10 °C to +55 °C	0.01% / °C
Relative humidity Operative range	10%-90% 0%-95%	10%-90%	-
Storage temperature	-40 °C to +70 °C	-	-

Table 9: Auxiliary DC supply voltage influence on functionality during operation

Dependence on	Within nominal range	Influence
Ripple, in DC auxiliary voltage	Max 12%	0.01% / %
Interrupted auxiliary DC voltage Without reset Correct function Restart time	48-250 V dc ±20%	 <50 ms 0-∞ s <180 s

Table 10: Frequency influence

Dependence on	Within nominal range	Influence
Frequency dependence	f_r ±10% for 50 Hz f_r ±10% for 60 Hz	±2.0% / Hz
Harmonic frequency dependence (10% content)	2nd, 3rd and 5th harmonic of f_r	±6.0%

Table 11: Electromagnetic compatibility

Test	Type test values	Reference standards
1 MHz burst disturbance	2.5 kV	IEC 60255-22-1, Class III
For short range galvanic modem	2.5kV	IEC 60255-22-1, Class III
For galvanic interface		
• common mode • differential mode	1 kV 0.5 kV	IEC 60255-22-1, Class II IEC 60255-22-1, Class II
Electrostatic discharge		
Direct application	Air 8 kV Contact 6 kV	IEC 60255-22-2, Class III
For short range galvanic modem	Air 8 kV	IEC 60255-22-2, Class III
	Contact 6 kV	
Fast transient disturbance	4 kV	IEC 60255-22-4, Class A
For short range galvanic modem	4 kV	IEC 60255-22-4, Class A
For galvanic interface	1 kV	IEC 60255-22-4, Class B
Surge immunity test	1-2 kV, 1.2/50µs 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, 3s	IEC 61000-4-8, Class V
Radiated electromagnetic field disturbance	10 V/m, 80-1000 MHz	IEC 60255-22-3
Radiated electromagnetic field disturbance	10 V/m, 80-1000 MHz, 1.4-2.0 GHz	IEC 61000-4-3, Class III
Radiated electromagnetic field disturbance	35 V/m 26-1000 MHz	IEEE/ANSI C37.90.2

Test	Type test values	Reference standards
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 12: Electromagnetic compatibility for RS485 interface

Test	Type test values	Reference standards
1 MHz burst disturbance	1 kV	IEC 60255-22-1, Class II
Electrostatic discharge Direct application	Air 8 kV Contact 6kV	IEC 60255-22-2, Class III
Fast transient disturbance	1kV	IEC 60255-22-4, Class B
Surge immunity test	1 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	10 V/m, 80-1000 MHz	IEC 60255-22-3
Radiated electromagnetic field disturbance	10 V/m, 80-1000 MHz, 1.4-2.0 GHz	IEC 61000-4-3, Class III
Radiated electromagnetic field disturbance	35V/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 13: Insulation

Test	Type test values	Reference standard
Dielectric test	2.0 kVAC, 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 14: CE compliance

Test	According to
Immunity	EN 61000-6-2
Emissivity	EN 61000-6-4
Low voltage directive	EN 50178

Table 15: 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

Table 16: Calendar and clock

Parameter	Range
Built-in calender	With leap years through 2098

Table 17: Internal event list

Data	Value
Recording manner	Continuous, event controlled
List size	40 events, first in-first out

Table 18: TIME - Time synchronisation

Function	Accuracy
Time tagging resolution	1 ms
Time tagging error with synchronisation once/60 s	± 1.5 ms
Time tagging error without synchronisation	± 3 ms/min

Table 19: Serial communication (SPA) via front

Function	Value
Protocol	SPA
Communication speed for the terminals	300, 1200, 2400, 4800, 9600 Bd
Slave number	1 to 899
Change of active group allowed	Yes
Change of settings allowed	Yes

Table 20: Front connection cable

Function	Value
Communication speed for the cable	0.3-115 Kbaud

Table 21: CL1 - Configurable blocks as basic

Update rate	Block	Availability
10 ms	AND	30 gates
	OR	60 gates
	INV	20 inverters
	SM	20 flip-flops
	GT	5 gates
	TS	5 timers
200 ms	SR	5 flip-flops
	XOR	39 gates

Table 22: Available timer function blocks as basic

Block	Availability	Setting range	Accuracy
TM	10 timers	0.000-60.000 s in steps of 1 ms	± 0.5% ± 10 ms
TP	10 pulse timers	0.000-60.000 s in steps of 1 ms	± 0.5% ± 10 ms
TL	10 timers	0.0-90000.0 s in steps of 0.1 s	± 0.5% ± 10 ms
TQ	10 puls timers	0.0-90000.0 s in steps of 0.1 s	± 0.5% ± 10 ms

Table 23: CL2 - Additional configurable logic blocks

Update rate	Block	Availability
200 ms	AND	239 gates
	OR	159 gates
	INV	59 inverters
	MOF	3 registers
	MOL	3 registers

