Machine Terminals

Product Guide

REM 543
REM 545

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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 swichgear installation.
- Extended functionality including protection, control, measurement, condition monitoring and communication.
- Non-directional/directional overcurrent/earth-fault protection functions, over-/undervoltage 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 with synchro-check, 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, active and reactive power and energy.
- Optional RTD/mA I/O-module for stator winding, bearing and ambient temperature monitoring. Analog mA outputs for interfacing with process control system.
- Condition monitoring including circuit-breaker condition monitoring, trip circuit supervision and internal self-supervision of the machine terminal.
- Communication over three communication interfaces: one for local communication with a PC and the others for remote communication with a substation control system or with a substation monitoring system.
- Part of the ABB's Distribution 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, LON bus or MODBUS communication with higher-level equipment. Further, LON interbay 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 frequency 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 HMI. 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 HMI backlight, switchgroups, and resetting of operation indications, latched output signals, registers and disturbance recorder.

Communication functions

The machine terminal REM 54_ provides three serial communication protocols: SPA, LON and MODBUS.

Standard functions

Standard functions are used for logics such as interlocking, alarming and control sequencing. The use of logic functions is not limited

Design (cont´d)

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 analogue 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.

Design (cont´d)

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.

Digital outputs
The digital 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

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.

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 HMI 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

Design (cont´d)

- LED indicator for control test and interlocking
- three protection LED indicators
- HMI 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 HMI 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 three serial communication ports, one port on the front panel and two ports on the rear panel.

The standard optical ABB connector

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.

SPA/Modbus communication on the rear connector X3.2

The 9-pin D-type subminiature male connector (RS-232 connection) on the rear panel connects the machine terminal to the distribution automation system via the SPA bus or the Modbus. The fibre-optic interface module type RER 123 is used for connecting the machine terminal to the fibre-optic communication bus for SPA protocol. A third-party fully isolated RS-232/RS-485 converter[1)] is used for connecting the machine terminal to the RS-485 multi-drop communication bus for the Modbus.

1) The port is not isolated. The functionality of the port is tested with Phoenix RS-232/RS-485 converter (PSM-ME-RS232/RS485-P). In the delivery of the REM 543 with Modbus communication, a dedicated cable is included.

LON/SPA bus communication on the rear connector X3.3

The 9-pin D-type subminiature female connector (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 for connecting the machine terminal to the fibre-optic communication bus. The module RER 103 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 HMI 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 HMI. 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.

Design (cont´d)

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 HMI or externally via the serial communication using the Relay Setting Tool CAP 501 or Substation Monitoring System SMS 510.

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 structure 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 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.

Design (cont´d)

