



Features

- Integrated machine terminals for the protection, control, measurement and supervision of small and medium size generators, synchronous motors and large asynchronous motors
- Voltage and current measurement via conventional measuring transformers or current sensors and voltage dividers
- Fixed man-machine interface including a large graphic display, or an external display module for flexible switchgear installation
- Extended functionality including protection, control, measurement, condition monitoring and communication
- Basic current and voltage protection functions and special functions for the protection of motors and generators, e.g. voltage controlled overcurrent protection, differential protection with several principles, underexcitation protection, underimpedance protection (line back-up prot.), thermal overload protection, protection against unbalanced load, abnormal frequency protection, reverse or low-forward power protection and start-up supervision for motors
- Control functions including local and remote control of switching objects, status indication of the switching objects and interlockings on bay and station level
- Measurement of phase currents, phase-to-phase and phase-to-neutral voltages, neutral current and residual voltage, frequency, power factor, harmonics, active and reactive power and energy, etc.
- Optional RTD/mA output module for stator winding, bearing and ambient temperature monitoring
- Condition monitoring including circuit-breaker condition monitoring, trip circuit supervision and internal self-supervision of the machine terminal
- Communication over two communication interfaces: one for local communication with a PC and the other for remote communication via a substation communication system
- Part of the ABB Substation Automation system

Application

The REM 543 and REM 545 rotating machine terminals are designed to be used as an integrated main protection system of generator and generator-transformer units in small and medium-power diesel, hydroelectric and steam power plants, etc. The protection of large and/or important MV synchronous and asynchronous motors used e.g. in pumps, fans, mills and crushers during start-up and normal run forms another application area. The REM 54_ machine terminals as integrated packages make possible compact marine environment solutions for unit protection, too.

In addition to protection, measurement, control and condition monitoring and general functions, the machine terminals are provided with a large amount of PLC functions allowing several automation and sequence logic functions needed for substation automation to be integrated into one unit. The data communication properties include SPA bus or LON bus communication with higher-level equipment. Further, LON communication, together with PLC functions, minimizes the need for hardwiring between the machine terminals.

Design

The machine terminals REM 543 and REM 545 differ from each other in the number of digital inputs and outputs available. Please refer to the section “Ordering” for more details.

The REM 54_ machine terminals incorporate a wide range of functions:

- Protection functions
- Measurement functions
- Control functions
- Condition monitoring functions
- General functions
- Communication functions
- Standard functions

The function blocks are documented on the CD-ROM “Technical Descriptions of Functions” (1MRS 750889-MCD).

Protection functions

Protection is one of the most important functions of the REM 54_ machine terminal. The protection function blocks are independent of each other and have their own setting groups, data recording, etc.

Typical current-based protection functions (e.g. overcurrent) can use either Rogowski coil or conventional current transformer measurement. Correspondingly, voltage-based functions (e.g. overvoltage) use either voltage dividers or voltage transformers.

For further information about functionality levels and the protection functions included in them, refer to the table “Functionality levels, protection functions” in section “Ordering”.

Measurement functions

The measurement functions include three-phase currents, neutral current, three-phase voltages, residual voltage, frequency, active and reactive power and power factor.

An optional RTD/analogue module can be used for measuring stator winding, bearing, and ambient temperatures.

Disturbance recorder

The transient disturbance recorder is able to record 16 current or voltage waveforms and 16 logic digital signals. The sampling fre-

quency of the analogue inputs is 2 kHz at the rated frequency of 50 Hz and 2.4 kHz at the rated frequency of 60 Hz.

The user can set the length of a recording within a range determined by the number of analogue inputs used. The number of recordings depends on the sampling frequency, length of recordings and number of analogue inputs.

The recordings can be uploaded with a DR-Collector Tool which converts the data to a COMTRADE format. The DR-Collector Tool is supported in CAP501 and CAP505 relay tools.

Control functions

The control functions are used to indicate the status of switching devices, i.e. circuit breakers and disconnectors, and to execute open and close commands for controllable switching devices of the switchgear. Furthermore, control functions provide on/off switching objects for control logic purposes and miscellaneous objects for data monitoring, etc.

The control functions configured with the Relay Configuration Tool must be linked to object status indicators included in the MIMIC configuration picture displayed on the MMI. The object status indicators are used to indicate the status of switching devices via the MIMIC picture and to control them locally.

Condition monitoring functions

Condition monitoring function blocks such as supervision of the energizing current and voltage input circuit, operation time counter, circuit-breaker electric wear, scheduled maintenance, trip circuit supervision and breaker travel time are available for the REM 54_ machine terminals.

General functions

Additional functions are available for different general purposes to be used in logics such as activation of MMI backlight, switch-groups, and resetting of operation indications, latched output signals, registers and disturbance recorder.

Communication functions

The machine terminal REM 54_ provides two serial communication protocols: SPA and LON.

Standard functions

Standard functions are used for logics such as interlocking, alarming and control sequencing. The use of logic functions is not limited and the functions can be interconnected with protection, control, measurement, condition monitoring and other standard functions. In addition, digital inputs and outputs and LON inputs and outputs can be connected to standard functions by using the Relay Configuration Tool.

Other functions

Low auxiliary voltage indication

The REM 54_ terminal is provided with a low auxiliary voltage indication feature. The power supply module issues an internal alarm signal when a drop in the power supply voltage is detected (ACFail, active low). The alarm signal is activated if the power supply voltage is about 10% below the lowest rated DC input voltage of the power supply module.

The indication of a low auxiliary voltage is available in the machine terminal configuration and can be connected to any signal output of the REM 54_.

Overtemperature indication

The REM 54_ machine terminal includes an internal temperature supervision function. The power supply module issues an internal alarm signal when overtemperature has been detected inside the terminal enclosure. The alarm signal will be activated once the temperature inside the terminal enclosure increases to +78°C (+75°C...+83°C). Overtemperature indication is available in the machine terminal configuration and can be connected to any signal output of the terminal.

Analogue channels

The machine terminal measures the analogue signals needed for protection, measuring, etc. via sensors developed by ABB or galvanically separated matching transformers.

Depending on whether sensors are included or not, REM 54_ machine terminals have 9 (without sensors) or 10 (with sensors) physical analogue channels. The number of channels used depends on the machine terminal configuration and the kind of matching transformers or sensor inputs used. Furthermore, the machine terminal includes virtual ana-

logue channels for calculating the neutral current and residual voltage from phase currents and voltages.

A current sensor (Rogowski coil) or a voltage divider can be connected to each sensor input.

Analogue channels of the machine terminal are configured with the CAP 505 Relay Product Engineering Tool.

A separate scaling factor can be set for each analogue channel. The factors enable differences between the ratings of the protected unit and those of the measuring device (CTs, VTs etc.). The setting value 1.00 means that the rated value of the protected unit is exactly the same as that of the measuring device.

- Machine terminals with the hardware number REM54x_xxxAAAA/CAAA/AAAB are configured for matching transformers
- Machine terminals with the hardware number REM54x_xxx AABA/CABA/AABB are configured for matching transformers and sensor inputs

Calculated analogue channels

The REM 54_ machine terminal includes virtual channels to obtain the neutral current and residual voltage when sensors are used. Current sensors and voltage dividers are connected to the machine terminal via coaxial cables and therefore a residual connection of the phase currents or an open-delta connection of the phase voltages cannot be made. Both the amplitude and the phase angle are calculated for the virtual channels.

Though primarily meant to be used with sensors, the calculated analogue channels can also be used with conventional current and voltage transformers.

Note! When sensitive earth-fault protection is needed, core balance transformers are not recommended to be replaced with the numerically derived sum of phase currents. Normally, an earth-fault setting below 10% of the rated value requires the use of a core balance transformer.

Digital inputs

The digital inputs of the machine terminal are voltage-controlled and optically isolated. The function of a digital input can be inverted. The programmable filter time removes

debounces and short disturbances on a digital input. The filter time is set for each digital input of the machine terminal.

Some specific digital inputs can be programmed either as digital inputs or as pulse counters. When a digital input operates as a pulse counter, the frequency range of the input is 0...100 Hz.

Oscillation suppression

The machine terminals have two global parameters for the suppression of digital input oscillation. The settings of these parameters determine the oscillation level and hysteresis for all digital inputs. An event is generated if oscillation is detected.

Attributes of a digital input for machine terminal configuration

For each digital input the status of the input (value), the time tag for the status change (time) and the validity of the digital input (invalidity) can be issued by the attributes. These attributes are available in the machine terminal configuration and can be used for various purposes.

RTD/analogue inputs

The REM 543 and REM 545 machine terminals equipped with an RTD/analogue module (RTD1) have eight general purpose analogue inputs for DC measurement. The RTD/analogue inputs are galvanically isolated from the machine terminal power supply and enclosure. However, the inputs have a common ground. The general purpose RTD/analogue inputs accept voltage-, current- or resistance-type signals. For each measuring mode, a separate parameter is provided for choosing between the available measurement ranges.

Digital outputs

The outputs of the machine terminal are categorized as follows:

- HSPO: High-speed power output, double-pole contact, preferred for tripping purposes and for circuit breaker and disconnector control
- PO: Power output, either single-pole or double-pole contact, preferred for circuit breaker and disconnector control
- SO: Signal output, either NO (Normally Open) or NO/NC (Normally Open/Normally Closed) contact. The output contact is a normal duty contact and cannot be used for controlling a heavy load such as a circuit breaker

Analogue outputs

The REM 543 and REM 545 feeder terminals equipped with an RTD/analogue module have four general purpose 0...20 mA analogue current outputs. All outputs are galvanically isolated from the supply and enclosure of the machine terminal and from each other.

Analogue outputs can be utilized for transferring any measured or calculated information to panel meters or e.g. PLCs.

Alarm LED indicators

The machine terminal offers eight alarm LED indicators to be configured with the Relay Mimic Editor. The LED colours (green, yellow, red), their use and the ON and OFF state texts can be freely defined. Three basic operation modes are supported: non-latched, latched-steady and latched blinking. Alarms can be acknowledged remotely, locally and by using logic.

The alarm channels include time tagging for detected alarms. The time tagging principle used depends on the operation mode.

Interlocking LED indicator

The interlocking LED indicates that control operation has been interlocked or that the interlocking is in bypass mode, e.g. when control is possible despite of interlocking.

Trip Circuit Supervision

The purpose of this function is to supervise the tripping circuitry of the circuit breaker. An alarm will be generated in case a faulty tripping circuit, e.g. a circuit is not able to perform a trip, is detected.

The supervision is based on the constant-current injection through the tripping circuitry.

Display panel

The machine terminal is provided with either a fixed display or an external display module. The external display module requires a separate voltage supply from a common source with the main unit. The display consists of 19 rows divided into two windows: a main window (17 rows) and an assisting window (2 rows).

The graphic display presents detailed information on MIMIC, objects, events, measurements, control alarms, and parameters. The assisting window is used for terminal-dependent indications/alarms and help messages.

Additionally, the panel includes the following MMI items:

- three push-buttons for object control (I, O, object selection)
- eight freely programmable alarm LEDs with different colours and modes according to the configuration
- LED indicator for control test and interlocking
- three protection LED indicators
- MMI push-button section with four arrow buttons and buttons for clear and enter
- optically isolated serial communication port
- backlight and contrast control
- freely programmable button (F) which can be used in the configuration of the machine terminal
- a button for remote/local control

The MMI has two main levels, the user level and the technical level. The user level is for “everyday” measurements and monitoring whereas the technical level is intended for advanced machine terminal programming.

Serial communication

The machine terminal has two serial communication ports, one on the front panel and the other on the rear panel.

The standard optical ABB connector (RS-232 connection) on the front panel is intended for the connection of a PC for configuring the machine terminal with CAP 50_ tools. The front interface uses the SPA bus protocol.

The 9-pin RS-485 connection on the rear panel connects the machine terminal to the distribution automation system via the SPA bus or the LON bus. The fibre-optic interface module type RER 103 is used to connect the machine terminal to the fibre-optic communication bus. The RER 103 module supports both SPA bus and LON bus communication.

Self-supervision

The machine terminal REM 54_ is provided with an extensive self-supervision system. The self-supervision system handles run-time fault situations and informs the user of faults via the MMI and SPA/LON bus communication.

When a fault has been detected, the green Ready indicator starts blinking and a fault indication text appears on the MMI. At the same time, the machine terminal delivers a fault signal to the self-supervision output relay and blocks the protection trip outputs.

When an internal fault appears, the self-supervision system generates an IRF code indicating the type of the fault. The fault code can be read from the machine terminal main menu.

Machine terminal configuration

The Relay Configuration Tool, based on the IEC 61131-3 standard and included in the CAP 505 Relay Product Engineering Tools, is used for configuring the basic terminal, protection and logic function blocks, control and measurement functions, timers and other functional elements included in the logic functions category.

The programmable system of REM 54_ machine terminals allows the output contacts to be operated in accordance with the state of the logic inputs and the outputs of the protection, control, measurement and condition monitoring functions. The PLC functions (e.g. interlocking and alarm logic) are programmed with Boolean functions, timers, counters, comparators and flip-flops. The program is written in the function block diagram language by using the configuration software.

Mimic configuration with Relay Mimic Editor

The Relay Mimic Editor, included in the CAP 505 Relay Product Engineering Tools, is used for configuring the graphic display and the alarm channels of the machine terminal. The mimic configuration may include circuit breakers, disconnectors, indicators, measurement data objects and user-defined texts and explanations. Any configuration can be saved for later use.

All of the eight alarm function blocks can be configured in the same alarm view of the mimic editor. ON and OFF state texts (only one language version at the time can be supported for the alarm) and LED colours can be defined. Three different colours can be used to define the ON and OFF state. Three basic modes are available:

- non-latched
- latched-steady
- latched blinking

Interlocking LED texts can also be defined in the same alarm view but the colour of the interlocking LED cannot be changed.

Lon network configuration

The Lon Network Tool is used for binding network variables between the machine terminal units. Typically, LON is used for transferring status data between units for interlocking sequences running in each machine terminal.

Machine terminal parameterization

The parameters of the machine terminal units can be set either locally over the MMI or externally via the serial communication using the Relay Setting Tool.

Local parameterization

When the parameters are set locally, the setting parameters can be chosen from the hierarchical menu structure. The desired language for parameter description can be selected.

External parameterization

The Relay Setting Tool is used for parameterizing and setting the machine terminal externally. The parameters can be set off-line on a PC and downloaded to the machine terminal over a communication port. The menu struc-

ture of the setting tool, including views for parameterization and settings, is the same as the menu structure of the machine terminal.

Terminal connections

All external circuits are connected to the terminal blocks on the rear panel. The terminal block for the measuring transformers consists of fixed screw terminals.

ABB sensors (Rogowski coil or voltage divider) are connected to the machine terminal with a special type of shielded twin BNC connectors. This type of connectors are used to improve reliability and protection against disturbances. Unused sensor inputs must be short-circuited with special connectors, type 1MRS 120515.

The serial interface RS-485 on the rear panel is used for connecting the machine terminal to the SPA bus or the LON bus. The SPA/LON bus is connected via a connection module type RER 103. The RER 103 is fitted to the 9-pole D-type subminiature connector and screwed to the rear panel.

The digital input and output contacts of the machine terminal are connected to the multipole connectors.

Protective earth is connected to the screw marked with the earth symbol.