Table 24: Additional timer function blocks

Block	Availability	Setting range	Accuracy
TP	40 pulse timers	0.000-60.000 s in steps of 1 ms	± 0.5% ± 10 ms

Current

Table 25: PD - Pole discordance logic, contact and current based

Function	Setting range	Accuracy
Auxiliary-contact-based function, time delay	(0.000-60.000) s in steps of 1 ms	± 0.5% ± 10 ms
Operate current	10% of I_r	± 2.5 % of I_r
Time delay	(0.000-60.000) s in steps of 1 ms	± 0.5 % ± 10 ms

Table 26: Reset ratio for Pole discordance, contact and current based

Function	Setting range	Acceptance criteria
Min phase current	10% of I_r	> 90%

Table 27: BFP - Breaker failure protection

Parameter	Setting range	Accuracy
Operate current, IP> (one measuring element per phase)	5-200% of I1b in steps of 1%	± 2.5% of I_r at $I \leq I_r$ ± 2.5% of I at $I > I_r$
Retrip time delay t1	0.000-60.000 s in steps of 1 ms	± 0.5% ± 10 ms
Back-up trip time delay t2	0.000-60.000 s in steps of 1 ms	± 0.5% ± 10 ms

Parameter	Value
Trip operate time	Max 18 ms
Operate time for current detection	Max 10 ms

Power system supervision

Table 28: LOV - Loss of voltage check

Parameter	Setting range	Accuracy
Operate voltage, UPE<	10-100% of U1b in steps of 1%	± 2.5% of U_r

Table 29: OVLD - Overload supervision function

Parameter	Setting range	Accuracy
Operate current, IP>	20-300% of I1b in steps of 1%	± 2.5% of I_r at $I \leq I_r$ ± 2.5% of I at $I > I_r$
Time delay, t	0.0-90000.0 s in steps of 0.1 s	± 0.5% ± 10 ms

Table 30: DLD - Dead line detection

Function		Setting range	Accuracy
Automatic check of dead line condition	Operate phase current, IP<	(5-100) % of I1b in steps of 1%	± 2.5 % of I_r
	Operate phase voltage, U<	(10-100) % of U1b in steps of 1%	± 2.5 % of U_r

System protection and control

Table 31: PSP - Pole slip protection function

Function	Value
Reactive and resistive reach for all setting parameters at I_r=1 A (for I_r = 5 A, divide values by 5)	0.10-400.00 ohm/phase in steps of 0.01ohm/phase
Timers	0.000-60.000s in steps of 0.001s
Counters	0-10 in steps of 1
Reset ratio	105% typically

Secondary system supervision

Table 32: CTSU - Current circuit supervision, current based

Function	Setting range	Accuracy
Operate current, IMinOp	5-100% of I1b in steps of 1%	± 2.5% of I_r

Table 33: FUSEns - Fuse failure supervision function, negative sequence

Function		Setting range	Accuracy
Negative-sequence quantities:	Operate voltage $3U_2$>	(10 - 50)% of U1b in steps of 1%	± 2.5 % of U_r
	Operate current $3I_2$>	(10 - 50)% of I1b in steps of 1%	± 2.5 % of I_r

Table 34: FUSEzs - Fuse failure supervision, zero sequence

Function		Setting range	Accuracy
Zero-sequence quantities:	Operate voltage $3U_0$>	(10-50)% of U1b in steps of 1%	± 2.5 % of U_r
	Operate current $3I_0$<	(10-50)% of I1b in steps of 1%	± 2.5 % of I_r

Table 35: FUSEdb - Fuse failure supervision, du/dt and di/dt based

Function	Setting range	Accuracy
Operate voltage change level, DU>	(50-90)% of U1b in steps of 1%	± 2.5% of Ur
Operate current change level, DI<	(10-50)% of I1b in steps of 1%	± 2.5% of Ir

Table 36: TCT - Voltage transformer supervision

Parameter	Setting range	Accuracy
Residual overvoltage limit, UN>	1.0-80.0% of Ub in steps of 0.1%	± 2.5% of U_r
Time delayed operation for start signal, tDelay	0.000-300.000 s in steps of 1 ms	± 0.5% ± 10 ms

Control

Table 37: SYN - Synchro-check with synchronizing and energizing-check

Parameter	Setting range	Accuracy
Frequency difference limit, FreqDiffSynch	50-500 mHz in steps of 10 mHz	≤20 mHz
Breaker closing pulse duration, tPulse	0.000-60.000 s in steps of 1 ms	± 0.5% ± 10 ms
Breaker closing time, tBreaker	0.02-0.50 s in steps of 0.01 s	± 0.5% ± 10 ms

Parameter	Value
Bus / line voltage frequency range limit	± 5 Hz from f_r
Bus / line voltage frequency rate of change limit	<0.21 Hz/s