Connector description

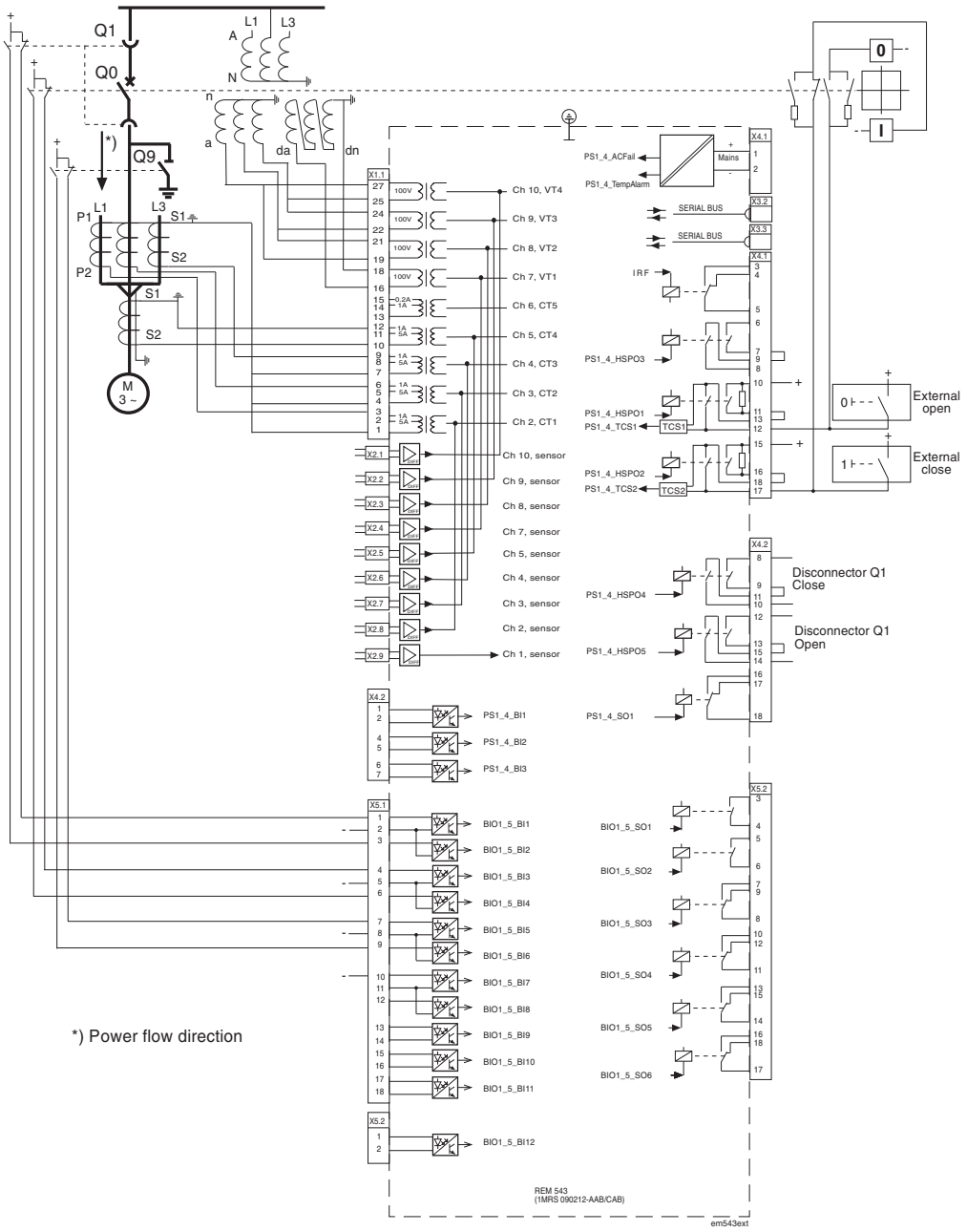


Fig. 1 Sample connection diagram of REM 543

Design (cont´d)