Connector description

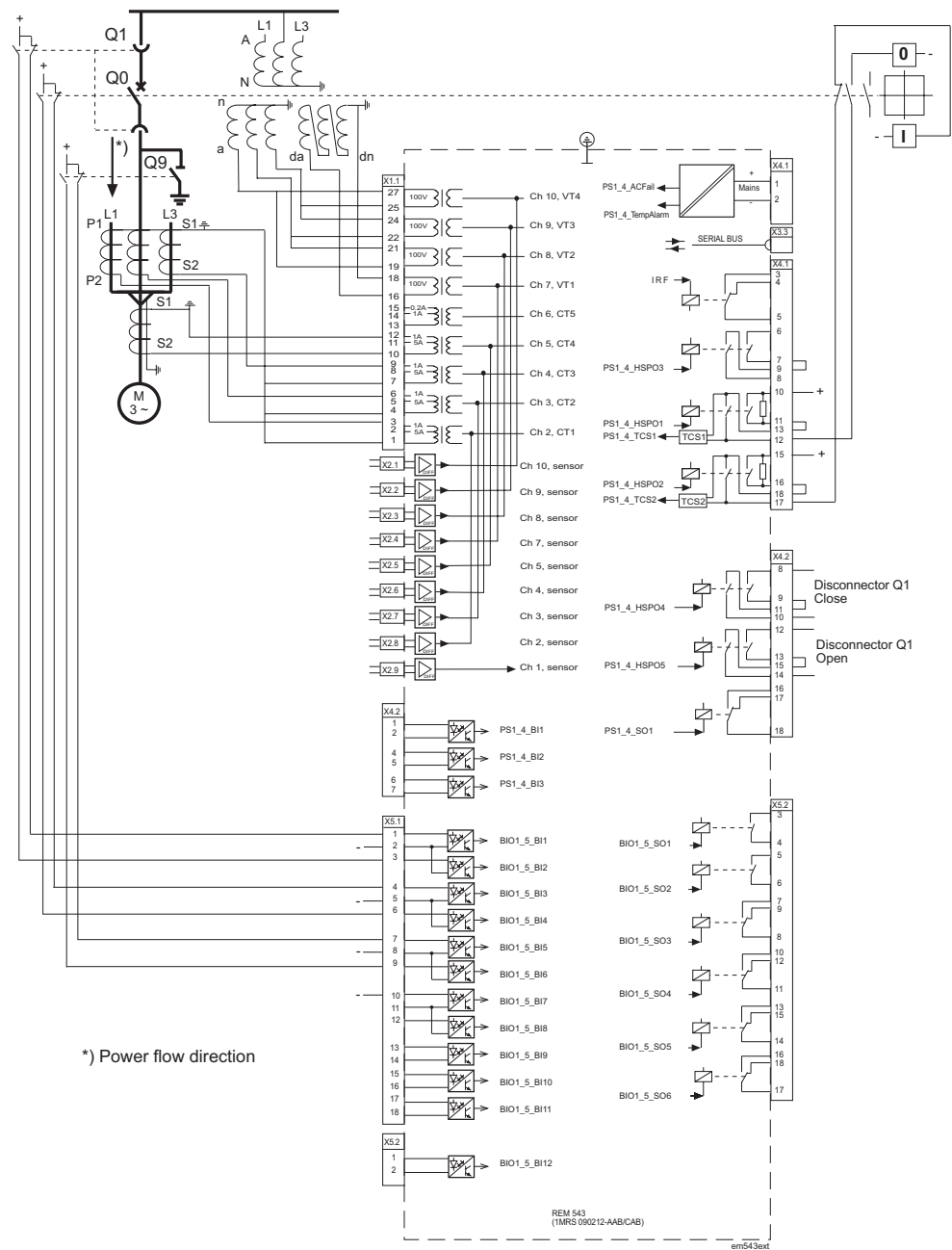


Fig. 1 Sample connection diagram of REM 543

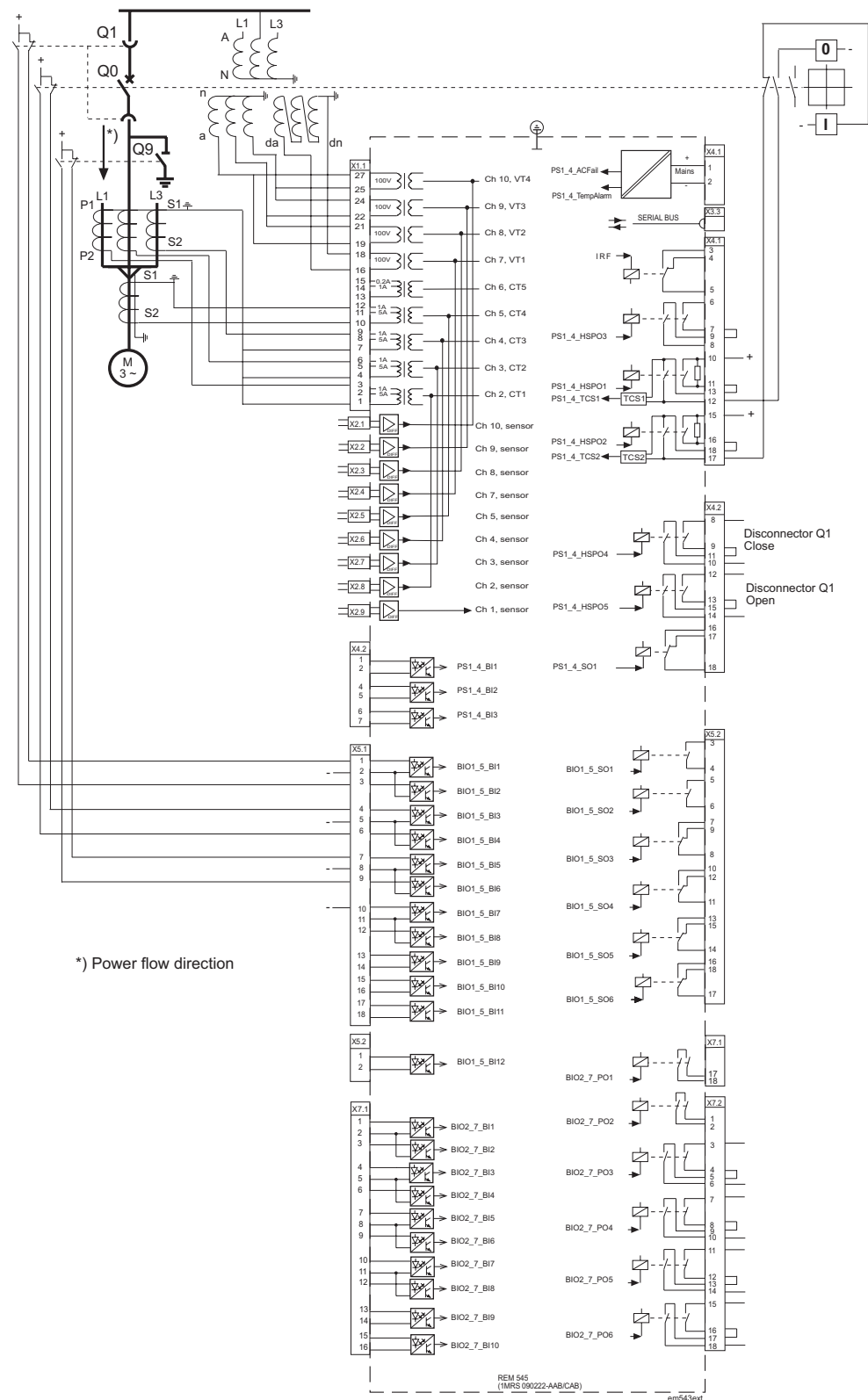


Fig. 2 Sample connection diagram of REM 545

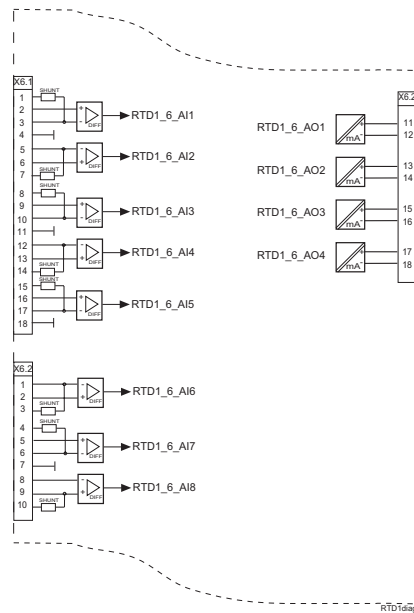


Fig. 3 Terminal diagram of the RTD/analogue module

Auxiliary voltage

For its operation, the REM 54_ terminal, including an external display module, requires a secured auxiliary voltage supply. The machine terminal's internal power supply module forms the voltages required by the machine terminal electronics. The power supply module is a galvanically isolated (fly-back type) dc/dc converter. A green protec-

tion LED indicator on the front panel is lit when the power supply module is in operation.

Power supply

The power supply module available for the REM 54_ is PS1/_. See Technical data, Table 8.

Technical data

Table 1: General function blocks

Functions	Description
MMIWAKE	Activation of MMI backlight
INDRESET	Resetting of operation indicators, latched output signals, registers and waveforms of e.g. in the disturbance recorder
SWGRP1...SWGRP20	Switchgroup SWGRP1...SWGRP20

Table 2: Standard function blocks

Functions	Description
ABS	Absolute value
ACOS	Principal arc cosine
ADD	Extensible adder
AND	Extensible AND connection
ASIN	Arc sine
ATAN	Arc tangent
BITGET	Get one bit
BITSET	Set one bit
BOOL_TO_*	Type conversion from BOOL to WORD/ USINT/ UINT/ UDINT/ SINT/ REAL/ INT/ DWORD/ DINT/ BYTE
BOOL2INT	Type conversion BOOL inputs to INT output
BYTE_TO_*	Type conversion from BYTE to WORD/ DWORD
COMH	Hysteresis comparator
COS	Cosine in radians
CTD	Down-counter
CTU	Up-counter
CTUD	Up-down counter
DATE_TO_UDINT	Type conversion from DATE to UDINT
DINT_TO_*	Type conversion from DINT to SINT/ REAL/ INT
DIV	Divider
DWORD_TO_*	Type conversion from DWORD to WORD/ BYTE
EQ	Extensible comparison to equal
EXP	Natural exponential
EXPT	Exponentiation
F_TRIG	Falling edge detector
GE	Extensible comparison to greater or equal
GT	Extensible comparison to greater
INT_TO_*	Type conversion from INT to REAL/ DINT
INT2BOOL	Type conversion from INT input to BOOL outputs
LE	Extensible comparison to less or equal
LIMIT	Limitation
LN	Natural logarithm
LOG	Logarithm base 10
LT	Extensible comparison to less
MAX	Extensible maximum
MIN	Extensible minimum
MOD	Modulo
MOVE	Move
MUL	Extensible multiplier
MUX	Extensible multiplexer
NE	Comparison to greater or less
NOT	Complement
OR	Extensible OR connection
R_TRIG	Rising edge detector
REAL_TO_*	Type conversion from REAL to USINT/ UINT/ UDINT/ SINT/ INT/ DINT
ROL	Rotate to left
ROR	Rotate to right
RS	Reset dominant bistable function block
RS_D	Reset dominant bistable function block with data input
SEL	Binary selection
SHL	Bit-shift to left

Table 2: Standard function blocks

Functions	Description
SHR	Bit-shift to right
SIN	Sine in radians
SINT_TO_*	Type conversion from SINT to REAL/ INT/ DINT
SUB	Subtractor
SQRT	Square root
SR	Set dominant bistable function block
XOR	Extensible exclusive OR connection
TAN	Tangent in radians
TIME_TO_*	Type conversion from TIME to UDINT/ TOD/ REAL
TOD_TO_*	Type conversion from TOD to UDINT/ TIME/ REAL
TOF	OFF-delay timer
TON	ON-delay timer
TP	Pulse
TRUNC_*	Truncation toward zero
UDINT_TO_*	Type conversion from UDINT to USINT/ UINT/ REAL
UINT_TO_*	Type conversion from UINT to USINT/ UDINT/ REAL/ BOOL
USINT_TO_*	Type conversion from USINT to UINT/ UDINT/ REAL
WORD_TO_*	Type conversion from WORD to DWORD/ BYTE

Table 3: Condition monitoring function blocks

Functions	Description
CMBWEAR1	Circuit-breaker electric wear 1
CMBWEAR2	Circuit-breaker electric wear 2
CMCU3	Supervision function of the energizing current input circuit
CMGAS1	Gas pressure monitoring 1
CMGAS3	Three-pole gas pressure monitoring
CMSCHED	Scheduled maintenance
CMSPRC1	Spring charging control 1
CMTCS1	Trip circuit supervision 1
CMTCS2	Trip circuit supervision 2
CMTIME1	Operate time counter 1 for the operate time used (e.g. motors)
CMTIME2	Operate time counter 2 for the operate time used (e.g. motors)
CMTRAV1	Breaker travel time 1
CMVO3	Supervision function of the energizing voltage input circuit

Table 4: Control function blocks

Functions	Description
COCB1	Circuit breaker 1 control with indication
COCB2	Circuit breaker 2 control with indication
COCBDIR	Direct open for CBs via MMI
CO3DC1	Three-state disconnecter (1) with indication
CO3DC2	Three-state disconnecter (2) with indication
CODC1...COC5	Disconnecter 1...5 with indication
COIND1...COIND8	Switching device 1...8 indication
COLOCAT	Logic controlled position selector
COSW1...COSW4	On/off switch 1...4
MMIALAR1...MMIALAR8	Alarm channel 1...8, LED indication
MMIDATA1...MMIDATA5	MIMIC data monitoring point 1...5

Table 5: Measurement function blocks

General measurement/ analogue input on RTD/analogue module, MEA1...8	
The general measurement function blocks can be used to measure general purpose dc or ac voltage signals with a sensor input. They also include a REAL type input which can be used to monitor any internal REAL type IEC 61131-3 based signal, e.g. input data from the RTD/analogue module.	
GE1...3 (V dc/ac)	-10000.00000...10000.00000
General REAL type input	-10000.00000...10000.00000

Analogue output on RTD/analogue module, MEAO1...4

The analogue output function blocks handle the scaling of any internal REAL type IEC 61131-3 based signal to fit a selectable 0...20 mA or 4...20 mA range for use with the outputs on the RTD/analogue module.

General REAL type input	-10000.00000...10000.00000
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Neutral current measurement, MECU1A and MECU1B

Io (A)	0.0...20000.0 A
Io (%)	0.0...80.0% In

Three-phase current measurement, MECU3A

IL1	0.0...20000.0 A
IL2	0.0...20000.0 A
IL3	0.0...20000.0 A
IL1	0.0...1000.0% In
IL2	0.0...1000.0% In
IL3	0.0...1000.0% In
IL1 demand	0.0...20000.0 A
IL2 demand	0.0...20000.0 A
IL3 demand	0.0...20000.0 A
IL1 demand	0.0...1000.0% In
IL2 demand	0.0...1000.0% In
IL3 demand	0.0...1000.0% In

Transient disturbance recorder for 16 analogue channels, MEDREC16

The transient disturbance recorder MEDREC16 is used for recording the current and voltage waveforms, as well as the status data of internal IEC 61131-3 based logic signals and digital inputs connected to the relay terminals. The maximum number of analogue inputs and logic signals is 16. One fundamental cycle contains 40 samples.

Operation mode	Saturation Overwrite Extension
Pre-trg time	0...100%
Over limit ILx	0.00...40.00 x In
Over limit Io	0.00...40.00 x In
Over limit Iob	0.00...40.00 x In
Over limit Uo	0.00...2.00 x Un
Over limit Ux	0.00...2.00 x Un
Over limit Uxy	0.00...2.00 x Un
Over limit U12b	0.00...2.00 x Un
Over limit ILxb	0.00...40.00 x In
Under limit Ux	0.00...2.00 x Un
Under limit Uxy	0.00...2.00 x Un
AI filter time	0.000...60.000 s

The recording can be triggered by any (or several) of the alternatives listed below:

- triggering on the rising or falling edge of any (or several) of the digital inputs
- triggering on overcurrent, overvoltage or undervoltage
- manual triggering via the menu or with the push-button F on the front panel (if configured)
- triggering via serial communication or a parameter
- periodic triggering

The recording length depends on the number of recordings and inputs used. For example, the following combination of recording length, number of recordings and number of inputs is available at 50 Hz:

# recordings \ # channels	1	3	10
1	1066 cyc. 21.3 s	399 cyc. 7.9 s	125 cyc. 2.5 s
5	212 cyc. 4.2 s	79 cyc. 1.5 s	25 cyc. 0.5 s
10	106 cyc. 2.1 s	39 cyc. 0.7 s	12 cyc. 0.24 s

System frequency measurement, MEFR1	
Frequency	10.00...75.00 Hz
Average Freq.	10.00...75.00 Hz
Voltage U	0.0...2.0 x Un

Three-phase power and energy measurement, MEPE7	
P3 (kW)	-999999...999999 kW
Q3 (kvar)	-999999...999999 kvar
Power factor DPF	-1.00...1.00
Power factor PF	-1.00...1.00
P3 demand (kW)	-999999...999999 kW
Q3 demand (kvar)	-999999...999999 kvar
Energy kWh	0...999999999 kWh
Reverse kWh	0...999999999 kWh
Energy kvarh	0...999999999 kvarh
Reverse kvarh	0...999999999 kvarh

Residual voltage measurement, MEVO1A	
Uo	0...150000 V
Uo	0.0...120.0% Un

Three-phase voltage measurement, MEVO3A	
UL1_U12	0.00...999.99 kV
UL2_U23	0.00...999.99 kV
UL3_U31	0.00...999.99 kV
UL1_U12	0.00...2.00 x Un
UL2_U23	0.00...2.00 x Un
UL3_U31	0.00...2.00 x Un
UL1_U12 average	0.00...999.99 kV
UL2_U23 average	0.00...999.99 kV
UL3_U31 average	0.00...999.99 kV
UL1_U12 average	0.00...2.00 x Un
UL2_U23 average	0.00...2.00 x Un
UL3_U31 average	0.00...2.00 x Un

Table 6: Protection function blocks

Three-phase non-directional overcurrent protection, low-set stage, NOC3Low, 3I>	
Start current	0.10...5.00 x In
Operate time at DT mode	0.05...300.00 s
Time multiplier at IDMT mode	0.05...1.00
Operation mode	Not in use Definite time Extremely inverse Very inverse Normal inverse Long time inverse RI-type inverse RD-type inverse
Measuring mode	Peak-to-peak Fundamental frequency
Drop-off time of the operate time counter	0...1000 ms
Operation accuracy	Note! The values below apply when f/fn = 0.95...1.05 ±2.5% of set value or ±0.01 x In Injected currents > 2.0 x start current: internal time < 32 ms total time < 40 ms 40...1000 ms (depends on the minimum pulse width set for the trip output) 0.95 < 45 ms ±2% of set value or ±20 ms Class index E = 5.0 or ±20 ms
Start time	
Reset time	
Reset ratio, typically	
Retardation time	
Operate time accuracy at DT mode	
Accuracy class index E at IDMT mode	
Three-phase non-directional overcurrent protection, high-set stage, NOC3High, 3I>>, and instantaneous stage, NOC3Inst, 3I>>>	
Start current	0.10...40.00 x In
Operate time	0.05...300.00 s
Operation mode	Not in use Definite time Instantaneous
Measuring mode	Peak-to-peak Fundamental frequency
Drop-off time of the operate time counter	0...1000 ms
Operation accuracy	Note! The values below apply when f/fn = 0.95...1.05 0.1...10 x In: ±2.5% of set value or ±0.01 x In 10...40 x In: ±5.0% of set value Injected currents > 2.0 x start current: internal time < 32 ms total time < 40 ms 40...1000 ms (depends on the minimum pulse width set for the trip output) 0.95 < 45 ms ±2% of set value or ±20 ms
Start time	
Reset time	
Reset ratio, typically	
Retardation time	
Operate time accuracy at DT mode	

Voltage-dependent overcurrent protection, low-set stage, VOC6Low, I(U)>, and high-set stage, VOC6High, I(U)>>	
Start current	0.10...5.00 x I _n
Operate time at DT mode	0.05...300.00 s
Time multiplier at IDMT mode	0.05...1.00
Control mode for voltage control	Voltage step Voltage slope Input step
Voltage limit for the voltage step mode	0.10...1.00 x U _n
Upper voltage limit for the voltage slope mode	0.60...1.00 x U _n
Lower voltage limit for the voltage slope mode	0.10...0.59 x U _n
Current multiplier for lower start current value	0.05...1.00
Operation mode	Not in use Definite time Extremely inverse Very inverse Normal inverse Long-time inverse RI-type inverse RD-type inverse
Measuring mode	Peak-to-peak Fundamental frequency
Voltage selection	Phase-to-phase voltages Phase-to-earth voltages
Drop-off time of the operate time counter	0.00...10.00 s
Operation accuracy	Note! The values below apply when f/f _n = 0.95...1.05 ±2.5% of set value or ±0.01 x I _n
Start time	±2.5% of set value or ±0.01 x I _n Injected currents > 2.0 x start current: internal time < 32 ms total time < 40 ms
Reset time	80...1040 ms (depends on the minimum pulse width set for the trip output)
Reset ratio, typically	0.96
Retardation time	< 45 ms
Operate time accuracy at DT mode	±2% of set value or ±20 ms
Accuracy class index E at IDMT mode	Class index E = 5.0 or ±20 ms