Table 38: SYN - Synchrocheck and energizing check

Function	Setting range	Accuracy
Synchrocheck:		
Frequency difference limit, FreqDiff	50-300 mHz in steps of 10 mHz	≤20 mHz
Voltage difference limit, UDiff	5-50% of U1b in steps of 1%	± 2.5% of U_r
Phase difference limit, PhaseDiff	5-75 degrees in steps of 1 degree	± 2 degrees
Energizing check:		
Voltage level high, UHigh	70-100% of U1b in steps of 1%	± 2.5% of U_r
Voltage level low, ULow	10-80% of U1b in steps of 1%	± 2.5% of U_r
Energizing period, automatic reclosing, tAutoEnerg	0.000-60.000 s in steps of 1 ms	± 0.5% ± 10 ms
Energizing period, manual closing, tManEnerg	0.000-60.000 s in steps of 1 ms	± 0.5% ± 10 ms
Phase shift φ_{line} - φ_{bus}	0-360 degrees in steps of 1 degree	
Voltage ratio U_{bus}/U_{line}	0.20-5.00 in steps of 0.01	

Table 39: Synchrocheck and energizing check, general

Parameter	Value
Synchrocheck:	
Bus voltage frequency range limit	± 5 Hz from f_r
Operate time	190 ms typically
Energizing check:	
Operate time	80 ms typically

Table 40: AR - Autorecloser

Parameter	Setting range	Accuracy
Automatic reclosing open time:		
shot 1 - t1 1ph	0.000-60.000 s in steps of 1 ms	± 0.5% ± 10 ms
shot 1 - t1 2ph	0.000-60.000 s in steps of 1 ms	± 0.5% ± 10 ms
shot 1 - t1 3ph	0.000-60.000 s in steps of 1 ms	± 0.5% ± 10 ms
shot 2 - t2 3ph	0.0-9000.0 s in steps of 0.1 s	± 0.5% ± 10 ms
shot 3 - t3 3ph	0.0-9000.0 s in steps of 0.1 s	± 0.5% ± 10 ms

Parameter	Setting range	Accuracy
shot 4 - t4 3ph	0.0-9000.0 s in steps of 0.1 s	± 0.5% ± 10 ms
Autorecloser maximum wait time for sync, tSync	0.0-90000.0 s in steps of 0.1 s	± 0.5% ± 10 ms
Duration of close pulse to circuit breaker tPulse	0.000-60.000 s in steps of 1 ms	± 0.5% ± 10 ms
Reclaim time, tReclaim	0.0-90000.0 s in steps of 0.1 s	± 0.5% ± 10 ms
Inhibit reset time, tInhibit	0.000-60.000 s in steps of 1 ms	± 0.5% ± 10 ms
Maximum trip pulse duration, tTrip (longer trip pulse durations will either extend the dead time or interrupt the reclosing sequence)	0.000-60.000 s in steps of 1 ms	± 0.5% ± 10 ms
Maximum wait time for release from Master, tWaitForMaster	0.0-90000.0 s in steps of 0.1 s	± 0.5% ± 10 ms
Maximum wait time between shots, tAutoWait	0.000-60.000 s in steps of 1 ms	± 0.5% ± 10 ms
Time delay before indicating reclosing unsuccessful, tUnsuc	0.0-90000.0 s in steps of 0.1 s	± 0.5% ± 10 ms
Time CB must be closed before AR becomes ready for a reclosing cycle, tCBClosed	0.000-60.000 s in steps of 1 ms	± 0.5% ± 10 ms

Table 41: AR - Autorecloser

Parameter	Value
Reclosing shots	1-4
Programs	Three pole trip: 1 Single, two and three pole trip: 6
Number of instances	Up to six depending on terminal type (different terminal types support different CB arrangements and numbers of bays)
Breaker closed before start	5 s

Logic

Table 42: TR - Tripping logic

Parameter	Value	Accuracy
Setting for the minimum trip pulse length, tTripMin	0.000 - 60.000 s in steps of 1 ms	± 0.5% ± 10 ms

Table 43: PDc - Pole discordance, contact based

Function	Setting range	Accuracy
Auxiliary-contact-based function - time delay	(0.000-60.000) s in steps of 1 ms	± 0.5 % ±10 ms

Table 44: CCHT - Communication channel test logic

Parameter	Setting range	Accuracy
Time interval between automatic starts of testing cycle, tStart	0.0-90000.0 s in steps of 0.1 s	± 0.5% ± 10 ms
Time interval available for test of the external function to be registered as successful, tWait	0.0-90000.0 s in steps of 0.1 s	± 0.5% ± 10 ms
Minimum time interval required before repeated test of the external function, tCh	0.0-90000.0 s in steps of 0.1 s	± 0.5% ± 10 ms
Duration of CS output signal, tCS	0.0-90000.0 s in steps of 0.1 s	± 0.5% ± 10 ms
Duration of CHOK output signal, tChOK	0.0-90000.0 s in steps of 0.1 s	± 0.5% ± 10 ms
Duration of inhibit condition extension after the BLOCK input signal resets, tInh	0.0-90000.0 s in steps of 0.1 s	± 0.5% ± 10 ms