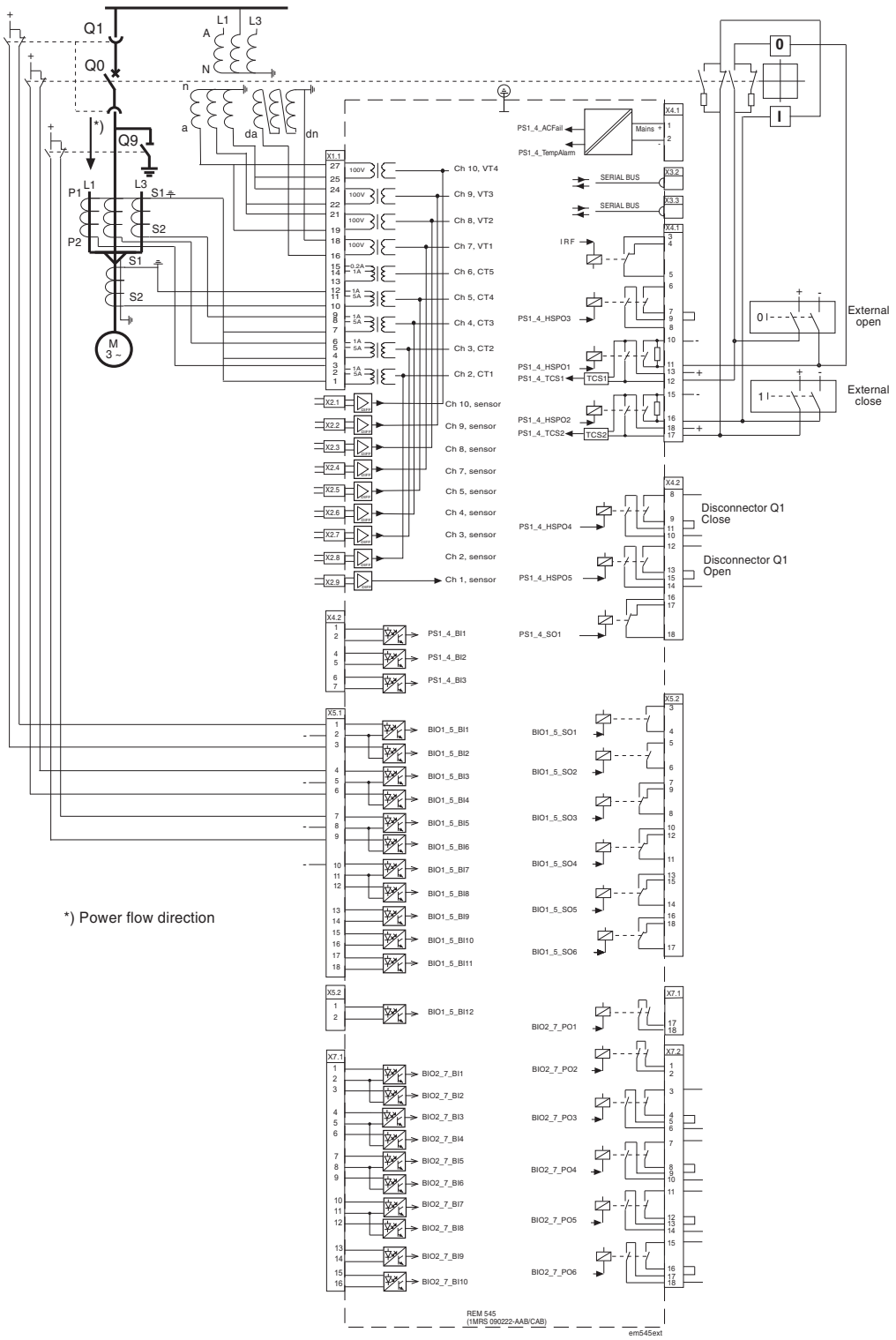


Fig. 2 Sample connection diagram of REM 545

Design (cont´d)

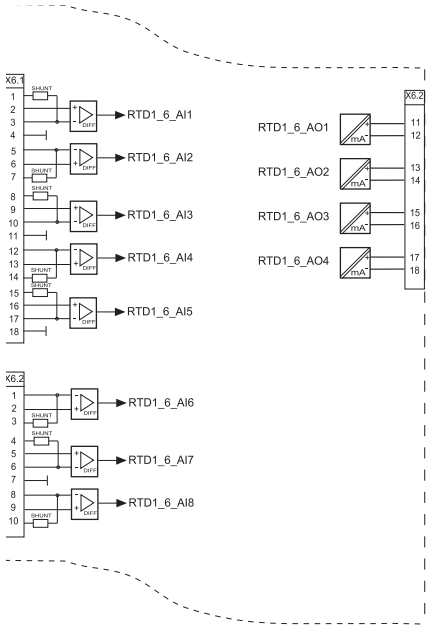


Fig. 3 Terminal diagram of the RTD/analogue module

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 protection 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 HMI 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

Technical data (cont´d)

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 exlusive 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 HMI
CO3DC1	Three-state disconnector (1) with indication
CO3DC2	Three-state disconnector (2) with indication
CODC1…COCD5	Disconnector 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, MEAI1...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) General REAL type input	-10000.00000...10000.00000 -10000.00000...10000.00000

Technical data (cont´d)

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

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

Technical data (cont´d)

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

Technical data (cont´d)

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 IEEE curves
Measuring mode	Peak-to-peak Fundamental frequency
Drop-off time of the operate time counter	0...1000 ms
	Note! The values below apply when f/fn = 0.95...1.05
Operation accuracy	±2.5% of set value or ±0.01 x In
Start time	Injected currents > 2.0 x start current: 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	< 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 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
	Note! The values below apply when f/fn = 0.95...1.05
Operation accuracy	0.1...10 x In: ±2.5% of set value or ±0.01 x In 10...40 x In: ±5.0% of set value
Start time	Injected currents > 2.0 x start current: 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	< 45 ms
Operate time accuracy at DT mode	±2% of set value or ±20 ms

Technical data (cont´d)