Three-phase underimpedance protection, low-set stage UI6Low, Z<, and high-set stage UI6High, Z<<	
Z-setting	0.01...60.00 p.u.
Operate time	0.04...300.00 s
UI6High	Not in use; In use
Meas. signals (phase selection)	4 selections for ph-e voltages 7 selections for ph-ph voltages (depends on the signals available)
Measuring mode	Peak-to peak; Fund.freq.
Operation accuracy	Note! The values below apply when f/f _n = 0.95...1.05 ± 3.0% of set value or ± 0.02 p.u.
Start time	Injected impedance = 0.50 x Z-setting: internal time < 42 ms total time < 50 ms
Reset time	70...1030 ms (depends on the minimum pulse width set for the TRIP output)
Reset ratio	Typ. 1.03
Retardation time	< 45 ms
Operate time accuracy	± 2% of set value or ± 20 ms

Stabilized differential protection for generators, Diff6G, 3ΔI>, 3ΔI>>	
Basic setting; the lowest ratio of differential and nominal current to cause a trip	5...50%
Starting ratio; slope of the 2nd line of the operating characteristics	10...50%
Turn-point 1; turnpoint between the 1st and 2nd line of the operating characteristics	0.0...1.0 x I _n
Turn-point 2; turnpoint between the 2nd and 3rd line of the operating characteristics	1.0...3.0 x I _n
Tripping value of the instantaneous stage	5...30 x I _n
Operation accuracy	Note! The values below apply when f/f _n = 0.95...1.05 Phase difference measurement: ±4° Stabilized stage: ±4% of set value or ±2% x I _n Instantaneous stage: ±4% of set value or ±2% x I _n Injected currents > 2.0 x operating current: internal time < 35 ms total time < 45 ms 60...1020 ms (depends on the minimum pulse width set for the trip output) 0.95 < 40 ms
Trip time	
Reset time	
Reset ratio, typically	
Retardation time	

High impedance or flux-balance based differential protection for generators and motors, Diff3, 3ΔI>	
Basic setting	0.5...50%
Operation accuracy	Note! The values below apply when f/f _n = 0.95...1.05 ± 2.5% of set value or ± 0.004 x I _n Injected currents > 2.0 x start current: internal time < 20 ms total time < 30 ms 60...1020 ms (depends on the minimum pulse width set for the TRIP output) 0.95 This function block cannot be retarded but trips once the current exceeds the operate value.
Trip time	
Reset time	
Reset ratio, typically	
Retardation time	

Non-directional earth-fault protection, low-set stage, NEF1Low, I₀>	
Start current	1.0...100.0% of I _n
Operate time at DT mode	0.05...300.00 s
Time multiplier at IDMT mode	0.05...1.00
Operation mode	Not in use Definite time Extremely inverse Very inverse Normal inverse Long time inverse RI-type inverse RD-type inverse
Measuring mode	Peak-to-peak Fundamental frequency
Drop-off time of the operate time counter	0...1000 ms
Operation accuracy	Note! The values below apply when f/f _n = 0.95...1.05 ±2.5% of set value + 0.0005 x I _n Injected currents > 2.0 x start current: internal time < 32 ms total time < 40 ms 40...1000 ms (depends on the minimum pulse width set for the trip output) 0.95 < 45 ms ±2% of set value or ±20 ms Class index E = 5.0 or ±20 ms
Start time	
Reset time	
Reset ratio, typically	
Retardation time	
Operate time accuracy at DT mode	
Accuracy class index E at IDMT mode	

Non-directional earth-fault protection, high-set stage, NEF1High, $I_0 \gg$, and instantaneous stage, NEF1Inst, $I_0 \gg \gg$	
Start current	0.10...12.00 x I_n
Operate time	0.05...300.00 s
Operation mode	Not in use Definite time Instantaneous
Measuring mode	Peak-to-peak Fundamental frequency
Drop-off time of the operate time counter	0...1000 ms
Operation accuracy	Note! The values below apply when $f/f_n = 0.95...1.05$ $\pm 2.5\%$ of set value or $+ 0.01 \times I_n$ Injected currents $> 2.0 \times$ start current: internal time < 32 ms total time < 40 ms 40...1000 ms (depends on the minimum pulse width set for the trip output) 0.95 < 45 ms $\pm 2\%$ of set value or ± 20 ms
Start time	
Reset time	
Reset ratio, typically	
Retardation time	
Operate time accuracy at DT mode	

Directional earth-fault protection, low-set stage, DEF2Low, $I_0 \rightarrow$	
Start current	1.0...25.0% of I_n
Start voltage	2.0...100.0% of U_n
Operate time at DT mode	0.1...300.0 s
Time multiplier at IDMT mode	0.05...1.00
Operation mode	Not in use Definite time Extremely inverse Very inverse Normal inverse Long time inverse
Operation criteria	Basic angle & U_0 Basic angle $I_0 \sin / \cos$ & U_0 $I_0 \sin / \cos$ Non-directional I_0 Non-directional U_0
Operation direction	Forward Reverse
Basic angle φ_b	-90° -60° -30° 0°
Operation characteristic	$I_0 \sin(\varphi)$ $I_0 \cos(\varphi)$
Intermittent E/F	Not active Active
Measuring mode	Peak-to-peak Fundamental frequency
Drop-off time of the operate time counter	0...1000 ms

Operation accuracy	Note! The values below apply when $f/f_n = 0.95...1.05$ $\pm 2.5\%$ of set value + $0.0005 \times I_n$ $\pm 2.5\%$ of set value or + $0.01 \times U_n$ Phase angle $\pm 2^\circ$
Start time	Injected neutral current > $2.0 \times$ start current and residual voltage > $2.0 \times$ start voltage: internal time < 72 ms total time < 80 ms
Reset time	40...1000 ms (depends on the minimum pulse width set for the trip output) 0.95
Reset ratio, typically	< 50 ms
Retardation time	$\pm 2\%$ of set value or ± 20 ms
Operate time accuracy at DT mode	Class index E = 5.0 or ± 20 ms
Accuracy class index E at IDMT mode	

Directional earth-fault protection, high-set stage, DEF2High, $I_0 \gg \rightarrow$, and instantaneous stage, DEF2Inst, $I_0 \gg \gg \rightarrow$	
Start current	1.0...200.0% of I_n
Start voltage	2.0...100.0% of U_n
Operate time	0.1...300.0 s
Operation mode	Not in use Definite time Instantaneous
Operation criteria	Basic angle & U_0 Basic angle $I_0 \sin / \cos$ & U_0 $I_0 \sin / \cos$ Non-directional I_0 Non-directional U_0
Operation direction	Forward Reverse
Basic angle ϕ_b	-90° -60° -30° 0°
Operation characteristic	$I_0 \sin(\phi)$ $I_0 \cos(\phi)$
Intermittent E/F	Not active Active
Measuring mode	Peak-to-peak Fundamental frequency
Drop-off time of the operate time counter	0...1000 ms
Operation accuracy	Note! The values below apply when $f/f_n = 0.95...1.05$ $\pm 2.5\%$ of set value + $0.0005 \times I_n$ $\pm 2.5\%$ of set value or + $0.01 \times U_n$ Phase angle $\pm 2^\circ$
Start time	Injected neutral current > $2.0 \times$ start current and residual voltage > $2.0 \times$ start voltage: internal time < 72 ms total time < 80 ms
Reset time	40...1000 ms (depends on the minimum pulse width set for the trip output) 0.95
Reset ratio, typically	< 50 ms
Retardation time	$\pm 2\%$ of set value or ± 20 ms
Operate time accuracy at DT mode	

High-impedance based restricted earth-fault protection, REF1A, ΔI_0>	
Basic setting; the lowest ratio of differential and nominal current to cause a trip	0.5...50%
Operation accuracy Trip time	Note! The values below apply when $f/f_n = 0.95...1.05$ $\pm 2.5\%$ of set value or $\pm 0.004 \times I_n$ Injected currents $> 2.0 \times$ operating current: internal time < 20 ms total time < 30 ms
Reset time	60...1020 ms (depends on the minimum pulse width set for the trip output)
Reset ratio	0.80...0.98
Retardation time	This function block cannot be retarded but trips once the current exceeds the operate value

Residual overvoltage protection, low-set stage, ROV1Low, U_0>	
Start voltage Operate time Operation mode	2.0...20.0% of U_n 0.05...300.00 s Not in use Definite time
Measuring mode	Peak-to-peak Fundamental frequency
Operation accuracy Start time	Note! The values below apply when $f/f_n = 0.95...1.05$ $\pm 2.5\%$ of set value or $\pm 0.01 \times U_n$ Injected voltages $> 2 \times$ start voltage: internal time < 32 ms total time < 40 ms
Reset time	40...1000 ms (depends on the minimum pulse width set for the trip output)
Reset ratio, typically	0.95
Retardation time	Total time for blocking: < 25 ms Total time when voltage drops below start value: < 50 ms
Operate time accuracy at DT mode	$\pm 2\%$ of set value or ± 20 ms

Residual overvoltage protection, high-set stage, ROV1High, U_0>>, and instantaneous stage, ROV1Inst, U_0>>>	
Start voltage Operate time Operation mode	2.0...80.0% of U_n 0.05...300.00 s Not in use Definite time
Measuring mode	Peak-to-peak Fundamental frequency
Operation accuracy Start time	Note! The values below apply when $f/f_n = 0.95...1.05$ $\pm 2.5\%$ of set value or $\pm 0.01 \times U_n$ Injected voltages $> 2 \times$ start voltage: internal time < 32 ms total time < 40 ms
Reset time	40...1000 ms (depends on the minimum pulse width set for the trip output)
Reset ratio, typically	0.95
Retardation time	Total time for blocking: < 25 ms Total time when voltage drops below start value: < 50 ms
Operate time accuracy at DT mode	$\pm 2\%$ of set value or ± 20 ms

Three-phase thermal overload protection for motors, generators and transformers, TOL3Dev, 3^L	
BASIC SETTINGS	
Starting current of the motor	0.10...10.00 x I _n
Max. starting time permitted for the motor	0.1...120.0 s
Number of starts allowed from cold state	1...3
Type of device to be protected	Motor; through-ventilated, rated power < 1500 kW Motor; through-ventilated, rated power > 1500 kW Motor; surface cooling, rated power < 500 kW Motor; surface cooling, rated power > 500 kW Generator; hydro or small air-cooled turbine generators Generator; large turbine generators Transformer
Trip temperature	80.0...120.0%
Prior alarm temperature	40.0...100.0%
Restart inhibit (temperature limit for successful restarting)	40.0...100.0%
Ambient temperature	-50.0...100.0°C
Cooling time-constant	1.0...10.0 x time constant
Heating time-constant for generator or transformer	1...999 min
ADVANCED SETTINGS	
Short time-constant for stator	0.0...999.0 min
Long time-constant for stator	0.0...999.0 min
Weighting factor of the short time-constant for stator	0.00...1.00
Temperature rise of stator at rated current	
Maximum temperature of stator	0.0...350.0 °C
Short time-constant for rotor	0.0...350.0 °C
Long time-constant for rotor	0.0...999.0 min
Weighting factor of the short time-constant for rotor	0.0...999.0 min
Temperature rise of rotor at rated current	0.00...1.00
Maximum temperature of rotor	0.0...350.0 °C 0.0...350.0 °C
Operation mode (principle of ambient temperature compensation)	Not in use No sensors; the set ambient temperature 1 sensor used 2 sensors used
Waiting time for a successful restart (Read-only parameter)	0...86400 s
Predicted time to the trip (Read-only parameter)	0...86400 s
Operation accuracy	Note! The values below apply when f/f _n = 0.95...1.05
Reset ratio	±1.0%, I = 0.1...10.0 x I _n Trip: (Calculated temp. rise - 0.1) / Trip temperature Start: (Calculated temp. rise - 0.1) / Prior alarm temperature Restart: (Calculated temp. rise - 0.1) / Restart inhibit temperature limit

Negative phase-sequence protection, low-set stage, NPS3Low, $I_2>$, and high-set stage, NPS3High, $I_2>>$	
Operation mode	Not in use
Start value of negative-sequence current I_2	Definite time
Operate time	Inverse time
Operating characteristic constant K (corresponds to the machine constant, equal to the $I_2^2 t$ constant of the machine as stated by machine manufacturer)	0.01...0.50 x I_n
Definite start time at inverse-time mode	0.1...120.0 s
Definite minimum operate time	5.0...100.0
Maximum operate time	
Cooling time of the machine	0.1...60.0 s
Number of phases to be measured	0.1...120.0 s
Rotation direction	500...10000 s
Drop-off time of the operate time counter	5...10000 s
	2 or 3
	Forward
	Reverse
	0...1000 ms
Operation accuracy	Note! The values below apply when $f/f_n = 0.95...1.05$ $\pm 2.5\%$ of set value or $\pm 0.01 \times I_n$ Injected negative-seq. current = 2.00 x start value: internal time < 32 ms total time < 40 ms 70...1030 ms (depends on the minimum pulse width set for the trip output) 0.96 < 45 ms $\pm 2\%$ of set value or ± 20 ms $\pm 2\%$ of the calculated ideal operate time or ± 20 ms
Start time	
Reset time	
Reset ratio, typically	
Retardation time	
Operate time accuracy at DT mode	
Accuracy class index E at IDMT mode, typically	

Three-phase overvoltage protection, low-set stage, OV3Low, 3U>	
Start voltage	0.10...1.60 x Un
Operate time	0.05...300.0 s
Time multiplier	0.05...1.00
Operation mode	Not in use
	Definite time
	A curve
	B curve
Measuring mode	Phase-to-phase voltages; peak-to-peak measurement Phase-to-phase voltages; fundamental freq. measurement Phase-to-earth voltages; fundamental freq. measurement
Operation hysteresis	1.0...5.0%
Operation accuracy	Note! The values below apply when $f/f_n = 0.95...1.05$ $\pm 2.5\%$ of set value
Start time	Injected voltages = 1.1 x start voltage: internal time < 42 ms total time < 50 ms
Reset time	40...1000 ms (depends on the minimum pulse width set for the trip output)
Reset ratio	0.96 (range 0.95...0.99)
Retardation time	< 50 ms
Operate time accuracy at DT mode	$\pm 2\%$ of set value or ± 20 ms
Accuracy class index E at IDMT mode, typically	± 20 ms

Three-phase overvoltage protection, high-set stage, OV3High, 3U>>	
Start voltage	0.10...1.60 x Un
Operate time	0.05...300.0 s
Operation mode	Not in use
	Definite time
Measuring mode	Phase-to-phase voltages; peak-to-peak measurement Phase-to-phase voltages; fundamental freq. measurement Phase-to-earth voltages; fundamental freq. measurement
Operation hysteresis	0.96 (range 0.95...0.99)
Operation accuracy	Note! The values below apply when $f/f_n = 0.95...1.05$ $\pm 2.5\%$ of set value
Start time	Injected voltages = 1.1 x start voltage: internal time < 42 ms total time < 50 ms
Reset time	40...1000 ms (depends on the minimum pulse width set for the trip output)
Reset ratio, typically	0.95
Retardation time	< 50 ms
Operate time accuracy at DT mode	$\pm 2\%$ of set value or ± 20 ms

Three-phase undervoltage protection, low-set stage, UV3Low, 3U<	
Start voltage	0.10...1.20 x Un
Operate time	0.1...300.0 s
Time multiplier	0.1...1.0
Operation mode	Not in use Definite time C curve
Measuring mode	Phase-to-phase voltages; peak-to-peak measurement Phase-to-phase voltages; fundamental freq. measurement Phase-to-earth voltages; fundamental freq. measurement
Operation hysteresis	1.0...5.0%
Operation accuracy	Note! The values below apply when $f/f_n = 0.95...1.05$ $\pm 2.5\%$ of set value or $\pm 0.01 \times U_n$ Injected voltages $< 0.5 \times$ start voltage: internal time < 32 ms total time < 40 ms 40...1000 ms (depends on the minimum pulse width set for the trip output) 1.04 (range 1.005...1.05) < 60 ms $\pm 2.5\%$ of set value ± 35 ms
Start time	
Reset time	
Reset ratio	
Retardation time	
Operate time accuracy at DT mode	
Accuracy class index E at IDMT mode, typically	

Three-phase undervoltage protection, high-set stage, UV3High, 3U<<	
Start voltage	0.10...1.20 x Un
Operate time	0.1...300.0 s
Operation mode	Not in use Definite time
Measuring mode	Phase-to-phase voltages; peak-to-peak measurement Phase-to-phase voltages; fundamental freq. measurement Phase-to-earth voltages; fundamental freq. measurement
Operation hysteresis	1.0...5.0%
Operation accuracy	Note! The values below apply when $f/f_n = 0.95...1.05$ $\pm 2.5\%$ of set value or $\pm 0.01 \times U_n$ Injected voltages $< 0.5 \times$ start voltage: internal time < 32 ms total time < 40 ms 40...1000 ms (depends on the minimum pulse width set for the trip output) 1.04 (range 1.005...1.05) < 60 ms $\pm 2.5\%$ of set value
Start time	
Reset time	
Reset ratio	
Retardation time	
Operate time accuracy at DT mode	

Phase-sequence voltage protection, PSV3St1 and PSV3St2, $U_1<$, $U_2>$, $U_1>$	
Start value $U_2>$	0.01...1.00 x Un
Start value $U_1<$	0.01...1.20 x Un
Start value $U_1>$	0.80...1.60 x Un
Operate time $U_2>$	0.04...60.00 s
Operate time $U_1<$	0.04...60.00 s
Operate time $U_1>$	0.04...60.00 s
Operation mode	Not in use; $U_1< \& U_2>$ & $U_1>$; $U_1< \& U_2>$; $U_2> \& U_1>$; $U_1< \& U_1>$; $U_2>$; $U_1<$; $U_1>$
Dir. selection	Forward; Reverse; Input ROT_DIR

Operation accuracy	Note! The values below apply when $f/f_n = 0.95...1.05$ $\pm 2.5\%$ of set value or $\pm 0.01 \times U_n$ U2> operation: Injected negative-seq. voltage = $1.1 \times$ start value: internal time < 42 ms total time < 50 ms U1< operation: Injected positive-seq. voltage = $0.50 \times$ start value: internal time < 32 ms total time < 40 ms U1> operation: Injected positive-seq. voltage = $1.1 \times$ start value: internal time < 42 ms total time < 50 ms 70...1030 ms (depends on the minimum pulse width set for the TRIP output) U2> operation: 0.96 U1< operation: 1.04 U1> operation: 0.99 < 45 ms (for all operations) $\pm 2\%$ of set value or ± 20 ms
Trip time	
Reset time	
Reset ratio, typically	
Retardation time	
Operate time accuracy	