Table 45: CN - Event counter

Function	Value
Counter value	0-10000
Max. count up speed	10 pulses/s

Monitoring

Table 46: DRP - Disturbance report setting performance

Data	Setting range
Pre-fault time, tPre	50-300 ms in steps of 10 ms
Post-fault time, tPost	100-5000 ms in steps of 100 ms
Limit time, tLim	500-6000 ms in steps of 100 ms
Number of recorded disturbances	Max. 10

Table 47: DR - Disturbance recorder setting performance

Function	Setting range
Overcurrent triggering	0-5000% of Inb in steps of 1%
Undercurrent triggering	0-200% of Inb in steps of 1%
Overvoltage triggering	0-200% of Unb in steps of 1% at 100 V sec.
Undervoltage triggering	0-110% of Unb in steps of 1%

Table 48: DR - Disturbance recorder performance

<table>
<tr><th colspan="3">Data</th><th>Value</th></tr>
<tr><td colspan="3">Number of binary signals</td><td>48</td></tr>
<tr><td colspan="3">Number of analog signals</td><td>10</td></tr>
<tr><td colspan="3">Sampling rate</td><td>2 kHz</td></tr>
<tr><td colspan="3">Recording bandwidth</td><td>5-250 Hz</td></tr>
<tr><td colspan="3">Total recording time with ten analog and 48 binary signals recorded. (The amount of harmonics can affect the maximum storage time)</td><td>40 s typically</td></tr>
<tr><td rowspan="4">Voltage channels</td><td colspan="2">Dynamic range</td><td>(0.01-2.00) x U_r at 100/200 V sec.</td></tr>
<tr><td colspan="2">Resolution</td><td>0.1% of U_r</td></tr>
<tr><td rowspan="2">Accuracy at rated frequency</td><td>$U \leq U_r$</td><td>$\pm$ 2.5% of U_r</td></tr>
<tr><td>$U > U_r$</td><td>$\pm$ 2.5% of U</td></tr>
<tr><td rowspan="5">Current channels</td><td rowspan="2">Dynamic range</td><td>Without DC off-set</td><td>(0.01-110.00) $\times I_r$</td></tr>
<tr><td>With full DC off-set</td><td>(0.01-60.00) $\times I_r$</td></tr>
<tr><td colspan="2">Resolution</td><td>0.5 % of I_r</td></tr>
<tr><td rowspan="2">Accuracy at rated frequency</td><td>$I \leq I_r$</td><td>$\pm$ 2.5 % of I_r</td></tr>
<tr><td>$I > I_r$</td><td>$\pm$ 2.5 % of I</td></tr>
</table>

Table 49: ER - Event recorder

<table>
<tr><th colspan="2">Function</th><th>Value</th></tr>
<tr><td rowspan="2">Event buffering capacity</td><td>Max. number of events/disturbance report</td><td>150</td></tr>
<tr><td>Max. number of disturbance reports</td><td>10</td></tr>
</table>

Table 50: Mean values (AC-monitoring)

Function	Nominal range	Accuracy
Frequency	(0.95 - 1.05) x f_r	$\pm$ 0.2 Hz
Voltage (RMS) Ph-Ph	(0.1 - 1.5) x U_r	$\pm$ 2.5% of U_r, at $U \leq U_r$ $\pm$ 2.5% of U, at $U > U_r$
Current (RMS)	(0.2 - 4) x I_r	$\pm$ 2.5% of I_r, at $I \leq I_r$ $\pm$ 2.5% of I, at $I > I_r$

Function	Nominal range	Accuracy
Active power*)	at $\|\cos \varphi\| \geq 0.9$	± 5.0%
Reactive power*)	at $\|\cos \varphi\| \leq 0.8$	± 7.5%
*) Measured at U_r and 20% of I_r		

Table 51: MIM - mA measuring function

Function	Setting range	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, I_Max	(-25.00 to +25.00) mA in steps of 0.01	
Min current of transducer to input, I_Min	(-25.00 to +25.00) mA in steps of 0.01	
High alarm level for input, HiAlarm	(-25.00 to +25.00) mA in steps of 0.01	
High warning level for input, HiWarn	(-25.00 to +25.00) mA in steps of 0.01	
Low warning level for input, LowWarn	(-25.00 to +25.00) mA in steps of 0.01	
Low alarm level for input, LowAlarm	(-25.00 to +25.00) mA in steps of 0.01	
Alarm hysteresis for input, Hysteresis	(0-20) mA in steps of 1	
Amplitude dead band for input, DeadBand	(0-20) mA in steps of 1	
Integrating dead band for input, IDeadB	(0.00-1000.00) mA in steps of 0.01	