Three-phase directional overcurrent function, low-set stage, DOC6Low, I>→	
Operation mode	Not in use; Definite time Extremely inv.; Very inverse Normal inverse Long-time inv.; RI-type inverse RD-type inverse
Start current	0.05…40.00 x In
Operate time	0.05…300.00 s
Time multiplier	0.05…1.00
Basic angle φ_b	0…90°
Operation direction	Forward Reverse
Earth-fault protection	Disabled Enabled
Measuring mode	Phase-to-phase voltages, peak-to-peak measurement Phase-to-phase voltages, fundamental freq. measurement Phase-to-earth voltages, peak-to-peak measurement Phase-to-earth voltages, fundamental freq. measurement
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 ±2.5% of measured voltage or ±0.01 x Un ±2°
Start time	Injected currents > 2.0 x start current: 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	< 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 directional overcurrent function, high-set stage, DOC6High, I>>→, and instantaneous stage, DOC6Inst, I>>>→	
Operation mode	Not in use Definite time Instantaneous
Start current	0.05…40.00 x In
Operate time	0.05…300.00 s
Basic angle φ_b	0…90°
Operation direction	Forward Reverse
Earth-fault protection	Disabled Enabled
Non-directional operation (when the direction cannot be determined)	Disabled Enabled
Measuring mode	Phase-to-phase voltages, peak-to-peak measurement Phase-to-phase voltages, fundamental freq. measurement Phase-to-earth voltages, peak-to-peak measurement Phase-to-earth voltages, fundamental freq. measurement
Drop-off time of the operate time counter	0...1000 ms

Technical data (cont´d)

	Note! The values below apply when f/fn = 0.95...1.05
Operation accuracy	0.1...10 x In: ±2.5% of set value or ±0.01 x In 10...40 x In: ±5.0% of set value ±2.5% of measured voltage or ±0.01 x Un ±2°
Start time	Injected currents > 2.0 x start current: 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	< 45 ms
Operate time accuracy at DT mode	±2% of set value or ±20 ms

Voltage-dependent overcurrent protection, low-set stage, VOC6Low, I(U)>, and high-set stage, VOC6High, I(U)>>	
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
Control mode for voltage control	Voltage step Voltage slope Input step
Voltage limit for the voltage step mode	0.10...1.00 x Un
Upper voltage limit for the voltage slope mode	0.60...1.00 x Un
Lower voltage limit for the voltage slope mode	0.10...0.59 x Un
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
	Note! The values below apply when f/fn = 0.95...1.05
Operation accuracy	±2.5% of set value or ±0.01 x In ±2.5% of set value or ±0.01 x Un
Start time	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

Technical data (cont´d)

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.
	Note! The values below apply when f/fn = 0.95...1.05
Operation accuracy	± 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 In
Turn-point 2; turnpoint between the 2nd and 3rd line of the operating characteristics	1.0...3.0 x In
Tripping value of the instantaneous stage	5...30 x In
	Note! The values below apply when f/fn = 0.95...1.05
Operation accuracy	Phase difference measurement: ±4° Stabilized stage: ±4% of set value or ±2% x In Instantaneous stage: ±4% of set value or ±2% x In
Trip time	Injected currents > 2.0 x operating current: internal time < 35 ms total time < 45 ms
Reset time	60...1020 ms (depends on the minimum pulse width set for the trip output)
Reset ratio, typically	0.95
Retardation time	< 40 ms

Technical data (cont´d)

High impedance or flux-balance based differential protection for generators and motors, Diff3, 3ΔI>	
Basic setting	0.5…50%
Operation time	0.03...0.50 s
Operation mode	Not in use Definite time Instantaneous
	Note! The values below apply when f/fn = 0.95...1.05
Operation accuracy	± 2.5% of set value or ± 0.004 x In
Trip time in instantaneous mode	Injected currents > 2.0 x start current: internal time < 20 ms total time < 30 ms
Start time in definite-time mode	Injected currents > 2.0 x start 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, typically	0.95
Retardation time in instantaneous mode	This function block cannot be retarded but trips once the current exceeds the operate value.
Retardation time in definite-time mode	< 40 ms

Non-directional earth-fault protection, low-set stage, NEF1Low, I_0>	
Start current	1.0…100.0% of 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 IEEE curves
Measuring mode	Peak-to-peak Fundamental frequency
Drop-off time of the operate time counter	0...1000 ms
	Note! The values below apply when f/fn = 0.95...1.05
Operation accuracy	±2.5% of set value + 0.0005 x In
Start time	Injected currents > 2.0 x start current: 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	< 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

Technical data (cont´d)

Non-directional earth-fault protection, high-set stage, NEF1High, I_0>>, and instantaneous stage, NEF1Inst, I_0>>>	
Start current	0.10…12.00 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
	Note! The values below apply when f/fn = 0.95...1.05
Operation accuracy	±2.5% of set value or + 0.01 x In
Start time	Injected currents > 2.0 x start current: 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	< 45 ms
Operate time accuracy at DT mode	±2% of set value or ±20 ms