Underfrequency or overfrequency protection, 5 stages, Freq1St1... Freq1St5, $f</f>$, df/dt	
Operation mode	Not in use $f</f>$ 1 timer $f</f>$ 2 timers $f</f>$ OR df/dt $f</f>$ AND df/dt $f</f>$ OR $df/dt<$ $f</f>$ AND $df/dt<$
Undervoltage limit for blocking	$0.30...0.90 \times U_n$
Start value for under-/overfrequency prot.	25.00...75.00 Hz
Operate time for under-/overfrequency prot.	0.10...120.00 s
Start value for df/dt protection	0.2...10.0 Hz/s
Operate time for df/dt protection	0.12...120.00 s
Operation accuracy	Under-/overfrequency ($f</f>$): ± 10 mHz Frequency rate of change (df/dt); real $df/dt < \pm 5$ Hz/s: ± 100 mHz/s real $df/dt < \pm 15$ Hz/s: $\pm 2.0\%$ of real df/dt Undervoltage blocking: $\pm 1.0\%$ of set value
Start time	Total start times at $f_n = 50$ Hz: Frequency measurement < 100 ms Df/dt measurement < 120 ms
Reset time	140...1000 ms (depends on the minimum pulse width set for the trip output)
Operate time accuracy	$\pm 2\%$ of set value or ± 30 ms

Underexcitation protection, low-set stage, UE6Low, X<	
Operate time	0.06...60.00 s
Distance of the top of the impedance circle from the R-axis	-10.00...10.00 p.u.
Diameter of the impedance circle	0.01...60.00 p.u.
Displacement of the centre of the impedance circle from the X-axis	-10.00...10.00 p.u.
Measuring mode	Not in use One-phase, phase-to-earth voltages, fundamental freq. One-phase, phase-to-phase voltages, fundamental freq. Three-phase, phase-to-earth voltages, fundamental freq. Three-phase, phase-to-phase voltages, fundamental freq. Three-phase, phase-to-earth voltages, positive sequence Three-phase, phase-to-phase voltages, positive sequence
Drop-off time	0.00...10.00 s
Operation accuracy	Note! The values below apply when $f/f_n = 0.95...1.05$ $\pm 4.0\%$ of set value or ± 0.02 p.u. Injected impedance = $0.50 \times$ circle radius: internal time < 62 ms total time < 70 ms 100...1100 ms (depends on the minimum pulse width set for the trip output) 1.04 < 45 ms $\pm 2\%$ of set value or ± 20 ms
Start time	
Reset time	
Reset ratio, typically	
Retardation time	
Operate time accuracy at DT mode	

Underexcitation protection, high-set stage, UE6High, X<<	
Operate time	0.06...10.00 s
Distance of the top of the impedance circle from the R-axis	-10.00...10.00 p.u.
Diameter of the impedance circle	0.01...60.00 p.u.
Displacement of the centre of the impedance circle from the X-axis	-10.00...10.00 p.u.
Measuring mode	Not in use One-phase, phase-to-earth voltages, fundamental freq. One-phase, phase-to-phase voltages, fundamental freq. Three-phase, phase-to-earth voltages, fundamental freq. Three-phase, phase-to-phase voltages, fundamental freq. Three-phase, phase-to-earth voltages, positive sequence Three-phase, phase-to-phase voltages, positive sequence
Drop-off time	0.00...10.00 s
Operation accuracy	Note! Values below apply when $f/f_n = 0.95...1.05$ $\pm 4.0\%$ of set value or ± 0.02 p.u. Injected impedance = $0.50 \times$ circle radius: internal time < 62 ms total time < 70 ms 100...1100 ms (depends on the minimum pulse width set for the trip output) 1.04 < 45 ms $\pm 2\%$ of set value or ± 20 ms
Start time	
Reset time	
Reset ratio, typically	
Retardation time	
Operate time accuracy at DT mode	

Overexcitation protection, low-set stage, OE1Low, U/f>, and high-set stage, OE1High, U/f>>	
U/f start (DT mode)	1.00...2.00 $\times U/f$
U/f start (IDMT mode)	1.00...2.00 $\times U/f$
U max cont.	0.80...1.60 $\times U_n$
Operate time	0.10...600.00 s
k	0.1...100.0
Maximum time	500...10000 s
Constant delay	0.1...120.0 s
Cooling time	5...10000 s
Operation mode	Not in use; Definite time; Curve#1; Curve#2

Operation accuracies	20...40 Hz: $\pm 4\%$ of set value; 40...80 Hz: $\pm 2\%$ of set value
Start time	Injected $U/f > 2.0 \times U_n/f_n$; internal time < 60 ms, total time < 70 ms
Reset time	100...1060 ms (depends on the set minimum pulse width for the TRIP output)
Reset ratio	20...40 Hz: typ. 0.99; 40...80 Hz: typ 0.97
Retardation time	< 105 ms
Operate time accuracy at definite-time mode	20...80 Hz: $\pm 4\%$ of set value or ± 40 ms
Operate time accuracy at inverse-time modes	± 100 ms or the accuracy appearing when the measured voltage varies $\pm 1.0\%$

Directional overpower protection, 3 stages, OPOW6St1...OPOW6St3, P>→/Q>→	
Operate time	0.04...300.00 s
Angle (power direction)	-90...90 °
Power setting (start power)	1.0...200.0 % S_n
Drop-off time	0.00...60.00 s
Measuring mode	Not in use U1,U2,U3 & I1,I2,I3 U12,U23,U0 & I1,I2,I3 U23,U31,U0 & I1,I2,I3 U12,U31,U0 & I1,I2,I3 U12,U23 & I1,I2,I3 U23,U31 & I1,I2,I3 U12,U31 & I1,I2,I3 U1 & I1 U2 & I2 U3 & I3 U12 & I3 U23 & I1 U31 & I2
Power direction	Forward Reverse
Operation accuracy	Note! The values below apply when $f/f_n = 0.95...1.05$ $\pm 1.0\%$ of set value or $\pm 0.01 \times$ rated value
Start time	Injected power $> 2.0 \times$ power setting: internal time < 32 ms total time < 40 ms
Reset time	70...1030 ms (depends on the minimum pulse width set for the trip output)
Reset ratio, typically	0.98
Retardation time	< 45 ms
Operate time accuracy at DT mode	$\pm 2\%$ of set value or ± 20 ms

Underpower or reverse power protection, 3 stages, UPOW6St1...UPOW6St3, P</P>←	
Operate time	0.04...300.00 s
Operation mode	Underpower Reverse power
Power setting (start power)	1.0...200.0% Sn
Waiting time after closing a CB	0.0...60.0 s
Disable mode	OFF ON
Drop-off time	0.00...60.00 s
Measuring mode	Not in use U1,U2,U3 & I1,I2,I3 U12,U23,U0 & I1,I2,I3 U23,U31,U0 & I1,I2,I3 U12,U31,U0 & I1,I2,I3 U12,U23 & I1,I2,I3 U23,U31 & I1,I2,I3 U12,U31 & I1,I2,I3 U1 & I1 U2 & I2 U3 & I3 U12 & I3 U23 & I1 U31 & I2
Power direction	Forward Reverse
Operation accuracy	Note! The values below apply when $f/f_n = 0.95...1.05$ $\pm 1.0\%$ of set value or $\pm 0.01 \times$ rated value $\pm 1.5\%$ of set value or $\pm 0.015 \times$ rated value when resistive voltage dividers are used
Start time	Injected power < 0.5 x power setting (underpower) or 2.0 x power setting (reverse power): internal time < 32 ms total time < 40 ms
Reset time	70...1030 ms (depends on the minimum pulse width set for the trip output)
Reset ratio, typically	0.98 (reverse power) 1.02 (underpower)
Retardation time	< 45 ms
Operate time accuracy at DT mode	$\pm 2\%$ of set value or ± 20 ms
Start-up supervision for motors, MotStart, I_s^2t , n<	
Start current (for motor)	1.0...10.0 x In
Start time (for motor)	0.3...250.0 s
Time-based restart inhibit limit	1.0...500.0 s
Countdown rate of the time counter	2.0...250.0 s/h
Stalling time permitted for rotor	2.0...120.0 s
Operation mode	Not in use I_s^2t I_s^2t & Stall
Start counter (Read-only parameter)	0...99999
Time to restart enable (Read-only parameter)	0...99999 min
Stall input (signal for motor stalling indication; read-only parameter)	Not active Active
Operation accuracy	$f/f_n = 0.95...1.05$: $\pm 2.5\%$ of set value or $\pm 0.01 \times$ In
Start time	$f/f_n = 0.95...1.50$: internal time < 22 ms total time < 30 ms $f/f_n = 0.50...0.95$: internal time < 32 ms total time < 40 ms
Reset ratio, typically	0.95
Retardation time	< 50 ms

Non-directional undercurrent, 2 stages, NUC3St1 and NUC3St2, 3I<	
Operation mode	Not in use Alarm Trip
Operation criteria	1,2 or 3 phases all 3 phases
Start current	0.10...0.99 x I _n
Operate time	0.1...600.0 s
Internal undercurrent blocking	Disabled Enabled
Blocking time from motor start-up	0...7200 s
Measuring mode	Peak-to-peak Fundamental frequency
Operation accuracy	Note! The values below apply when f/f _n = 0.95...1.05 ±2.5% of set value or ±0.01 x I _n Injected currents = 0.5 x start current: internal time < 92 ms total time < 100 ms 40...1000 ms (depends on the minimum pulse width set for the trip output) 1.02 < 80 ms ±2% of set value or ±25 ms
Start time	
Reset time	
Reset ratio, typically	
Retardation time	
Operate time accuracy at DT mode	

Phase reversal protection, PREV3, 3I↷, 3I↶	
Operation mode	Not in use; 2-phase; 3-phase
Operate time	0.1...10.0 s
Expected rotation direction	Forward; Reverse
Operation accuracy	Note! The values below apply when f/f _n = 0.95...1.05 Phase angle difference: ±2° Current: ±0.01 x I _n When the phase order is reversed and the injected currents = 1.0 x I _n : internal time < 72 ms total time < 80 ms 40...1000 ms (depends on the minimum pulse width set for the trip output) Reset value for the phase angle difference : 3° < 60 ms ±2% of set value or ±20 ms
Start time	
Reset time	
Reset ratio	
Retardation time	
Operate time accuracy	

Three-phase transformer inrush and motor start-up current detector Inrush3, 3I_{2f}>	
Ratio I _{2f} /I _{1f} >	5...50%
Start current	0.10...5.00 x I _n
Operation mode	Not in use Inrush mode Start-up mode
Operation accuracy	Note! The values below apply when f/f _n = 0.95...1.05 Current meas.: ±2.5% of set value or ±0.01 x I _n Ratio I _{2f} /I _{1f} measurement: ±5.0% of set value Internal time < 32 ms Total time < 40 ms
Start time	

Fuse failure supervision, FuseFail, FUSEF	
Ratio U ₂ /U ₁ >	10...50%
Ratio I ₂ /I ₁ <	10...50%

Operation accuracy	When $f/f_n = 0.98...1.02$ ± 2.0 percentage units (of settings Ratio U2/U1> and Ratio I2/I1<) When $f/f_n = 0.95...1.05$ ± 4.0 percentage units (of settings Ratio U2/U1> and Ratio I2/I1<)
BSOUT activation time (when the task interval is 10 ms)	Injected negative-sequence voltage = $2.00 \times \text{Ratio U2/U1>}$ ($f/f_n = 0.98...1.02$): < 35 ms (within the same task)
Reset time	20 ms (within the same task)
Reset ratio	for Ratio U2/U1>: 0.8...0.96 for Ratio I2/I1<: 1.04...1.2

Table 7: Energizing inputs

Rated frequency		50.0/60.0 Hz	
Current inputs	rated current		1 A/5 A
	Thermal withstand capability	continuously	4 A/20 A
		for 1 s	100 A/500 A
	dynamic current withstand, half-wave value		250 A/1250 A
	input impedance		<100 mΩ/<20 mΩ
Voltage inputs	rated voltage		100 V/110 V/115 V/120 V (parameterization)
	voltage withstand, continuously		$2 \times U_n$ (240 V)
	burden at rated voltage		<0.5 VA
Sensor inputs, max 9	voltage range RMS		± 9.4 V
	voltage range peak		± 12 V
	input impedance		>4.7 MΩ
	input capacitance		< 1 nF

Table 8: Auxiliary power supplies

Type	PS1/240V	External display module	PS1/48V
Input voltage, ac	110/120/220/240 V		-
Input voltage, dc	110/125/220 V		24/48/60 V
Operating range	ac 85...110%, dc 80...120% of rated value		dc 80...120% of rated value
Burden	<50 W		
Ripple in dc auxiliary voltage	max. 12% of the dc value		
Interruption time in auxiliary dc voltage without resetting	<50 ms, 110 V and <100 ms, 200 V		
Internal overtemperature indication	+78°C (+75...+83°C)		

Table 9: Digital inputs

Power supply version	PS1/240 V	PS1/48 V
Input voltage, dc	110/125/220 V	24/48/60/110/125/220 V
Operating range, dc	80...265 V	18...265 V
Current drain	~2...25 mA	
Power consumption/input	<0.8 W	
Pulse counting (specific digital inputs), frequency range	0...100 Hz	

Table 10: RTD/analogue inputs

Supported RTD sensors	100 Ω Platinum	TCR 0.00385 (DIN 43760)
	250 Ω Platinum	TCR 0.00385
	1000 Ω Platinum	TCR 0.00385
	100 Ω Nickel	TCR 0.00618 (DIN 43760)
	120 Ω Nickel	TCR 0.00618
	250 Ω Nickel	TCR 0.00618
	1000 Ω Nickel	TCR 0.00618
	10 Ω Copper	TCR 0.00427
Max lead resistance (three-wire measurement)	200 Ω per lead	
Accuracy	$\pm 0.5\%$ of full scale $\pm 1.0\%$ of full scale for 10 Ω Copper RTD	
Isolation	2 kV (inputs to outputs and inputs to protective earth)	
Sampling frequency	5 Hz	
Response time	$\leq$ Filter time + 30 ms (430 ms...5.03 s)	
RTD/ Resistance sensing current	max 4.2 mA RMS 6.2 mA RMS for 10 Ω Copper	
Current input impedance	274 $\Omega \pm 0.1\%$	

Table 11: Signal outputs

Max system voltage	250 V ac/dc
Continuous carry	5 A
Make and carry for 0.5 s	10 A
Make and carry for 3 s	8 A
Breaking capacity when control circuit time-constant L/R <40 ms, at 48/110/220 V dc	1 A/0.25 A/0.15 A

Table 12: Power outputs

Max system voltage		250 V ac/dc
Continuous carry		5 A
Make and carry for 0.5 s		30 A
Make and carry for 3 s		15 A
Breaking capacity when control circuit time-constant L/R <40 ms, at 48/110/220 V dc		5 A/3 A/1 A
Minimum contact load		100 mA, 24 V ac/dc (2.4 VA)
TCS (Trip Circuit Supervision)	Control voltage range	20...265 V ac/dc
	Current drain through the supervision circuit	approx. 1.5 mA (0.99...1.72 mA)
	Minimum voltage (threshold) over a contact	20 V ac/dc (15...20 V)

Table 13: Analogue outputs

Output range	0...20 mA
Accuracy	$\pm 0.5\%$ of full scale
Max load	600 Ω
Isolation	2 kV (output to output, output to inputs and output to protective earth)
Response time	≤ 85 ms

Table 14: Environmental conditions

Specified service temperature range	-10...+55°C
Transport and storage temperature range	-40...+70°C

Table 14: Environmental conditions

Degree of protection by enclosure	Front side, flush-mounted	IP 54
	Rear side, connection terminals	IP 20
Dry heat test		according to IEC 60068-2-2 (BS 2011: Part 2.1 B)
Dry cold test		according to IEC 60068-2-1
Damp heat test cyclic		according to IEC 60068-2-30 r.h. = 95%, T = 25°...55°C
Storage temperature tests		according to IEC 60068-2-48

Table 15: Standard tests

Insulation tests	Dielectric test IEC 60255-5	Test voltage	2 kV, 50 Hz, 1 min.
	Impulse voltage test IEC 60255-5	Test voltage	5 kV, unipolar impulses, waveform 1.2/50 µs, source energy 0.5 J
	Insulation resistance measurements IEC 60255-5	Insulation resistance	> 100 MΩ, 500 V dc
Mechanical tests	Vibration tests (sinusoidal)		IEC 60255-21-1, class I
	Shock and bump test		IEC 60255-21-2, class I

Table 16: Electromagnetic compatibility tests

The EMC immunity test level fulfills the requirements listed below		
1 MHz burst disturbance test, class III (IEC 60255-22-1)	common mode	2.5 kV
	differential mode	1.0 kV
Electrostatic discharge test, class III (IEC 61000-4-2 and 60255-22-2)	for contact discharge	6 kV
	for air discharge	8 kV
Radio frequency interference test	conducted, common mode (IEC 61000-4-6)	10 V (rms), f = 150 kHz...80 MHz
	radiated, amplitude-modulated (IEC 61000-4-3)	10 V/m (rms), f = 80...1000 MHz
	radiated, pulse-modulated (ENV 50204)	10 V/m, f = 900 MHz
	radiated, test with a portable transmitter (IEC 60255-22-3, method C)	f = 77.2 MHz, P = 6 W; f = 172.25 MHz, P = 5 W
Fast transient disturbance test (IEC 60255-22-4 and IEC 61000-4-4)	power supply	4 kV
	I/O ports	2 kV
Surge immunity test (IEC 61000-4-5)	power supply	4 kV, common mode 2 kV, differential mode
	I/O ports	2 kV, common mode 1 kV, differential mode
Power frequency (50 Hz) magnetic field (IEC 61000-4-8)	100 A/m	
Voltage dips and short interruptions (IEC 61000-4-11)	30%, 10 ms	
	> 90%, 5000 ms	
Electromagnetic emission tests (EN 55011 and EN 50081-2)	conducted RF emission (mains terminal)	EN 55011, class A
	radiated RF emission	EN 55011, class A
CE approval	Complies with the EMC directive 89/336/EEC and the LV directive 73/23/EEC	