Table 52: IMA - Increased accuracy of AC input quantities

Function	Nominal range	Accuracy
Frequency	(0.95 - 1.05) x f_r	± 0.2 Hz
Voltage (RMS) Ph-Ph	(0.8 - 1.2) x U_r	± 0.25% of U_r, at $U \leq U_r$ ± 0.25% of U, at $U > U_r$
Current (RMS)	(0.2 - 2) x I_r	± 0.25% of I_r, at $I \leq I_r$ ± 0.25% of I, at $I > I_r$
Active power	$0.8 \times U_r < U < 1.2 \times U_r$ $0.2 \times I_r < I < 2 \times I_r$	± 0.5% of S_r at $S \leq S_r$ ± 0.5% of S at $S > S_r$
Reactive power	$0.8 \times U_r < U < 1.2 \times U_r$ $0.2 \times I_r < I < 2 \times I_r$	± 0.5% of S_r at $S \leq S_r$ ± 0.5% of S at $S > S_r$

Metering

Table 53: PC - Pulse counter logic for metering

Function	Setting range	Accuracy
Input frequency	See Binary Input Module (BIM)	-
Cycle time for pulse counter	30 s, 1 min, 1 min 30 s, 2 min, 2 min 30 s, 3 min, 4 min, 5 min, 6 min, 7 min 30s, 10 min, 12 min, 15 min, 20 min, 30 min, 60 min	± 0,1% of set value

Data communication

Table 54: SPA - Serial communication

Function	Value
Protocol	SPA
Communication speed	300, 1200, 2400, 4800, 9600, 19200 or 38400 Bd
Slave number	1 to 899
Remote change of active group allowed	yes/no
Remote change of settings allowed	yes/no
Connectors and optical fibres	glass or plastic

Table 55: LON - Serial communication

Function	Value
Protocol	LON
Communication speed	1.25 Mbit/s
Connectors and optical fibres	glass or plastic

Table 56: IEC 60870-5-103 - Serial communication

Function	Value
Protocol	IEC 60870-5-103
Communication speed	9600, 19200 Bd
Connectors and optical fibres	glass or plastic

Table 57: Optical fibre connection requirements for SPA/IEC

	Glass fibre	Plastic fibre
Cable connector	ST connector	HFBR, Snap-in connector
Fibre diameter	62.5/125 μm 50/125 μm	1 mm
Max. cable length	1000 m	25 m

Table 58: RS485 connection requirements for SPA/IEC

Cable connector	Phoenix, MSTB 2.5/6-ST-5.08 1757051
Cable dimension	SSTP according to EIA Standard RS485
Max. cable length	100 m

Table 59: LON - Optical fibre connection requirements for LON bus

	Glass fibre	Plastic fibre
Cable connector	ST-connector	HFBR, Snap-in connector
Fibre diameter	62.5/125 μm 50/125 μm	1 mm
Max. cable length	1000 m	25 m

Table 60: DCM - Galvanic data communication module

Interface type	According to standard	Connector type
V.36/V11 Co-directional (on request)	ITU (CCITT)	D-sub 25 pins
V.36/V11 Contra-directional	ITU (CCITT)	D-sub 25 pins
X.21/X27	ITU (CCITT)	D-sub 15 pins
RS 530/RS422 Co-directional (on request)	EIA	D-sub 25 pins
RS 530/RS422 Contra-directional	EIA	D-sub 25 pins
G.703 Co-directional	ITU (CCITT)	Screw
Function	**Value**	
Data transmission	synchronous, full duplex	
Transmission type	56 or 64 kbit/s For G703 only 64 kbit/s	

Table 61: DCM-SGM - Short-range galvanic module

Data transmission	Synchronous, full duplex
Transmission rate	64 kbit/s (256 kBaud; code transparent)
Clock source	Internal or derived from received signal
Range	< 3 km
Line interface	Balanced symmetrical three-state current loop (4 wires)
Connector	5-pin connector with screw connection
Insulation	2,5 kV 1 min. Opto couplers and insulating DC/DC-converter
	15 kV with additional insulating transformer

Table 62: DCM-FOM - Fibre optical communication module

Optical interface		
Type of fibre	Graded-index multimode 50/125μm or 62,5/125μm	Single mode 9/125 μm
Wave length	1300 nm	1300 nm
Optical transmitter injected power	LED -17 dBm	LED -22 dBm
Optical receiver sensitivity	PIN diode -38 dBm	PIN diode -38 dBm
Optical budget	21 dB	16 dB
Transmission distance	typical 15-20 km [a)]	typical 40-60 km [a)]
Optical connector	Type FC-PC	Type FC-PC
Protocol	ABB specific	ABB specific

Optical interface		
Data transmission	Synchronous, full duplex	Synchronous, full duplex
Transmission rate	64 kbit/s	64 kbit/s
Clock source	Internal or derived from received signal	Internal or derived from received signal
a) depending on optical budget calculation		

Table 63: DCM-SFOM - Short-range fibre optical module

Data transmission	Synchronous, full duplex
Transmission rate	64 kbit/s
Clock source	Internal or derived from received signal
Optical fibre	Graded-index multimode 50/125μm or 62,5/125μm
Wave length	850 nm
Optical connectors	ST
Optical budget	15 dB
Transmission distance	typically 3-5 km a)
Protocol	FIBERDATA specific
Optical connector	Type ST
a) depending on optical budget calculation	