Technical data (cont´d)

Directional earth-fault protection, low-set stage, DEF2Low, I_0>→	
Start current	1.0…25.0% of In
Start voltage	2.0…100.0% of Un
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 & Uo Basic angle IoSin/Cos & Uo IoSin/Cos Non-directional Io Non-directional Uo
Operation direction	Forward Reverse
Basic angle φ_b	-90° -60° -30° 0°
Operation characteristic	IoSin(φ) IoCos(φ)
Intermittent E/F	Not active Active
Measuring mode	Peak-to-peak Fundamental frequency
Drop-off time of the operate time counter	0...1000 ms
	Note! The values below apply when f/fn = 0.95...1.05
Operation accuracy	±2.5% of set value + 0.0005 x In ±2.5% of set value or + 0.01 x Un Phase angle ±2°
Start time	Injected neutral current > 2.0 x start current and residual voltage > 2.0 x 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)
Reset ratio, typically	0.95
Retardation time	< 50 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

Technical data (cont´d)

Directional earth-fault protection, high-set stage, DEF2High, I_0>>→, and instantaneous stage, DEF2Inst, I_0>>>→	
Start current	1.0…200.0% of In
Start voltage	2.0…100.0% of Un
Operate time	0.1…300.0 s
Operation mode	Not in use Definite time Instantaneous
Operation criteria	Basic angle & Uo Basic angle IoSin/Cos & Uo IoSin/Cos Non-directional Io Non-directional Uo
Operation direction	Forward Reverse
Basic angle φ_b	-90° -60° -30° 0°
Operation characteristic	IoSin(φ) IoCos(φ)
Intermittent E/F	Not active Active
Measuring mode	Peak-to-peak Fundamental frequency
Drop-off time of the operate time counter	0...1000 ms
	Note! The values below apply when f/fn = 0.95...1.05
Operation accuracy	±2.5% of set value + 0.0005 x In ±2.5% of set value or + 0.01 x Un Phase angle ±2°
Start time	Injected neutral current > 2.0 x start current and residual voltage > 2.0 x 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)
Reset ratio, typically	0.95
Retardation time	< 50 ms
Operate time accuracy at DT mode	±2% of set value or ±20 ms

Technical data (cont´d)

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%
	Note! The values below apply when f/fn = 0.95...1.05
Operation accuracy	±2.5% of set value or ±0.004 x In
Trip time	Injected currents > 2.0 x 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	2.0…20.0% of Un
Operate time	0.05…300.00 s
Operation mode	Not in use Definite time
Measuring mode	Peak-to-peak Fundamental frequency
	Note! The values below apply when f/fn = 0.95...1.05
Operation accuracy	±2.5% of set value or ±0.01 x Un
Start time	Injected voltages >2 x 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	±2% of set value or ±20 ms

Residual overvoltage protection, high-set stage, ROV1High, U_0>>, and instantaneous stage, ROV1Inst, U_0>>>	
Start voltage	2.0…80.0% of Un
Operate time	0.05…300.00 s
Operation mode	Not in use Definite time
Measuring mode	Peak-to-peak Fundamental frequency
	Note! The values below apply when f/fn = 0.95...1.05
Operation accuracy	±2.5% of set value or ±0.01 x Un
Start time	Injected voltages >2 x 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	±2% of set value or ±20 ms

Technical data (cont´d)

Three-phase thermal overload protection for motors, generators and transformers, TOL3Dev, 3□	
BASIC SETTINGS	
Starting current of the motor	0.10...10.00 x In
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
Estimated time to the trip (Read-only parameter)	0...86400 s
Operation accuracy Reset ratio	Note! The values below apply when f/fn = 0.95...1.05 ±1.0%, I = 0.1...10.0 x In 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

Technical data (cont´d)