Table 17: Data communication

Rear interface, connector X3.3	RS485 connection	
	LON bus or SPA bus, selectable	
	the fibre-optic interface module RER 103 is needed for galvanic isolation	
	data transfer rates	SPA bus: 4.8/9.6/19.2 kbps, selectable LON bus: 78.0 kbps/1.2 Mbps, selectable
Rear interface, connectors X3.1 and X3.2	not used, reserved for future purposes	
Rear interface, connector X3.4	RJ45 connection	
	galvanically isolated RJ45 connection for an external display panel communication cable	
		1MRS 120511.001
Front panel	optical RS 232 connection	
	data code	ASCII
	data transfer rates	4.8, 9.6 or 19.2 kbps, selectable
	serial communication cable	1MKC 9500011
Asynchronous serial communication parameters	start bits	1
	data bits	7
	parity	even
	stop bits	1
	baud rate	9.6 kbps (default)
Communication protocols	SPA-bus protocol LON bus	

Table 18: General

Toolboxes	CAP 501 CAP 505 LNT 505
Event recording	all events are recorded in higher level syntax: reason, time, date the last 100 events are recorded
Data recording	records operate values
Protection functions Control functions Condition monitoring functions Measurement functions	see Technical Descriptions of Functions, CD-ROM (1MRS 750889-MCD)
Self-supervision	RAM circuits ROM circuits Parameter memory circuits CPU watchdog Power supply Digital I/O modules MMI module RTD/analogue input module Internal communication bus A/D converters and analogue multiplexers
Mechanical dimensions	Width: 223.7 mm (1/2 of a 19" rack) Height, frame: 265.9 mm (6U) Height, box: 249.8 mm Depth: 235 mm For dimension drawings, refer to the Installation Manual (1MRS 750526-MUM)
Weight of the unit	~8 kg

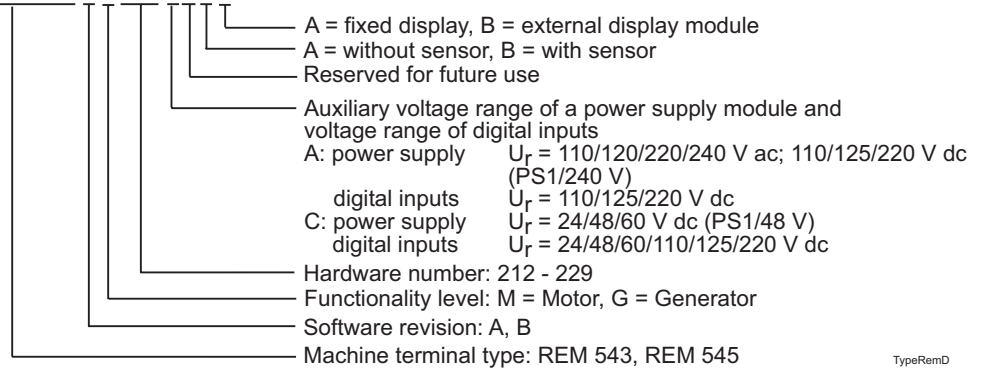
Ordering

The following is to be specified when ordering REM 54_ machine terminals: order number, display language combination and quantity of machine terminals.

The order number is labelled on the marking strip on the front panel of the machine terminal delivered, e.g.
Order No: REM543BM212AAAA.

Each REM 54_ machine terminal has a specific order number that identifies the machine terminal type as well as the hardware and the software as described in the figure below.

REM543BM212AAAA



TypeRemD

The display language combination (see table below) is identified by a three-digit suffix in the software number labelled on the front panel of the machine terminal, e.g. Software No: 1MRS110019-001.

Language combinations

Suffix	Language combination
001	English-German
002	English-Swedish
003	English-Finnish

The REM 543 and REM 545 machine terminals differ from each other as to the number of digital inputs and outputs as follows.

Number of inputs/outputs

Number of inputs/outputs	REM 543	REM 545
Digital inputs	15	25
Trip circuit supervision inputs	2	2
Power outputs (NO single-pole)	-	2
Power outputs (NO double-pole)	5	9
Signal outputs (NO)	2	2
Signal outputs (NO/NC)	5	5
Self-supervision outputs	1	1

The functionality level determines the selection of function blocks available for the machine terminal (see the tables below). For

more detailed information on the separate function blocks included in each selection, please consult your relay supplier.

Functionality levels, protection functions

ANSI Code	IEC Symbol	Function	Code	FUNCTIONALITY LEVELS	
				REM 543/5 Motor	REM 543/5 Generator
		SHORT CIRCUITS:			
51	3I >	Three-phase non-directional overcurrent, low-set stage	NOC3Low	X	X
50/51/51B	3I >>	Three-phase non-dir. overcurrent, high-set stage / blockable overcurrent	NOC3High	X	X
50/51B	3I >>>	Three-phase non-dir. overcurrent, inst. stage / blockable overcurrent	NOC3Inst	X	X
51V	I(U) >	Voltage dependent overcurrent, low-set stage	VOC6Low	X	X
51V	I(U) >>	Voltage dependent overcurrent, high-set stage	VOC6High	X	X
87G/87M	3ΔI>	High-impedance/flux-balance based diff. protection for motors/generators	Diff3	X	X
87G	3ΔI>, 3ΔI>>	Stabilized three-phase differential protection for generators	Diff6G		X
21G	Z<	Three-phase underimpedance protection, low-set stage	UI6Low		X
21G	Z<<	Three-phase underimpedance protection, high-set stage	UI6High		X
		EARTH-FAULTS:			
51N	I _o > / SEF	Non-directional earth-fault, low-set stage	NEF1Low	X	X
50N/51N	I _o >>	Non-directional earth-fault, high-set stage	NEF1High	X	X
50N	I _o >>> / I _{o-o} >	Non-directional earth-fault, instantaneous stage	NEF1Inst	X	X
67N/51N	I _o > / SEF ->	Directional earth-fault, low-set stage	DEF2Low	X	X
67N	I _o >> ->	Directional earth-fault, high-set stage	DEF2High	X	X
67N	I _o >>> ->	Directional earth-fault, instantaneous stage	DEF2Inst	X	X
87N	ΔI _o >, REF	High-impedance based restricted earth-fault protection	REF1A		X
59N	U _o >	Residual overvoltage, low-set stage	ROV1Low	X	X
59N	U _o >>	Residual overvoltage, high-set stage	ROV1High	X	X
59N	U _o >>>	Residual overvoltage, instantaneous stage	ROV1Inst	X	X
		OVERLOAD/UNBALANCED LOAD:			
49M/49G/49T	3θ>	Three-phase thermal overload for motors/ generators/ transformers	TOL3Dev	X	X
46	I ₂ >	Negative-phase-sequence protection, low-set stage	NPS3Low	X	X
46	I ₂ >>	Negative-phase-sequence protection, high-set stage	NPS3High	X	X
		OVER/UNDERVOLTAGE:			
59	3U >	Three-phase overvoltage, low-set stage	OV3Low	X	X
59	3U >>	Three-phase overvoltage, high-set stage	OV3High	X	X
27	3U <	Three-phase undervoltage, low-set stage	UV3Low	X	X

Functionality levels, protection functions

ANSI Code	IEC Symbol	Function	Code	FUNCTIONALITY LEVELS	
				REM 543/ 5 Motor	REM 543/5 Generator
27	3U <<	Three-phase undervoltage, high-set stage	UV3High	X	X
27, 47, 59	U1<, U2>, U1>	Three-phase phase-sequence voltage protection, stage 1	PSV3St1	X	X
27, 47, 59	U1<, U2>, U1>	Three-phase phase-sequence voltage protection, stage 2	PSV3St2	X	X
		OVER/UNDERFREQUENCY / LOAD SHEDDING AND RESTORATION:			
81U/81O	f < / f > / df/dt	Underfrequency or overfrequency incl. rate of change, stage 1	Freq1St1		X
81U/81O	f < / f > / df/dt	Underfrequency or overfrequency incl. rate of change, stage 2	Freq1St2		X
81U/81O	f < / f > / df/dt	Underfrequency or overfrequency incl. rate of change, stage 3	Freq1St3		X
81U/81O	f < / f > / df/dt	Underfrequency or overfrequency incl. rate of change, stage 4	Freq1St4		X
81U/81O	f < / f > / df/dt	Underfrequency or overfrequency incl. rate of change, stage 5	Freq1St5		X
		OVER/UNDERPOWER:			
32P/32Q	P> -> / Q> ->	Three-phase directional overpower protection, stage 1	OPOW6St1		X
32P/32Q	P> -> / Q> ->	Three-phase directional overpower protection, stage 2	OPOW6St2		X
32P/32Q	P> -> / Q> ->	Three-phase directional overpower protection, stage 3	OPOW6St3		X
32	P< / P> <-	Three-phase underpower or reverse power protection, stage 1	UPOW6St1		X
32	P< / P> <-	Three-phase underpower or reverse power protection, stage 2	UPOW6St2		X
32	P< / P> <-	Three-phase underpower or reverse power protection, stage 3	UPOW6St3		X
		OVER/UNDEREXCITATION:			
24	U/f>	Overexcitation protection, low-set stage	OE1Low		X
24	U/f>>	Overexcitation protection, high-set stage	OE1High		X
40	X<	Three-phase underexcitation protection, low-set stage	UE6Low		X
40	X<<	Three-phase underexcitation protection, high-set stage	UE6High		X
		ADDITIONAL FUNCTIONS:			
68	3I ₂ f>	Three-phase inrush detector	Inrush3	X	X
60	FUSEF	Fuse failure supervision	FuseFail		X
62BF	CBFP	Circuit breaker failure	-	X	X
48, 14, 66	Is ² t, n<	Start-up supervision for motors	MotStart	X	X
37	3I<	Three-phase non-directional undercurrent protection, stage 1	NUC3St1	X	X
37	3I<<	Three-phase non-directional undercurrent protection, stage 2	NUC3St2	X	X
46R	3I↶, 3I↷	Phase reversal protection	PREV3	X	X

Functionality levels, other functions

IEC Symbol	Function	Code	FUNCTIONALITY LEVELS	
			REM543/5 Motor	REM543/5 Generator
	MEASUREMENT FUNCTION			
	CURRENT			
3I	Three-phase current	MECU3A	X	X
Io	Neutral current	MECU1A	X	X
Io	Neutral current, B stage	MECU1B	X	X
	VOLTAGE			
3U	Three-phase voltage	MEVO3A	X	X
Uo	Residual voltage	MEVO1A	X	X
	ENERGY / POWER			
E / P / Q / pf	Three-phase power and energy (incl. cos ϕ)	MEPE7	X	X
	FREQUENCY			
f	System frequency	MEFR1	X	X
	RECORDING			
	Transient disturbance recorder	MEDREC16	X	X
	RTD MODULE			
	Measurement of RTD/analogue inputs, general measurement	MEA1...8	X	X
	Measurement of analogue outputs (Note! Only in products with an RTD/analogue module)	MEAO1...4	X	X
	CONDITION MONITORING FUNCTION			
	CIRCUIT BREAKER			
CBCM	CB electric wear 1	CMBWEAR1	X	X
CBCM	CB electric wear 2	CMBWEAR2	X	X
CBCM	Operate Time Counter 1 (e.g. motors)	CMTIME1	X	X
CBCM	Operate Time Counter 2 (e.g. motors)	CMTIME2	X	X
CBCM	Gas pressure supervision	CMGAS1	X	X
CBCM	Gas pressure supervision for three poles	CMGAS3	X	X
CBCM	Spring charging control 1	CMSPRC1	X	X
CBCM	Breaker travel time 1	CMTRAV1	X	X
CBCM	Scheduled maintenance	CMSCHED	X	X
	TRIP CIRCUIT			
TCS	Trip Circuit Supervision 1	CMTCS1	X	X
TCS	Trip Circuit Supervision 2	CMTCS2	X	X
	MEASURING CIRCUIT			
MCS	Supervision of the energizing current input circuit	CMCU3	X	X
MCS	Supervision of the energizing voltage input circuit	CMVO3	X	X
	CONTROL FUNCTION			
	CIRCUIT BREAKERS, DISCONNECTORS / EARTHING SWITCH			
	Circuit breaker 1, 2 (2 state inputs / 2 control outputs)	COCB1...2	X	X
	Disconnecter 1...5 (2 state inputs / 2 control outputs)	CODC1...5	X	X
	Three state disconnecter 1, 2 (3 state inputs / 4 control outputs)	CO3DC1...2	X	X
	Object indication 1...8 (2 state inputs)	COIND1...8	X	X
	MIMIC dynamic data point 1...5 on MMI (single-line diagram)	MMIDATA 1...5	X	X
	Alarm 1...8 on MMI (alarm view)	MMIALAR 1...8	X	X

Functionality levels, other functions

IEC Symbol	Function	Code	FUNCTIONALITY LEVELS	
			REM543/5 Motor	REM543/5 Generator
	On/off switch 1...4 on MMI (single-line diagram)	COSW1...4	X	X
	Direct open for CBs via MMI	COCBDIR	X	X
	Logic control position selector	COLOCAT	X	X
	ADDITIONAL FUNCTIONS			
	Interlocking	-	X	X
	Command control	-	X	X
	STANDARD FUNCTIONS			
	Operation indication, relay and register reset	INDRESET	X	X
	Activation of MMI backlight	MMIWAKE	X	X
	Switchgroups SWGRP1...SWGRP20	SWGRP 1....20	X	X
	PLC logics (AND, OR, timers etc.) acc. to IEC 61131-3	-	X	X
	DATA COMMUNICATION			
	Event to be defined by the customer, E0...E63	EVENT230	X	X
	SPA bus	-	X	X
	LON bus	-	X	X
	GENERAL FUNCTIONS			
	Main / secondary setting		X	X
	Remote setting		X	X
	Self-supervision		X	X
	Annunciating, event generating and value recording		X	X
	Measurement, parameter and switching device status display		X	X
	Remote-end binary signal transfer		X	X
	Binary signal interbay transfer		X	X

Overview of REM hardware configurations

REM 543	Order number									
Hardware numbers	REM543B_212AAAA	REM543B_212CAAA	REM543B_212AABA	REM543B_212CABA	REM543B_212AAAB	REM543B_212AABB	REM543A_213AAAA	REM543A_213CAAA	REM543A_213AABA	REM543A_213CABA
Analogue interface										
Sensor channels (current/voltage)			9	9		9			9	9
Current transformer 1/5 A	4	4	4	4	4	4	4	4	4	4
Current transformer 0.2/1 A	1	1	1	1	1	1	1	1	1	1
Voltage transformer 100 V	4	4	4	4	4	4	4	4	4	4
Main processor boards										
CPU module	1	1	1	1	1	1	1	1	1	1
Power supply boards										
Type 1: 80...265 Vac/Vdc	1		1		1	1	1		1	1
Type 1: 18...265 Vdc		1		1				1		1
Type 2: 80...265 Vac/Vdc										
Type 2: 18...265 Vac/Vdc										
Digital I/O boards										
Type 1: threshold voltage 80 Vdc	1		1		1	1	1		1	1
Type 1: threshold voltage 18 Vdc		1		1				1		1
Type 2: threshold voltage 80 Vdc										
Type 2: threshold voltage 18 Vdc										
Analogue I/O board										
RTD/analogue module							1	1	1	1
Display boards										
Graphic MMI display, fixed	1	1	1	1			1	1	1	1
Graphic MMI display, external					1	1				1
Mechanical design										
1/2 enclosure	1	1	1	1	1	1	1	1	1	1
Digital inputs	15						15			
Power outputs, single-pole	0						0			
Power outputs, double-pole	5						5			
Signal outputs (NO)	2						2			
Signal outputs (NO/NC)	5						5			
Supervised trip circuits	2						2			
IRF outputs	1						1			
RTD/analogue inputs	0						8			
Analogue outputs	0						4			

REM 543	Order number											
Hardware numbers	REM543B_214AAAA	REM543B_214CAAA	REM543B_214AABA	REM543B_214CABA	REM543B_214AAAB	REM543B_214AABB	REM543A_215AAAA	REM543A_215CAAA	REM543A_215AABA	REM543A_215CABA	REM543A_215AAAB	REM543A_215AABB
Analogue interface												
Sensor channels (current/voltage)			9	9		9			9	9		9
Current transformer 1/5 A	6	6	6	6	6	6	6	6	6	6	6	6
Current transformer 0.2/1 A												
Voltage transformer 100 V	3	3	3	3	3	3	3	3	3	3	3	3
Main processor boards												
CPU module	1	1	1	1	1	1	1	1	1	1	1	1
Power supply boards												
Type 1: 80...265 Vac/Vdc	1		1		1	1	1		1		1	1
Type 1: 18...265 Vdc		1		1				1		1		
Type 2: 80...265 Vac/Vdc												
Type 2: 18...265 Vac/Vdc												
Digital I/O boards												
Type 1: threshold voltage 80 Vdc	1		1		1	1	1		1		1	1
Type 1: threshold voltage 18 Vdc		1		1				1		1		
Type 2: threshold voltage 80 Vdc												
Type 2: threshold voltage 18 Vdc												
Analogue I/O board												
RTD/analogue module							1	1	1	1	1	1
Display boards												
Graphic MMI display, fixed	1	1	1	1			1	1	1	1		
Graphic MMI display, external					1	1					1	1
Mechanical design												
1/2 enclosure	1	1	1	1	1	1	1	1	1	1	1	1
Digital inputs	15						15					
Power outputs, single-pole	0						0					
Power outputs, double-pole	5						5					
Signal outputs (NO)	2						2					
Signal outputs (NO/NC)	5						5					
Supervised trip circuits	2						2					
IRF outputs	1						1					
RTD/analogue inputs	0						8					
Analogue outputs	0						4					