Hardware modules

Table 64: BIM, IOM, PSM - Binary inputs

Inputs	RL24	RL48	RL110	RL220
Binary inputs	BIM: 16, IOM: 8, PSM: 4			
Debounce frequency	5 Hz (BIM), 1 Hz (IOM)			
Oscillating signal discriminator.*	Blocking and release settable between 1-40 Hz			
Binary input voltage RL	24/30 VDC +/-20%	48/60 VDC +/-20%	110/125 VDC +/-20%	220/250 VDC +/-20%
Power dissipation (max.)	0.05 W/input	0.1 W/input	0.2 W/input	0.4 W/input
*) Only available for BIM				

Table 65: BOM, IOM, PSM - Binary outputs

Function or quantity		Trip and Signal relays	Fast signal relays
Binary outputs		BOM: 24, IOM: 10, PSM: 4	IOM: 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

Function or quantity		Trip and Signal relays	Fast signal relays
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
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<40ms		48 V/1 A	48 V/1 A
		110 V/0.4 A	110 V/0.4 A
		220 V/0.2 A	220 V/0.2 A
		250 V/0.15 A	250 V/0.15 A
Maximum capacitive load		-	10 nF
Power consumption for each output relay		≤ 0.15 W	

Table 66: MIM - Energizing quantities, rated values and limits

Quantity			Rated value	Nominal range
mA input module	input range		± 20 mA	-
	input resistance		R_{in} = 194 ohm	-
	power consumption	each mA-module	≤ 4 W	-
		each mA-input	≤ 0.1 W	-

Table 67: MIM - Temperature dependence

Dependence on	Within nominal range	Influence
Ambient temperature, mA-input ± 20 mA	-10°C to +55°C	0.02% / °C

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 REx 5xx 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)

Binary I/O capabilities

Binary I/O resided on power supply module *(PSM)*

Measuring capabilities

A/D module *(ADM)*
Transformer module *(TRM)*

Current

Pole-discordance protection, current and contact based *(PD)*
Breaker failure protection *(BFP)*

Power system supervision

Loss of voltage check *(LOV)*
Overload supervision *(OVLD)*
Dead line detection *(DLD)*

Secondary system supervision

Current circuit supervision, current based *(CTSU)*
Fuse failure supervision, Zero sequence *(FUSEzs)*

Logic

Single, two or three pole tripping logic *(TR01-1/2/3)*

Monitoring

Event recorder *(ER)*
Supervision of AC input quantities *(DA)*
Supervision of mA input quantities *(MI)* (Requires optional mA-transducer module, *MIM*)

Product specification

REB 551	Quantity:	▭	1MRK 002 498-AE

Default:

The terminal is delivered without loaded configuration.

Use the configuration and programming tool (CAP 540) to build a configuration from start or to make an example configuration complete.

Option:

Customer specific configuration	On request

Rule: Select only one alternative.

Engergizing quantities for binary inputs on power supply module	24-30 V	☐	1MRK 002 238-AA
	48-60 V	☐	1MRK 002 238-BA
	110-125 V	☐	1MRK 002 238-CA
	220-250 V	☐	1MRK 002 238-DA

Note: Auxiliary dc voltage EL, connected to the power supply module, is (48-250) V.

Measuring capabilities

Add measuring capabilities by selecting input energizing options from the following tables.

Rule: Select only one alternative.

Rated measuring input energizing quantities	1 A, 110 V	☐	1MRK 000 157-MB
	1 A, 220 V	☐	1MRK 000 157-VB
	5 A, 110 V	☐	1MRK 000 157-NB
	5 A, 220 V	☐	1MRK 000 157-WB

Control

Rule: One Synchrocheck must be ordered

Synchrocheck and energizing check, single circuit breaker *(SYN1)*	☐	1MRK 001 458-GA
Synchrocheck and energizing check, double circuit breakers *(SYN12)*	☐	1MRK 001 458-FA
Synchrocheck and energizing check, 1 1/2 breaker arrangement, per breaker *(SYN1 1/2)*	☐	1MRK 001 458-HA
Synchrocheck with synchronizing and energizing check, single circuit breaker *(SYNsy1)*	☐	1MRK 001 458-KA
Synchrocheck with synchronizing and energizing check, double circuit breaker *(SYNsy12)*	☐	1MRK 001 457-HA

Optional functions

System protection and control

Pole slip protection *(PSP)*	☐	1MRK 001 457-SA

Secondary system supervision

Rule: If (FUSEdb) based option is selected (FUSEns) option must be ordered.