Negative phase-sequence protection, low-set stage, NPS3Low, I_2>, and high-set stage, NPS3High, I_2>>	
Operation mode	Not in use Definite time Inverse time
Start value of negative-sequence current I2	0.01...0.50 x In
Operate time	0.1....120.0 s
Operating characteristic constant K (corresponds to the machine constant, equal to the I^2_2t constant of the machine as stated by machine manufacturer)	5.0...100.0
Definite start time at inverse-time mode	0.1...60.0 s
Definite minimum operate time	0.1...120.0 s
Maximum operate time	500...10000 s
Cooling time of the machine	5...10000 s
Number of phases to be measured	2 or 3
Rotation direction	Forward Reverse
Drop-off time of the operate time counter	0...1000 ms
	Note! The values below apply when f/fn = 0.95...1.05
Operation accuracy	±2.5% of set value or ±0.01 x In
Start time	Injected negative-seq. current = 2.00 x start value: 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	0.96
Retardation time	< 45 ms
Operate time accuracy at DT mode	±2% of set value or ±20 ms
Accuracy class index E at IDMT mode, typically	±2% of the calculated ideal operate time or ±20 ms

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%
	Note! The values below apply when f/fn = 0.95...1.05
Operation accuracy	±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	±2% of set value or ±20 ms
Accuracy class index E at IDMT mode, typically	±20 ms

Technical data (cont´d)

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)
	Note! The values below apply when f/fn = 0.95...1.05
Operation accuracy	±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	±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%
	Note! The values below apply when f/fn = 0.95...1.05
Operation accuracy	±2.5% of set value or ±0.01 x Un
Start time	Injected voltages < 0.5 x 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	1.04 (range 1.005...1.05)
Retardation time	< 60 ms
Operate time accuracy at DT mode	±2.5% of set value
Accuracy class index E at IDMT mode, typically	±35 ms

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%
	Note! The values below apply when f/fn = 0.95...1.05
Operation accuracy	±2.5% of set value or ±0.01 x Un
Start time	Injected voltages < 0.5 x 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	1.04 (range 1.005...1.05)
Retardation time	< 60 ms
Operate time accuracy at DT mode	±2.5% of set value

Technical data (cont´d)

Phase-sequence voltage protection, PSV3St1 and PSV3St2, U_1<, U_2>, U_1>	
Start value U2>	0.01…1.00 x Un
Start value U1<	0.01…1.20 x Un
Start value U1>	0.80…1.60 x Un
Operate time U2>	0.04…60.00 s
Operate time U1<	0.04…60.00 s
Operate time U1>	0.04…60.00 s
Operation mode	Not in use; U1< & U2> & U1>; U1< & U2>; U2> & U1>; U1< & U1>; U2>; U1<; U1>
Dir. selection	Forward; Reverse; Input ROT_DIR
	Note! The values below apply when f/fn = 0.95...1.05
Operation accuracy	± 2.5% of set value or ± 0.01 x Un
Trip time	U2> operation: Injected negative-seq. voltage = 1.1 x start value: internal time < 42 ms total time < 50 ms U1< operation: Injected positive-seq. voltage = 0.50 x start value: internal time < 32 ms total time < 40 ms U1> operation: Injected positive-seq. voltage = 1.1 x start value: 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, typically	U2> operation: 0.96 U1< operation: 1.04 U1> operation: 0.99
Retardation time	< 45 ms (for all operations)
Operate time accuracy	± 2% of set value or ± 20 ms

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 x Un
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 < ±5 Hz/s: ±100 mHz/s real df/dt < ±15 Hz/s: ±2.0% of real df/dt Undervoltage blocking: ±1.0% of set value
Start time	Total start times at fn = 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	±2% of set value or ±30 ms

Technical data (cont´d)

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
	Note! The values below apply when f/fn = 0.95...1.05
Operation accuracy	±4.0% of set value or ±0.02 p.u.
Start time	Injected impedance = 0.50 x circle radius: internal time < 62 ms total time < 70 ms
Reset time	100...1100 ms (depends on the minimum pulse width set for the trip output)
Reset ratio, typically	1.04
Retardation time	< 45 ms
Operate time accuracy at DT mode	±2% of set value or ±20 ms

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
	Note! Values below apply when f/fn = 0.95...1.05
Operation accuracy	±4.0% of set value or ±0.02 p.u.
Start time	Injected impedance = 0.50 x circle radius: internal time < 62 ms total time < 70 ms
Reset time	100...1100 ms (depends on the minimum pulse width set for the trip output)
Reset ratio, typically	1.04
Retardation time	< 45 ms
Operate time accuracy at DT mode	±2% of set value or ±20 ms

Technical data (cont´d)