REM 543	Order number											
Hardware numbers	REM543B_2164AAAA	REM543B_216CAAAA	REM543B_216AABA	REM543B_216CABA	REM543B_216AAAB	REM543B_216AABB	REM543A_217AAAA	REM543A_217CAAA	REM543A_217AABA	REM543A_217CABA	REM543A_217AAAB	REM543A_217AABB
Analogue interface												
Sensor channels (current/voltage)			9	9		9			9	9		9
Current transformer 1/5 A	7	7	7	7	7	7	7	7	7	7	7	7
Current transformer 0.2/1 A												
Voltage transformer 100 V	2	2	2	2	2	2	2	2	2	2	2	2
Main processor boards												
CPU module	1	1	1	1	1	1	1	1	1	1	1	1
Power supply boards												
Type 1: 80...265 Vac/Vdc	1		1		1	1	1		1		1	1
Type 1: 18...265 Vdc		1		1				1		1		
Type 2: 80...265 Vac/Vdc												
Type 2: 18...265 Vac/Vdc												
Digital I/O boards												
Type 1: threshold voltage 80 Vdc	1		1		1	1	1		1		1	1
Type 1: threshold voltage 18 Vdc		1		1				1		1		
Type 2: threshold voltage 80 Vdc												
Type 2: threshold voltage 18 Vdc												
Analogue I/O board												
RTD/analogue module							1	1	1	1	1	1
Display boards												
Graphic MMI display, fixed	1	1	1	1			1	1	1	1		
Graphic MMI display, external					1	1					1	1
Mechanical design												
1/2 enclosure	1	1	1	1	1	1	1	1	1	1	1	1
Digital inputs	15						15					
Power outputs, single-pole	0						0					
Power outputs, double-pole	5						5					
Signal outputs (NO)	2						2					
Signal outputs (NO/NC)	5						5					
Supervised trip circuits	2						2					
IRF outputs	1						1					
RTD/analogue inputs	0						8					
Analogue outputs	0						4					

REM 543	Order number									
Hardware numbers	REM543B_2184AAAA	REM543B_218CAAA	REM543B_218AABA	REM543B_218CABA	REM543B_218AAAB	REM543B_218AABB	REM543A_219AAAA	REM543A_219CAAA	REM543A_219AABA	REM543A_219CABA
Analogue interface										
Sensor channels (current/voltage)			9	9		9			9	9
Current transformer 1/5 A	8	8	8	8	8	8	8	8	8	8
Current transformer 0.2/1 A										
Voltage transformer 100 V	1	1	1	1	1	1	1	1	1	1
Main processor boards										
CPU module	1	1	1	1	1	1	1	1	1	1
Power supply boards										
Type 1: 80...265 Vac/Vdc	1		1		1	1	1		1	1
Type 1: 18...265 Vdc		1		1				1		1
Type 2: 80...265 Vac/Vdc										
Type 2: 18...265 Vac/Vdc										
Digital I/O boards										
Type 1: threshold voltage 80 Vdc	1		1		1	1	1		1	1
Type 1: threshold voltage 18 Vdc		1		1				1		1
Type 2: threshold voltage 80 Vdc										
Type 2: threshold voltage 18 Vdc										
Analogue I/O board										
RTD/analogue module							1	1	1	1
Display boards										
Graphic MMI display, fixed	1	1	1	1			1	1	1	1
Graphic MMI display, external					1	1				1
Mechanical design										
1/2 enclosure	1	1	1	1	1	1	1	1	1	1
Digital inputs	15						15			
Power outputs, single-pole	0						0			
Power outputs, double-pole	5						5			
Signal outputs (NO)	2						2			
Signal outputs (NO/NC)	5						5			
Supervised trip circuits	2						2			
IRF outputs	1						1			
RTD/analogue inputs	0						8			
Analogue outputs	0						4			

REM 545	Order number											
Hardware numbers	REM545B_222AAAA	REM545B_222CAAA	REM545B_222AABA	REM545B_222CABA	REM545B_222AAAB	REM545B_222AABB	REM545A_223AAAA	REM545A_223CAAA	REM545A_223AABA	REM545A_223CABA	REM545A_223AAAB	REM545A_223AABB
Analogue interface												
Sensor channels (current/voltage)			9	9		9			9	9		9
Current transformer 1/5 A	4	4	4	4	4	4	4	4	4	4	4	4
Current transformer 0.2/1 A	1	1	1	1	1	1	1	1	1	1	1	1
Voltage transformer 100 V	4	4	4	4	4	4	4	4	4	4	4	4
Main processor boards												
CPU module	1	1	1	1	1	1	1	1	1	1	1	1
Power supply boards												
Type 1: 80...265 Vac/Vdc	1		1		1	1	1		1		1	1
Type 1: 18...265 Vdc		1		1				1		1		
Type 2: 80...265 Vac/Vdc												
Type 2: 18...265 Vac/Vdc												
Digital I/O boards												
Type 1: threshold voltage 80 Vdc	1		1		1	1	1		1		1	1
Type 1: threshold voltage 18 Vdc		1		1				1		1		
Type 2: threshold voltage 80 Vdc	1		1		1	1	1		1		1	1
Type 2: threshold voltage 18 Vdc		1		1				1		1		
Analogue I/O board												
RTD/analogue module							1	1	1	1	1	1
Display boards												
Graphic MMI display, fixed	1	1	1	1			1	1	1	1		
Graphic MMI display, external					1	1					1	1
Mechanical design												
1/2 enclosure	1	1	1	1	1	1	1	1	1	1	1	1
Digital inputs	25						25					
Power outputs, single-pole	2						2					
Power outputs, double-pole	9						9					
Signal outputs (NO)	2						2					
Signal outputs (NO/NC)	5						5					
Supervised trip circuits	2						2					
IRF outputs	1						1					
RTD/analogue inputs	0						8					
Analogue outputs	0						4					

REM 545	Order number											
Hardware numbers	REM545B_224AAAA	REM545B_224CAAA	REM545B_224AABA	REM545B_224CABA	REM545B_224AAAB	REM545B_224AABB	REM545A_225AAAA	REM545A_225CAAA	REM545A_225AABA	REM545A_225CABA	REM545A_225AAAB	REM545A_225AABB
Analogue interface												
Sensor channels (current/voltage)			9	9		9			9	9		9
Current transformer 1/5 A	6	6	6	6	6	6	6	6	6	6	6	6
Current transformer 0.2/1 A												
Voltage transformer 100 V	3	3	3	3	3	3	3	3	3	3	3	3
Main processor boards												
CPU module	1	1	1	1	1	1	1	1	1	1	1	1
Power supply boards												
Type 1: 80...265 Vac/Vdc	1		1		1	1	1		1		1	1
Type 1: 18...265 Vdc		1		1				1		1		
Type 2: 80...265 Vac/Vdc												
Type 2: 18...265 Vac/Vdc												
Digital I/O boards												
Type 1: threshold voltage 80 Vdc	1		1		1	1	1		1		1	1
Type 1: threshold voltage 18 Vdc		1		1				1		1		
Type 2: threshold voltage 80 Vdc	1		1		1	1	1		1		1	1
Type 2: threshold voltage 18 Vdc		1		1				1		1		
Analogue I/O board												
RTD/analogue module							1	1	1	1	1	1
Display boards												
Graphic MMI display, fixed	1	1	1	1			1	1	1	1		
Graphic MMI display, external					1	1					1	1
Mechanical design												
1/2 enclosure	1	1	1	1	1	1	1	1	1	1	1	1
Digital inputs	25						25					
Power outputs, single-pole	2						2					
Power outputs, double-pole	9						9					
Signal outputs (NO)	2						2					
Signal outputs (NO/NC)	5						5					
Supervised trip circuits	2						2					
IRF outputs	1						1					
RTD/analogue inputs	0						8					
Analogue outputs	0						4					

REM 545	Order number											
Hardware numbers	REM545B_226AAAA	REM545B_226CAAA	REM545B_226AABA	REM545B_226CABA	REM545B_226AAAB	REM545B_226AABB	REM545A_227AAAA	REM545A_227CAAA	REM545A_227AABA	REM545A_227CABA	REM545A_227AAAB	REM545A_227AABB
Analogue interface												
Sensor channels (current/voltage)			9	9		9			9	9		9
Current transformer 1/5 A	7	7	7	7	7	7	7	7	7	7	7	7
Current transformer 0.2/1 A												
Voltage transformer 100 V	2	2	2	2	2	2	2	2	2	2	2	2
Main processor boards												
CPU module	1	1	1	1	1	1	1	1	1	1	1	1
Power supply boards												
Type 1: 80...265 Vac/Vdc	1		1		1	1	1		1		1	1
Type 1: 18...265 Vdc		1		1				1		1		
Type 2: 80...265 Vac/Vdc												
Type 2: 18...265 Vac/Vdc												
Digital I/O boards												
Type 1: threshold voltage 80 Vdc	1		1		1	1	1		1		1	1
Type 1: threshold voltage 18 Vdc		1		1				1		1		
Type 2: threshold voltage 80 Vdc	1		1		1	1	1		1		1	1
Type 2: threshold voltage 18 Vdc		1		1				1		1		
Analogue I/O board												
RTD/analogue module							1	1	1	1	1	1
Display boards												
Graphic MMI display, fixed	1	1	1	1			1	1	1	1		
Graphic MMI display, external					1	1					1	1
Mechanical design												
1/2 enclosure	1	1	1	1	1	1	1	1	1	1	1	1
Digital inputs	25						25					
Power outputs, single-pole	2						2					
Power outputs, double-pole	9						9					
Signal outputs (NO)	2						2					
Signal outputs (NO/NC)	5						5					
Supervised trip circuits	2						2					
IRF outputs	1						1					
RTD/analogue inputs	0						8					
Analogue outputs	0						4					

REM 545	Order number											
Hardware numbers	REM545B_228AAAA	REM545B_228CAAA	REM545B_228AABA	REM545B_228CABA	REM545B_228AAAB	REM545B_228AABB	REM545A_229AAAA	REM545A_229CAAA	REM545A_229AABA	REM545A_229CABA	REM545A_229AAAB	REM545A_229AABB
Analogue interface												
Sensor channels (current/voltage)			9	9		9			9	9		9
Current transformer 1/5 A	8	8	8	8	8	8	8	8	8	8	8	8
Current transformer 0.2/1 A												
Voltage transformer 100 V	1	1	1	1	1	1	1	1	1	1	1	1
Main processor boards												
CPU module	1	1	1	1	1	1	1	1	1	1	1	1
Power supply boards												
Type 1: 80...265 Vac/Vdc	1		1		1	1	1		1		1	1
Type 1: 18...265 Vdc		1		1				1		1		
Type 2: 80...265 Vac/Vdc												
Type 2: 18...265 Vac/Vdc												
Digital I/O boards												
Type 1: threshold voltage 80 Vdc	1		1		1	1	1		1		1	1
Type 1: threshold voltage 18 Vdc		1		1				1		1		
Type 2: threshold voltage 80 Vdc	1		1		1	1	1		1		1	1
Type 2: threshold voltage 18 Vdc		1		1				1		1		
Analogue I/O board												
RTD/analogue module							1	1	1	1	1	1
Display boards												
Graphic MMI display, fixed	1	1	1	1			1	1	1	1		
Graphic MMI display, external					1	1					1	1
Mechanical design												
1/2 enclosure	1	1	1	1	1	1	1	1	1	1	1	1
Digital inputs	25						25					
Power outputs, single-pole	2						2					
Power outputs, double-pole	9						9					
Signal outputs (NO)	2						2					
Signal outputs (NO/NC)	5						5					
Supervised trip circuits	2						2					
IRF outputs	1						1					
RTD/analogue inputs	0						8					
Analogue outputs	0						4					

Hardware versions of REM 543 and REM 545

For the number of digital inputs and outputs of REM 54_ machine terminals, refer to the tables above. The number of matching transformers, sensor inputs and analogue inputs and outputs, and the auxiliary voltage range vary between the different hardware versions of REM 54_. Moreover, both REM 543 and REM 545 can be supplied with an RTD/analogue module.

Software configuration

Each REM 54_ machine terminal allows various software configurations based on separate functions. Functions included in the selected

functionality level can be activated within the scope of the I/O connections and considering the total CPU load of the functions.

Parts and assembly descriptions

To achieve the best possible operation accuracy, all parts of REM 54_ have been calibrated together. Thus, each product forms a whole for which no separate spare parts can be supplied. In the event of malfunction, please consult your machine terminal supplier.

Application examples

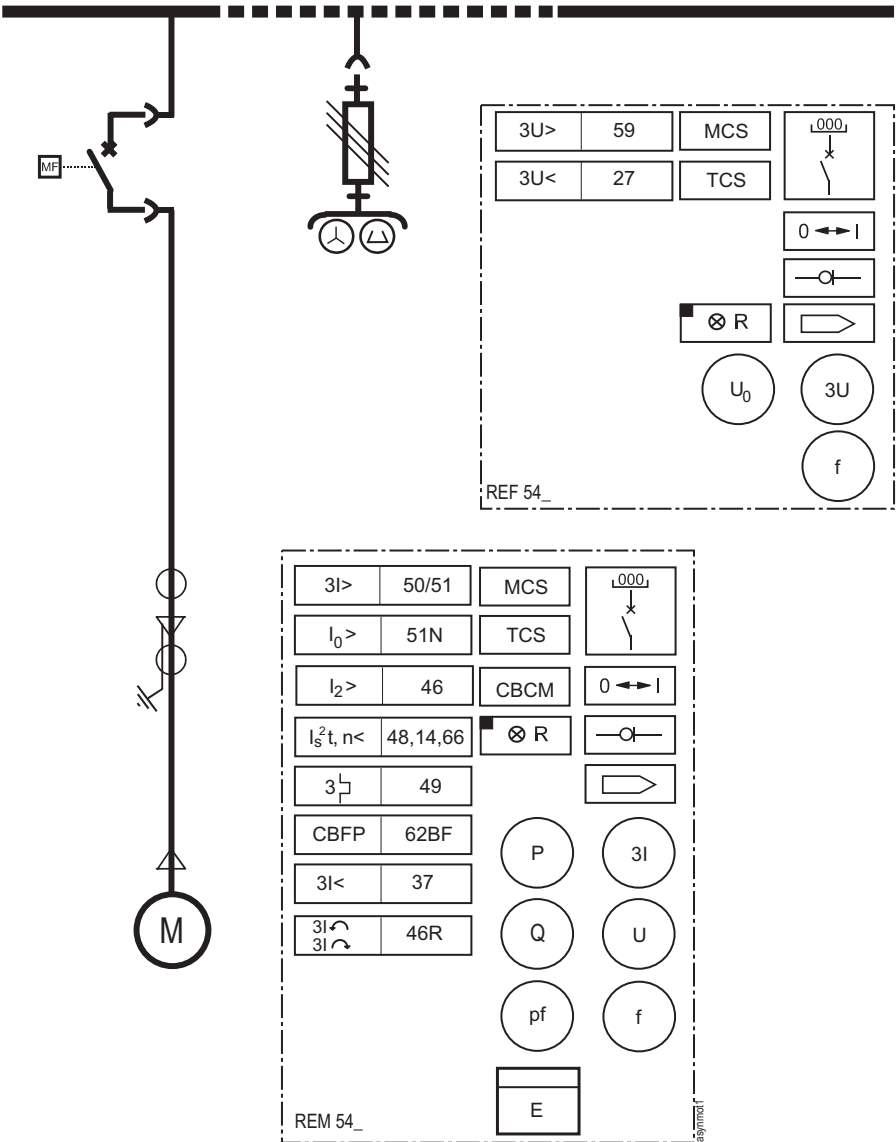


Fig. 4 REM 54_ used for the protection of a directly started asynchronous motor.

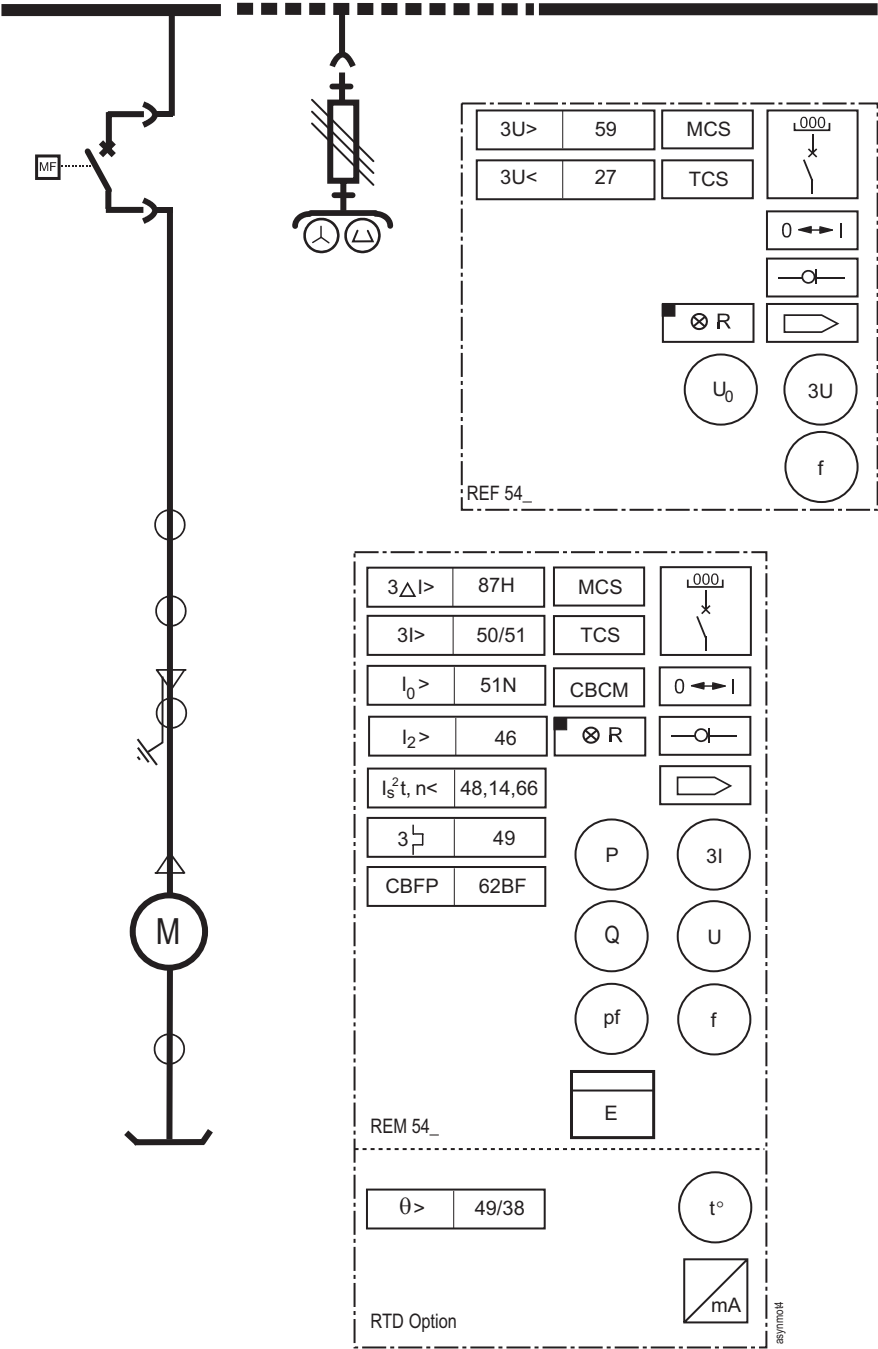


Fig. 5 REM 54_ used for the protection of a directly started asynchronous motor. High-impedance principle applied for differential protection.