Fuse failure supervision, Negative sequence *(FUSEns)*	☐	1MRK 001 457-YA
Fuse failure supervision, du/dt and di/dt based *(FUSEdb)*	☐	1MRK 001 459-YA
Voltage transformer supervision *(TCT)*	☐	1MRK 001 455-TA

Control

Single command, 16 signals *(CD)*	☐	1MRK 001 458-EA
Autorecloser - 1- and/or 3-phase, single circuit breaker *(AR1-1/3)*	☐	1MRK 001 458-LA
Autorecloser - 1- and/or 3-phase, double circuit breakers *(AR12-1/3)*	☐	1MRK 001 457-KA
Autorecloser - 3-phase, single circuit breaker *(AR1-3)*	☐	1MRK 001 458-MA
Autorecloser- 3-phase, double circuit breaker *(AR12-3)*	☐	1MRK 001 457-LA

Logic

Additional single, two or three pole tripping logic *(TR02-1/2/3)*	☐	1MRK 001 459-XA
Pole discordance logic (contact based) *(PDc)*	☐	1MRK 001 458-UA
Additional configurable logic blocks *(CL2)*	☐	1MRK 001 457-MA
Communication channel test logic *(CCHT)*	☐	1MRK 001 459-NA

Rule: If Binary signal transfer to remote end (RTC) is selected Remote end data communication module must be ordered

Binary signal transfer to remote end *(RTC12)*	☐	1MRK 001 458-ZA

Note: The LON based communication capability option is necessary

Multiple command, one fast block with 16 signals (CM1)	☐	1MRK 001 455-RA
Multiple command, 79 medium speed blocks each with 16 signals *(CM79)*	☐	1MRK 001 458-YA

Monitoring

Disturbance recorder *(DR)*	☐	1MRK 001 458-NA
Trip value recorder *(TVR)*	☐	1MRK 001 458-SA
Increased accuracy of AC input quantities *(IMA)*	☐	1MRK 000 597-PA

Metering

Note: The binary input module (BIM) with enhanced pulse counting capabilities is needed for pulse counting

Pulse counter logic for metering *(PC)*	☐	1MRK 001 458-TA
Six event counters *(CN)*	☐	1MRK 001 445-CA

Second HMI language (standard)

Note: Only one alternative is possible

2nd HMI language, german *(HMI-de)*	German	☐	1MRK 001 459-AA
2nd HMI language, russian *(HMI-ru)*	Russian	☐	1MRK 001 459-BA
2nd HMI language, french *(HMI-fr)*	French	☐	1MRK 001 459-CA
2nd HMI language, spanish *(HMI-es)*	Spanish	☐	1MRK 001 459-DA
2nd HMI language, italian *(HMI-it)*	Italian	☐	1MRK 001 459-EA
Customer specific language	Contact your local ABB representative for availability		

Hardware

Indication module

18 LED indication module *(LED-HMI)*	☐	1MRK 000 008-DA

Case size

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

Table 68: Maximum hardware configurations for I/O modules

Maximum number of modules Note: Standard order of location for I/O modules is BIM-BOM-IOM-MIM-DCM from right to left as seen from the rear side of the terminal	Case size	
	3/4 x 19” 1MRK 000 151-GC ☐	1/2 x 19” 1MRK 000 151-FC ☐
Binary input module *(BIM)*	8	3
Binary output modules *(BOM)* Binary input/output modules *(IOM)*	4	3
Milliampere input module *(MIM)*	3	1
Data communication module for remote terminal communication *(DCM)*	1	1
Total in case	*8*	*3*

Binary input/output modules

Binary input module *(BIM)* 16 inputs

RL24-30 VDC	Quantity:		1MRK 000 508-DB
RL48-60 VDC	Quantity:		1MRK 000 508-AB
RL110-125 VDC	Quantity:		1MRK 000 508-BB
RL220-250 VDC	Quantity:		1MRK 000 508-CB

Binary input module with enhanced pulse counting capabilities for the pulse counter logic for metering *(BIM)* 16 inputs

Rule: Can only be ordered together with the pulse counter logic for metering (PC) optional function

RL24-30 VDC	Quantity:		1MRK 000 508-HA
RL48-60 VDC	Quantity:		1MRK 000 508-EA
RL110-125 VDC	Quantity:		1MRK 000 508-FA
RL220-250 VDC	Quantity:		1MRK 000 508-GA

Rule: The number of binary output modules (BOM) and binary I/O modules (IOM) together in a terminal may not exceed a total of 4.

Binary output module 24 output relays *(BOM)*	Quantity:		1MRK 000 614-AB

Rule: The number of binary I/O modules (IOM) and binary output modules (BOM) together in a terminal may not exceed a total of 4.