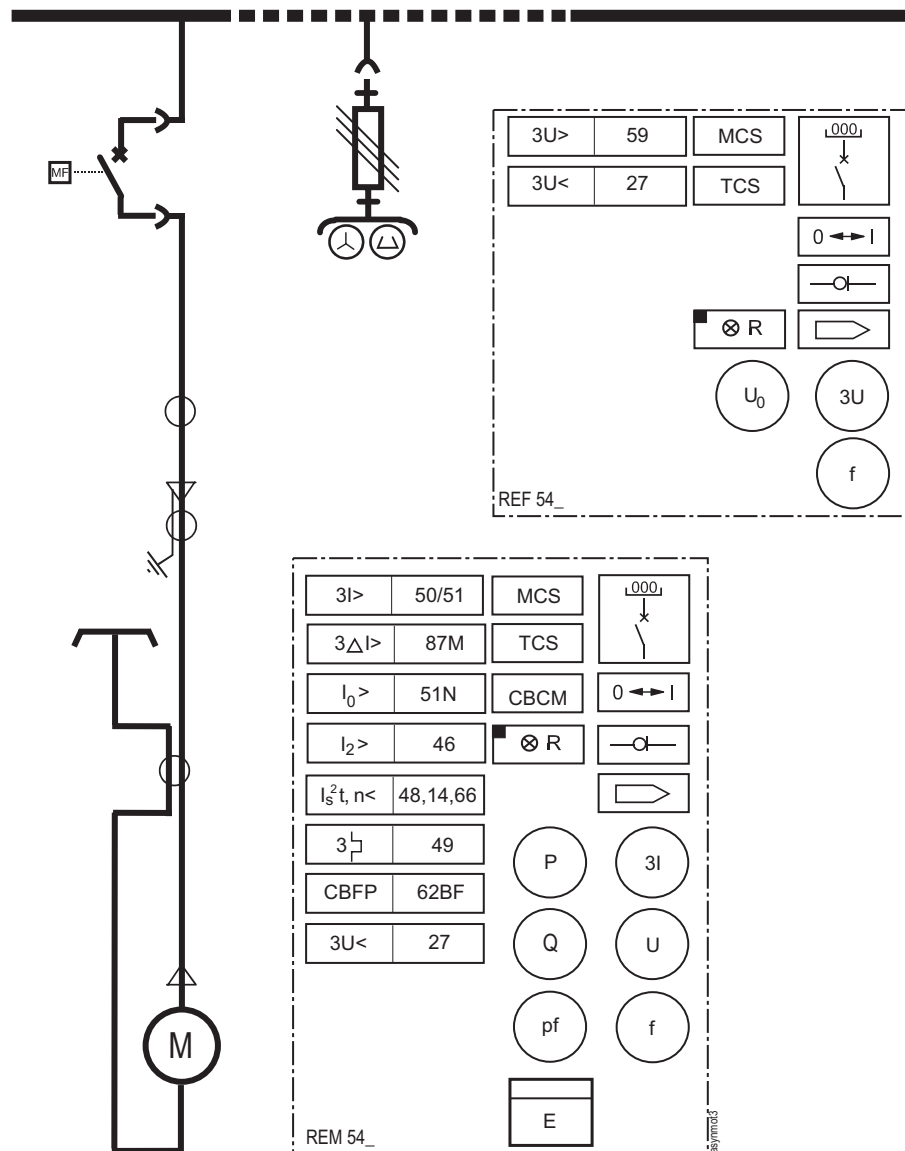


Fig. 6 REM 54_ used for the protection of a directly started asynchronous motor. Flux-balance principle applied for differential protection.

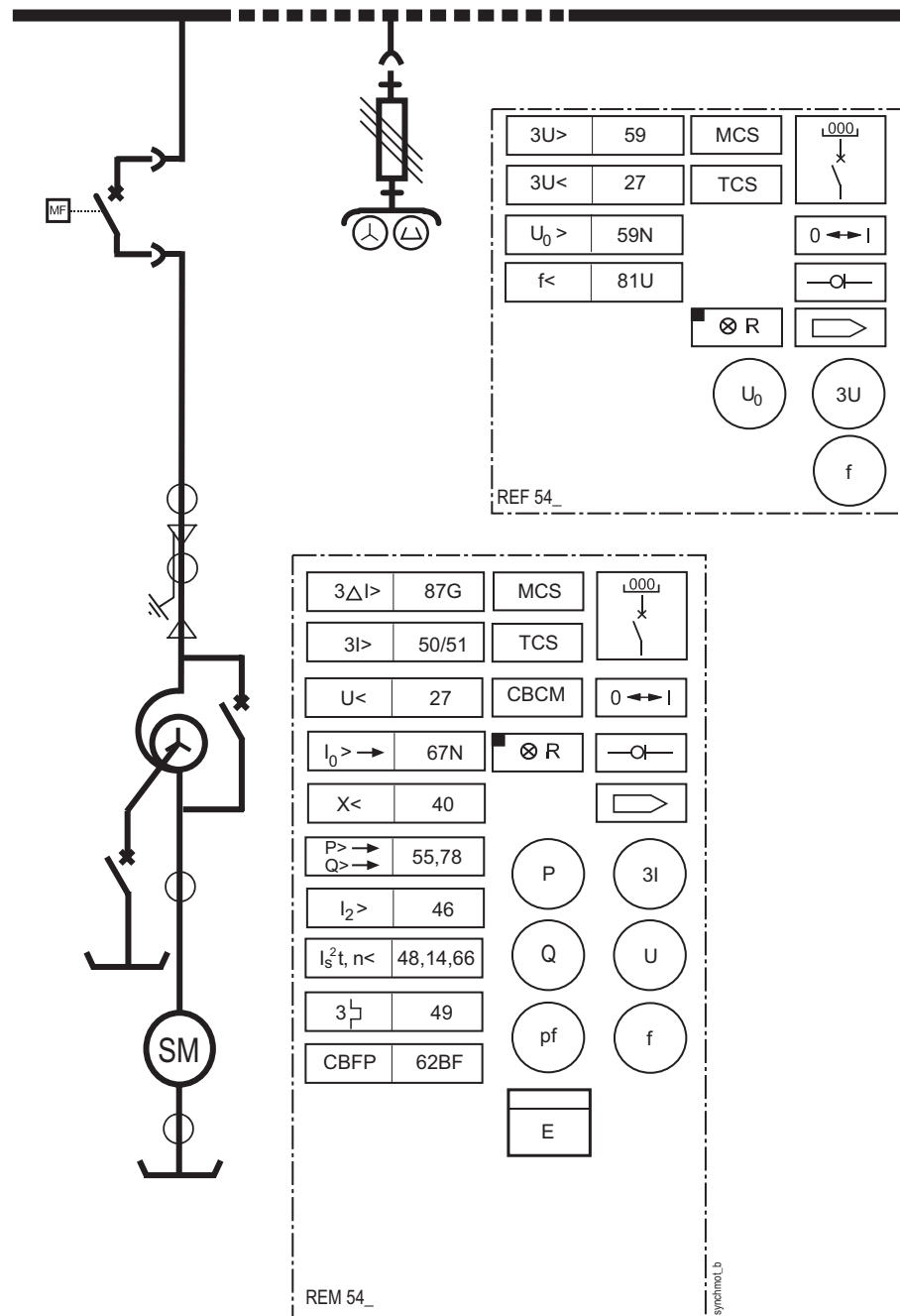


Fig. 7 REM 54_ used for the protection of a synchronous motor started with an autotransformer. Pole slip function implemented with directional power functions.

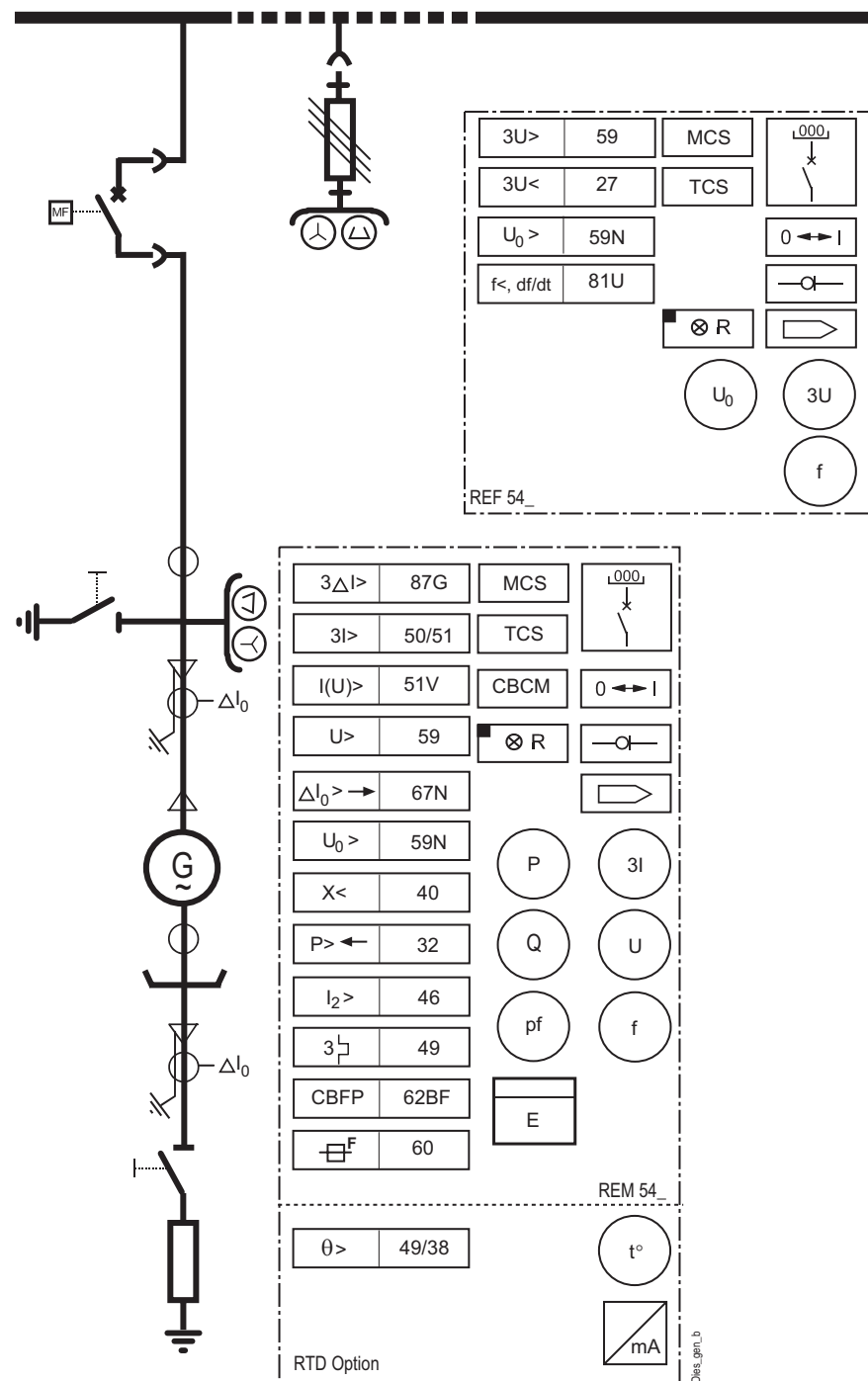


Fig. 8 Diesel generator application, several units in parallel connection, each unit individually earthed. Earth-fault current is small, typically 3-5 A.

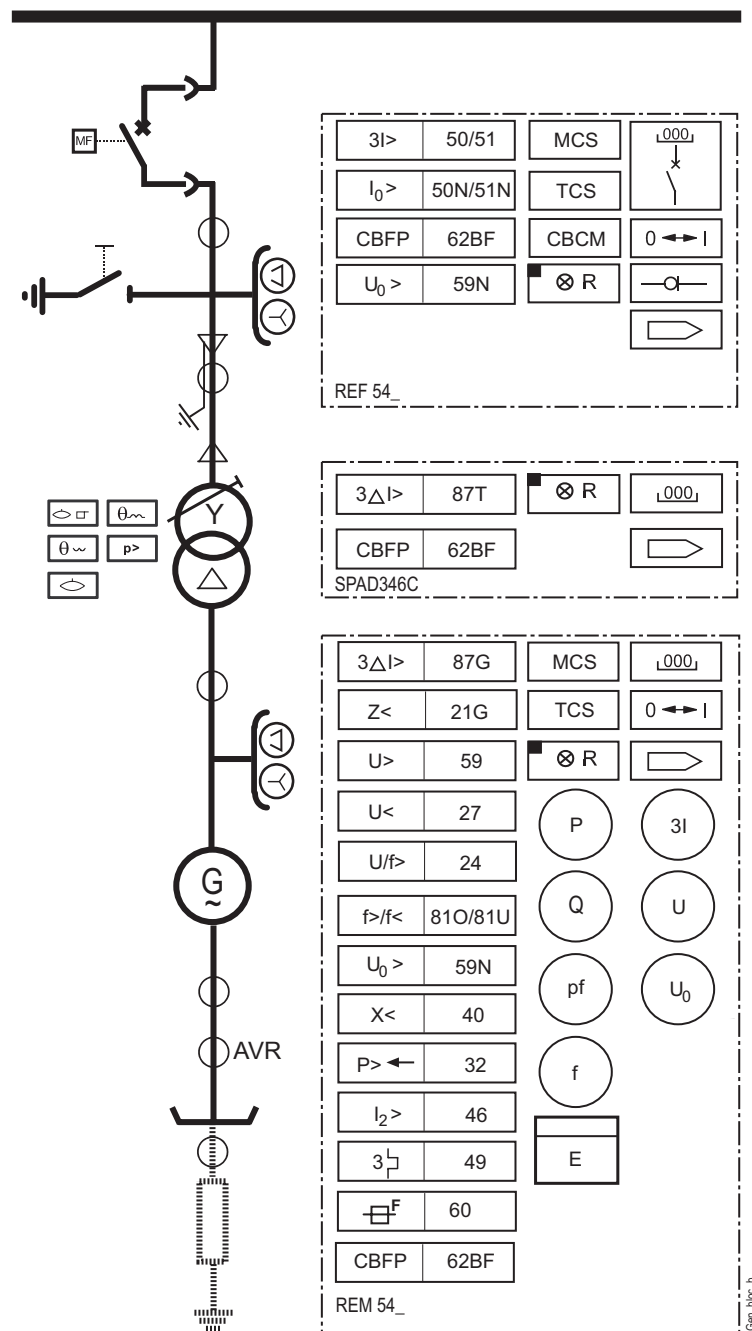


Fig. 9 Generator in block connection with a transformer. The stabilized transformer differential relay SPAD346C is used for overall differential protection. An earthing resistor is recommended.

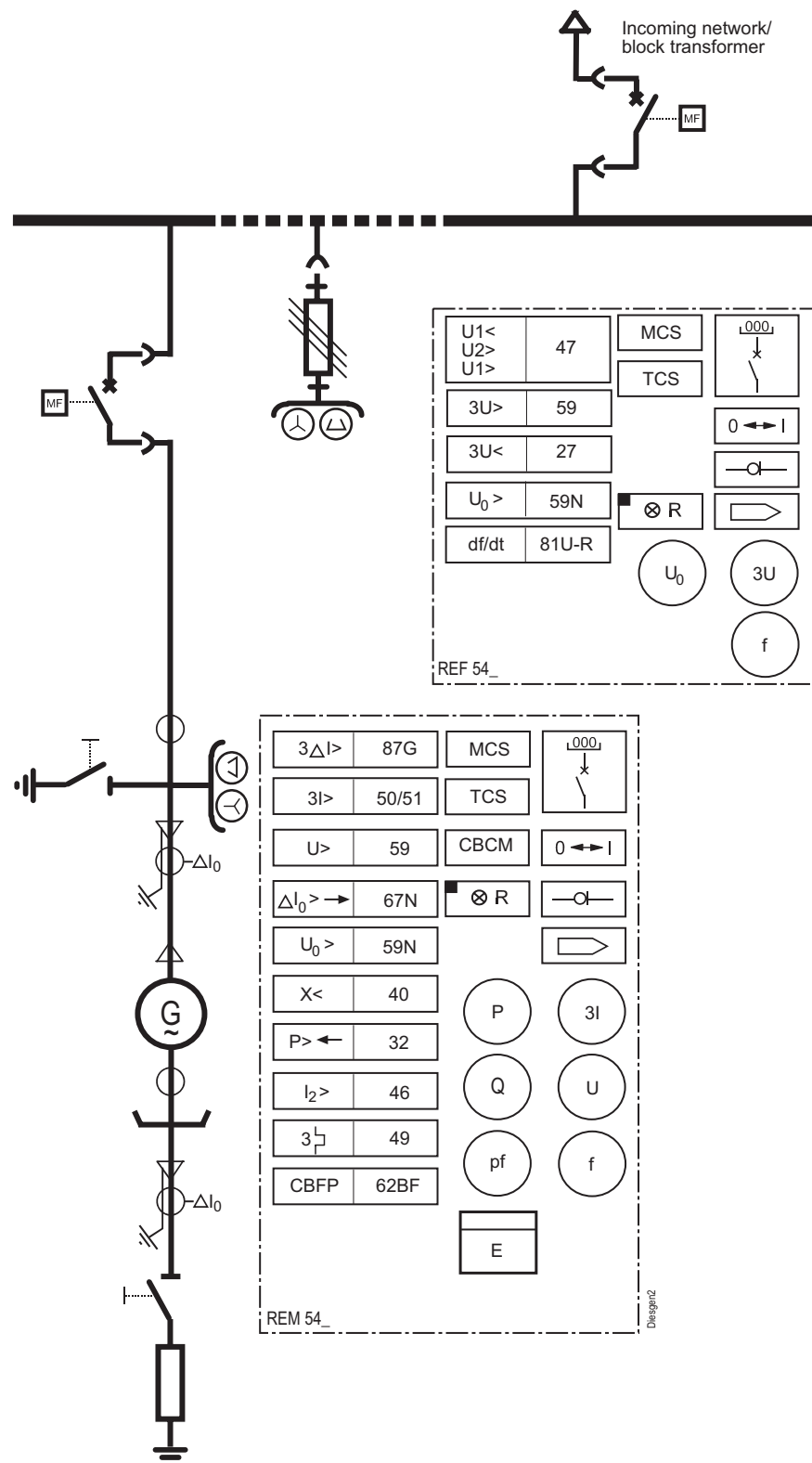


Fig. 10 Embedded power plant generator application, several units in parallel connection.