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

RL24-30 VDC	Quantity:		1MRK 000 173-GB
RL48-60 VDC	Quantity:		1MRK 000 173-AC
RL110-125 VDC	Quantity:		1MRK 000 173-BC
RL220-250 VDC	Quantity:		1MRK 000 173-CC

mA input module 6 channels *(MIM)*	Quantity:		1MRK 000 284-AB

Remote end data communication modules (only one alternative can be selected)

Co-directional V.36 galvanic module *(DCM-V36co)*	☐	On request
Contra-directional V.36 galvanic module *(DCM-V36contra)*	☐	1MRK 000 185-BA
X.21 galvanic module *(DCM-X21)*	☐	1MRK 000 185-CA
Co-directional RS530 galvanic module *(DCM-RS530co)*	☐	On request
Contra-directional RS530 galvanic module *(DCM-RS530contra)*	☐	1MRK 000 185-EA
Fibre optical module *(DCM-FOM)*	☐	1MRK 000 195-AA
Short range galvanic module *(DCM-SGM)*	☐	1MRK 001 370-AA
Short range fibre optical module *(DCM-SFOM)*	☐	1MRK 001 370-DA
Co-directional G.703 galvanic module *(DCM-G.703)*	☐	1MRK 001 370-CA

Serial communication module

Serial communication protocols - possible combinations of interface and connectors			
	Alt 1	Alt 2	Alt 3
X13	SPA/IEC fibre optic	SPA/IEC RS485	SPA fibre optic
X15	LON fibre optic	LON fibre optic	IEC fibre optic

LOC X13, only one alternative can be selected

SPA/IEC 60870-5-103 interface *(SPA/IECpl)*	Plastic fibres	☐	1MRK 000 168-FA
SPA/IEC 60870-5-103 interface *(SPA/IEC/LONgl)*	Glass fibres	☐	1MRK 000 168-DA
SPA/IEC 60870-5-103 interface RS485 galvanic, **terminated** for termination of last terminal in multi-drop *(SPA/IEC/RS485t)*	RS485 galvanic	☐	1MRK 002 084-BA
SPA/IEC 60870-5-103 interface, RS485 galvanic, **unterminated** for point-to-point or intermediate location in multi-drop *(SPA/IEC/RS 485ut)*	RS485 galvanic	☐	1MRK 002 084-CA

LOC X15, only one alternative can be selected

LON interface *(LONpl)*	Plastic fibres	☐	1MRK 000 168-EA
LON interface *(SPA/IEC/LONgl)*	Glass fibres	☐	1MRK 000 168-DA
IEC 60870-5-103 interface *(SPA/IEC/LONgl)*	Glass fibres	☐	1MRK 000 168-DA
IEC 60870-5-103 interface *(SPA/IECpl)*	Plastic fibres	☐	1MRK 000 168-FA

Test switch

Test switch module RTXP 24 in RHGS6 case	☐	1MRK 000 371-CA
With internal earthing	☐	RK 926 215-BB
With external earthing	☐	RK 926 215-BC
On/off switch for the DC-supply *(On/off switch)*	☐	RK 795 017-AA

Mounting details with IP40 protection from the front

19” rack mounting kit *(19” rack)*	☐	1MRK 000 020-BR
Wall mounting kit *(Wall)*	☐	1MRK 000 020-DA
Flush mounting kit *(Flush)*	☐	1MRK 000 020-Y
Semiflush mounting kit *(Semi-flush)*	☐	1MRK 000 020-BS
Additional seal for IP54 protection of flush and semiflush mounted terminals *(IP 54)*	☐	1MKC 980 001-2

Accessories

Protection cover

Cover for rear area including fixing screws and assembly instruction	6U, 3/4 x 19”	☐	1MRK 000 020-AB
	6U, 1/2 x 19”	☐	1MRK 000 020-AC

Mounting kits

Side-by-side mounting kit *(Side-by-side)*		☐	1MRK 000 020-Z

Converters

21-15X: Optical/electrical converter for short range fibre optical module V.36 (supply 48-110 VDC) *(21-15X)*		▭	1MRK 001 295-CA
21-16X: Optical/electrical converter for short range fibre optical module X.21/G 703 (supply 48-110 VDC) *(21-16X)*		▭	1MRK 001 295-DA

Key switch

Key switch for restriction of settings via LCD-HMI *(Key switch)*	Quantity:	▭	1MRK 000 611-A

Front connection cable

Front connection cable between LCD-HMI and PC for terminal handling (Opto/9-pole D-sub) *(Front connection cable)*	Quantity:	▭	1MKC 950 001-2

Manuals

One CD with all 500 series manuals is always delivered with each terminal

Rule: Specify the number of extra CD's requested

User documentation CD-ROM REx 5xx, RET 521, RED 521 (DOC-CD)	Quantity:	▭	1MRK 002 270-AA

Rule: Specify the number of printed manuals requested

Operator's manual	Quantity:	▭	1MRK 505 099-UEN
Technical reference manual	Quantity:	▭	1MRK 505 100-UEN
Installation and commissioning manual	Quantity:	▭	1MRK 505 101-UEN
Application manual	Quantity:	▭	1MRK 505 102-UEN

Customer feedback

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

Technical overview brochure

Accessories for REx 5xx*2.3	1MRK 514 009-BEN
CAP 540*1.2	1MRK 511 112-BEN

Manufacturer

ABB Automation Technology Products AB
Substation Automation
SE-721 59 Västerås
Sweden
Telephone: +46 (0) 21 34 20 00
Facsimile: +46 (0) 21 14 69 18
Internet: www.abb.com/substationautomation