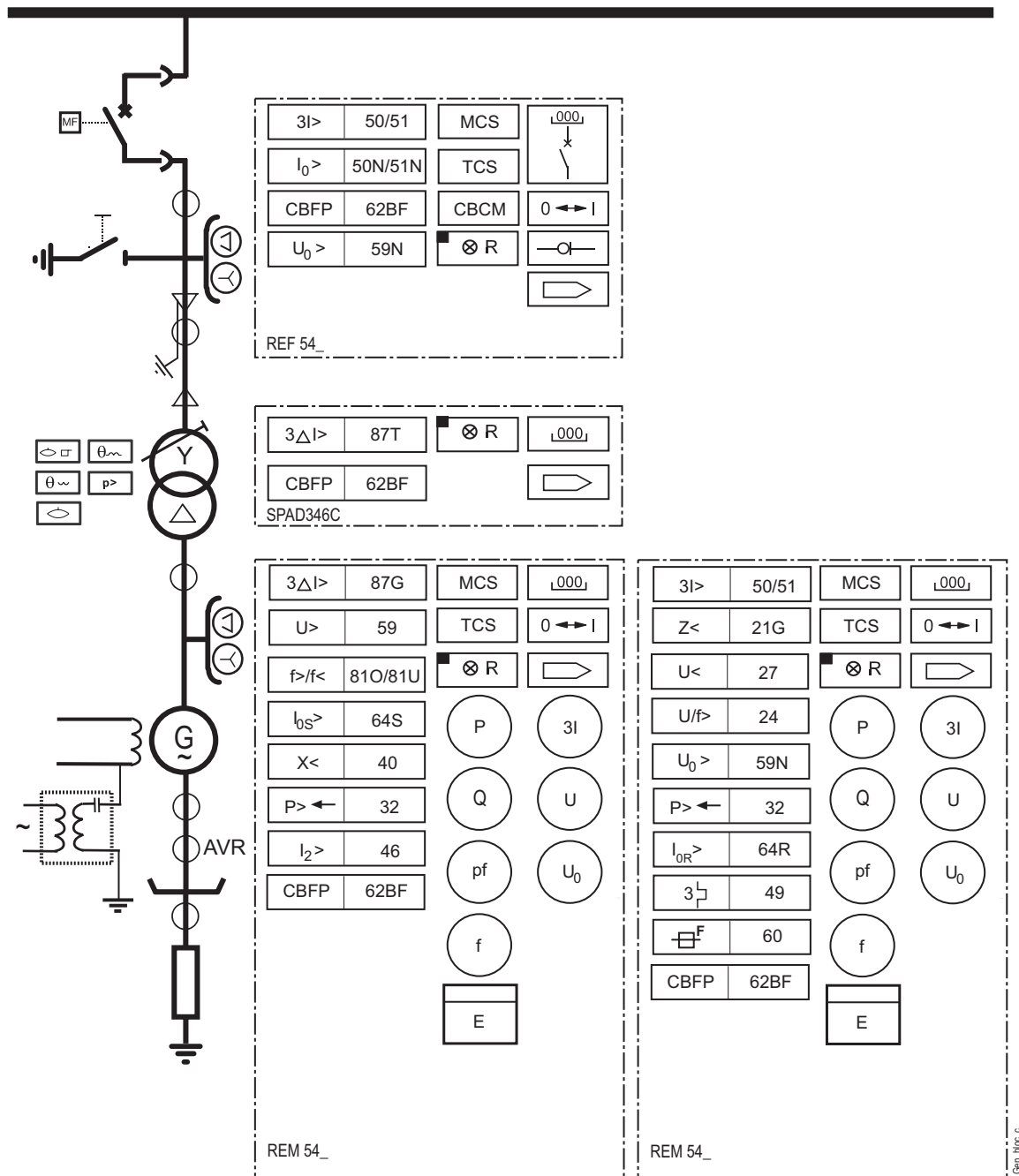


Fig. 11 Generator in block connection with a transformer. The stabilized transformer differential relay SPAD346C is used for overall differential protection. An earthing resistor is recommended. Functionality divided between two REM terminals.

$3I>$	50/51	= three-phase overcurrent protection, low-set, high-set and instantaneous stages available (NOC3_)
$I_0>$	50N/51N	= earth-fault protection, low-set, high-set and instantaneous stages available (NEF1_)
$I_2>$	46	= negative phase-sequence protection, low-set and high-set stages available (NPS3_)
$3U>$	59	= three-phase overvoltage protection, low-set and high-set stages available (OV3_)
$U>$	59	= overvoltage protection (OV3_)
$3U<$	27	= three-phase undervoltage protection, low-set and high-set stages available (UV3_)
$U<$	27	= undervoltage protection (UV3_)
$U_0>$	59N	= residual overvoltage protection, low-set, high-set and instantaneous stages available (ROV1_)
$f>/f<$	81O/81U	= underfrequency or overfrequency protection, stages 1, 2, 3, 4 and 5 available (Freq1St_)
df/dt	81U-R	= frequency rate of change function (included in the under/overfrequency protection Freq1St_)
$f<,df/dt$	81U	= underfrequency protection, stages 1, 2, 3, 4 and 5 available, including frequency rate of change function (included in the under/overfrequency protection Freq1St_)
$3\overline{I}$	49	= three-phase thermal overload protection for motors, generators and transformers (TOL3Dev)
$3\Delta I>$	87T	= stabilized three-phase differential protection for transformers (function of SPAD 346C)
$\Delta I_0>\rightarrow$	67N	= directional differentially connected earth-fault protection, low-set, high-set and instantaneous stages available (DEF2_)
$I_0>\rightarrow$	67N	= directional earth-fault protection, low-set, high-set and instantaneous stages available (DEF2_)
$3\Delta I>$	87G	= stabilized three-phase differential protection for generators (Diff6G)
$3\Delta I>$	87H/87M	= high-impedance or flux-balance based differential protection for generators and motors (Diff3)
$3\Delta I>$	87M	= high-impedance or flux-balance based differential protection for motors (Diff3)
CBFP	62BF	= circuit-breaker failure protection (included in all current-based short circuit and earth-fault protection function blocks)
$X<$	40	= underexcitation protection, low-set and high-set stages available (UE6_)
$P>\leftarrow$	32	= underpower, low-forward power or reverse power protection, stages 1, 2 and 3 available (UPOW6St_)
$I_s^2t, n<$	48,14,66	= start-up supervision for motors (MotStart)
$Z<$	21G	= three-phase underimpedance protection, low-set and high-set stages available (UI6_)
$U/f>$	24	=overexcitation protection, low-set and high-set stages available (OE1_)
$U1<$ $U2>$ $U1>$	27,47,59	=phase-sequence voltage protection, two stages available (PSV3St_)
$I(U)>$	51V	=voltage-dependent overcurrent protection, low-set and high-set stages available (VOC6_)
$f<$	81U	=underfrequency protection, stages available1, 2, 3, 4 and 5 available (Freq1St_)

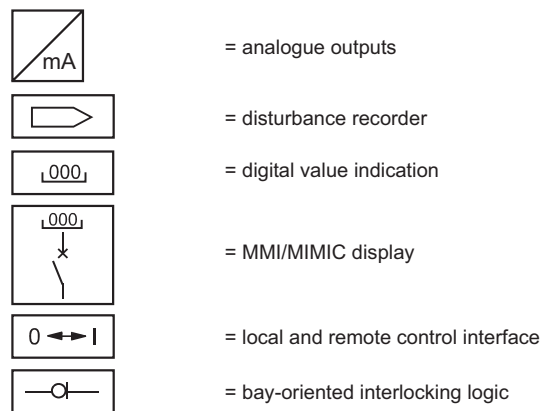
Remsymb1

Fig. 12 Symbol notations, part I

	55,78	= pole slip protection implemented with three-phase directional overpower protection, stages 1, 2 and 3 available (OPOW6St_)
	60	= fuse failure supervision (FuseFail)
	64S	= stator earth-fault protection
	64R	= rotor earth-fault protection
	49/38	= overtemperature protection of stator windings and bearings implemented with RTDs
	37	= three-phase non-directional undercurrent protection, stages 1 and 2 available (NUC3St2)
	46R	= phase reversal protection (PREV3)
		= measuring circuit supervision
		= trip circuit supervision
		= circuit-breaker condition monitoring
		= active power measurement, indication and supervision
		= reactive power measurement, indication and supervision
		= three-phase current measurement
		= three-phase voltage or phase-to-phase voltage measurement, indication and supervision
		= voltage measurement, indication and supervision
		= frequency measurement, indication and supervision
		= power factor measurement, indication and supervision
		= residual voltage measurement, indication and supervision
		= temperature metering, indication and supervision
		= energy counter, forward or reverse active/reactive energy
		= annunciating, event generating and value recording functions

Remsymb2

Fig. 13 Symbol notations, part II



Remsyms3

Fig. 14 Symbol notations, part III

Functions of the REM 54_ machine terminal

Table 19: Protection functions

Types of fault	IEEE Device No.	IEC Symbol	Protection function	Function block code
Short circuits	51	3I>	Three-phase non-directional overcurrent, low-set stage	NOC3Low
	50 / 51	3I>>	Three-phase non-directional overcurrent, high-set stage	NOC3High
	50 / 51B	3I>>>	Three-phase non-directional overcurrent, instantaneous stage	NOC3Inst
	51V	I(U)>	Voltage-dependent overcurrent, low-set stage	VOC6Low
	51V	I(U)>>	Voltage-dependent overcurrent, high-set stage	VOC6High
	87G	3DI>	Stabilized three-phase differential protection for generators	Diff6G
	87G/87M	3DI>	High-impedance or flux-balance based differential protection for generators and motors	Diff3

Table 19: Protection functions

Types of fault	IEEE Device No.	IEC Symbol	Protection function	Function block code
Earth faults	51N	$I_0 > / \text{SEF}$	Non-directional earth-fault, low-set stage	NEF1Low
	50N / 51N	$I_0 >>$	Non-directional earth-fault, high-set stage	NEF1High
	50N	$I_0 >>>$	Non-directional earth-fault, instantaneous stage	NEF1Inst
	67N / 51N	$I_0 > \rightarrow / \text{SEF}$	Directional earth-fault, low-set stage	DEF2Low
	67N	$I_0 >> \rightarrow$	Directional earth-fault, high-set stage	DEF2High
	67N	$I_0 >>> \rightarrow$	Directional earth-fault, instantaneous stage	DEF2Inst
	87N	$\Delta I_0 >, \text{REF}$	High-impedance based restricted earth-fault	REF1A
	59N	$U_0 >$	Residual overvoltage, low-set stage	ROV1Low
	59N	$U_0 >>$	Residual overvoltage, high-set stage	ROV1High
	59N	$U_0 >>>$	Residual overvoltage, instantaneous stage	ROV1Inst
Overload / unbalanced load	49M/ 49G/ 49T	3 	Three-phase thermal overload (motors, generators, transformers)	TOL3Dev
	46	$I_2 >$	Negative-phase sequence, low-set stage	NPS3Low
	46	$I_2 >>$	Negative-phase sequence, high-set stage	NPS3High
Overvoltage/ undervoltage	59	$3U >$	Three-phase overvoltage, low-set stage	OV3Low
	59	$3U >>$	Three-phase overvoltage, high-set stage	OV3High
	27	$3U <$	Three-phase undervoltage, low-set stage	UV3Low
	27	$3U <<$	Three-phase undervoltage, high-set stage	UV3High
	27/ 47/ 59	$U, <, U_2 >, U_1 >$	Phase-sequence voltage protection, stage 1	PSV3St1
	27/ 47/ 59	$U, <, U_2 >, U_1 >$	Phase-sequence voltage protection, stage 2	PSV3St2
Overfrequency/ underfrequency	81U/ 81O	$f </f>, df/dt$	Underfrequency or overfrequency (incl. rate of change), stage 1	Freq1St1
	81U/ 81O	$f </f>, df/dt$	Underfrequency or overfrequency (incl. rate of change), stage 2	Freq1St2
	81U/ 81O	$f </, df/dtf>$	Underfrequency or overfrequency (incl. rate of change), stage 3	Freq1St3
	81U/ 81O	$f </f>, df/dt$	Underfrequency or overfrequency (incl. rate of change), stage 4	Freq1St4
	81U/ 81O	$f </f>, df/dt$	Underfrequency or overfrequency (incl. rate of change), stage 5	Freq1St5

Table 19: Protection functions

Types of fault	IEEE Device No.	IEC Symbol	Protection function	Function block code
Underexcitation/ overexcitation	40	X<	Three-phase underexcitation protection, low-set stage	UE6Low
	40	X<<	Three-phase underexcitation protection, high-set stage	UE6High
	24	U/f>	Overexcitation, low-set stage	OE1Low
	24	U/f>>	Overexcitation, high-set stage	OE1High
Underimpedance	21G	Z<	Three-phase underimpedance protection, low-set stage	UI6Low
	21G	Z<<	Three-phase underimpedance protection, high-set stage	UI6High
Overpower/ underpower	32P / 32Q	P>→/ Q>→	Three-phase directional overpower, stage1	OPOW6St1
	32P / 32Q	P>→/ Q>→	Three-phase directional overpower, stage2	OPOW6St2
	32P / 32Q	P>→/ Q>→	Three-phase directional overpower, stage2	OPOW6St3
	32	P</P>←	Three-phase underpower or reverse power, stage 1	UPOW6St1
	32	P</P>←	Three-phase underpower or reverse power, stage 2	UPOW6St2
	32	P</P>←	Three-phase underpower or reverse power, stage 3	UPOW6St3
Motor functions	48, 14, 66	$I_s^2t, n<$	Three-phase start-up supervision for motors	MotStart
	37	3I<	Three-phase non-directional undercurrent, stage 1	NUC3St1
	37	3I<	Three-phase non-directional undercurrent, stage 2	NUC3St2
	46R	$3I\curvearrowright, 3I\curvearrowleft$	Phase reversal protection	PREV3
Additional functions	68	$3I_{2f}>$	Three-phase transformer inrush and motor start-up current detector	Inrush3
	60	FUSEF	Fuse failure supervision	FuseFail
	62BF	CBFP	Circuit breaker failure (incl. in every current-based short-circuit and earth-fault protection function block)	-

Table 20: Measurement functions

Types of measurement	IEC Symbol	Measurement function	Function block code
RTD/ analogue module	mA/ V/ °C/ Ω	General measurement/ Analogue input on RTD/ analogue module	MEAI1...8
	mA	Analogue output on RTD/ analogue module	MEAO1...4
Current	3I	Three-phase current	MECU3A
	I_0	Neutral current, stage A	MECU1A
	I_0	Neutral current, stage B	MECU1B
Voltage	3U	Three-phase voltage	MEVO3A
	U_0	Residual voltage	MEVO1A
Energy / Power	E, P, Q, pf	Three-phase power and energy (incl. cos φ)	MEPE7

Table 20: Measurement functions

Types of measurement	IEC Symbol	Measurement function	Function block code
Frequency	f	System frequency	MEFR1
Recording		Transient disturbance recorder	MEDREC16

Table 21: Condition monitoring functions

Type of condition monitoring	Symbol	Condition monitoring function	Function block code
Circuit breaker	CBCM	CB electric wear 1	CMBWEAR1
	CBCM	CB electric wear 2	CMBWEAR2
	CBCM	Operate time counter 1 (e.g. motors)	CMTIME1
	CBCM	Operate time counter 2 (e.g. motors)	CMTIME2
	CBCM	Gas pressure monitoring	CMGAS1
	CBCM	Three-pole gas pressure monitoring	CMGAS3
	CBCM	Spring charging control 1	CMSPRC1
	CBCM	Breaker travel time 1	CMTRAV1
	CBCM	Scheduled maintenance	CMSCHED
Trip circuit	TCS	Trip Circuit Supervision 1	CMTCS1
	TCS	Trip Circuit Supervision 2	CMTCS2
Measuring circuit	MCS	Supervision of the energizing current input circuit	CMCU3
	MCS	Supervision of the energizing voltage input circuit	CMVO3

Table 22: Control functions

Types of control	Symbol	Control function	Function block code
Circuit breaker	$0 \leftrightarrow 1$	Circuit breaker 1 (2 state inputs / 2 control outputs)	COCB1
	$0 \leftrightarrow 1$	Circuit breaker 2 (2 state inputs / 2 control outputs)	COCB2
	$0 \leftrightarrow 1$	Direct open for CBs via MMI	COCBDir
Disconnecter	$0 \leftrightarrow 1$	Disconnecter 1...5 (2 state inputs / 2 control outputs)	CODC1...CODC5
	$0 \leftrightarrow 1$	Three state disconnector 1 (3 state inputs/ 4 control outputs)	CO3DC1
	$0 \leftrightarrow 1$	Three state disconnector 2 (3 state inputs/ 4 control outputs)	CO3DC2
Other control functions		Object indication 1...8 (2 state inputs)	COIND1...COIND8
		On/off switch 1...4 (1 output)	COSW1...COSW4
		Logic control position selector	COLOCAT
		MIMIC dynamic data point 1...5	MMIDATA1...MMIDATA5
		Alarm 1...8 (MMI, remote)	MMIALAR1...MMIALAR8

References

Additional information

Technical Reference Manual	1MRS 750915-MUM
Technical Descriptions of Functions	1MRS 750889-MCD (CD-ROM only)
Installation Manual	1MRS 750526-MUM
Operator's Manual	1MRS 750500-MUM
Technical Description of the RER 103	1MRS 750532-MUM
Configuration Guideline	1MRS 750745-MUM

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