Overexcitation protection, low-set stage, OE1Low, U/f>, and high-set stage, OE1High, U/f>>	
U/f start (DT mode)	1.00...2.00 x U/f
U/f start (IDMT mode)	1.00...2.00 x U/f
U max cont.	0.80...1.60 x Un
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: ±4% of set value; 40...80 Hz: ±2% of set value
Start time	Injected U/f > 2.0 x Un/fn; 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: ±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 ±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 % Sn
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
	Note! The values below apply when f/fn = 0.95...1.05
Operation accuracy	±1.0% of set value or ±0.01 x rated value
Start time	Injected power > 2.0 x 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	±2% of set value or ±20 ms

Technical data (cont´d)

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
	Note! The values below apply when f/fn = 0.95...1.05
Operation accuracy	±1.0% of set value or ±0.01 x rated value ±1.5% of set value or ±0.015 x 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	±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^2t I^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/fn = 0.95...1.05: ±2.5% of set value or ±0.01 x In
Start time	f/fn = 0.95...1.50: internal time < 22 ms total time < 30 ms f/fn = 0.50...0.95: internal time < 32 ms total time < 40 ms
Reset ratio, typically	0.95
Retardation time	< 50 ms

Technical data (cont´d)

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 In
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
	Note! The values below apply when f/fn = 0.95...1.05
Operation accuracy	±2.5% of set value or ±0.01 x In
Start time	Injected currents = 0.5 x start current: internal time < 92 ms total time < 100 ms
Reset time	40...1000 ms (depends on the minimum pulse width set for the trip output)
Reset ratio, typically	1.02
Retardation time	< 80 ms
Operate time accuracy at DT mode	±2% of set value or ±25 ms

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
	Note! The values below apply when f/fn = 0.95...1.05
Operation accuracy	Phase angle difference: ±2° Current: ±0.01 x In
Start time	When the phase order is reversed and the injected currents = 1.0 x In: internal time <72 ms total time <80 ms
Reset time	40...1000 ms (depends on the minimum pulse width set for the trip output)
Reset ratio	Reset value for the phase angle difference : 3°
Retardation time	<60 ms
Operate time accuracy	±2% of set value or ±20 ms

Synchro-check/voltage check function stage 1 and stage 2, SCVCSt1 and SCVCSt2, SYNC	
Upper threshold voltage Umax	0.50…1.00 x Un
Lower threshold voltage Umin	0.10…0.80 x Un
Voltage difference ΔU	0.02…0.60 x Un
Phase angle difference Δphase	5…90°
Frequency difference Δf	0.02…5.00 Hz
Operation accuracy	Note! The values below apply when f/fn = 0.95...1.05 ±2.5% of set value or ±0.01 x Un ±10 mHz ±2°
Reset time	< 50 ms
Reset ratio	0.975 x Un
Operate time accuracy	±2% of set value or ±20 ms

Technical data (cont´d)

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

Fuse failure supervision, FuseFail, FUSEF	
Ratio U2/U1> Ratio I2/I1<	10...50% 10...50%
Operation accuracy BSOUT activation time (when the task interval is 10 ms) Reset time Reset ratio	When f/fn = 0.98...1.02 ±2.0 percentage units (of settings Ratio U2/U1> and Ratio I2/I1<) When f/fn = 0.95...1.05 ±4.0 percentage units (of settings Ratio U2/U1> and Ratio I2/I1<) Injected negative-sequence voltage = 2.00 x Ratio U2/U1> (f/fn=0.98...1.02): < 35 ms (within the same task) 20 ms (within the same task) 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 x 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)		

Technical data (cont´d)

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
	120 Ω Nickel	TCR 0.00672 (MIL-T-24388C)
	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	±0.5% of full scale ±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	≤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 Ω ±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)

Technical data (cont´d)

Table 13: Analogue outputs

Output range	0...20 mA
Accuracy	±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
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
	Seismic tests		IEC 60255-21-3, class 2

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	

Technical data (cont´d)

Table 16: Electromagnetic compatibility tests

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	
DNV approval		
UL approval	Recognition pending	

Technical data (cont´d)

Table 17: Data communication

Rear interface, connector X3.1	not used, reserved for future purpose	
Rear interface, connector X3.2	RS232 connection	
	Protocol	MODBUS RTU/ASCII or SPA bus, selectable
	data transfer rates	SPA bus: 4.8/9.6/19.2 kbps, selectable Modbus: 0.3/1.2/2.4/4.8/9.6 kbps, selectable
	the fibre-optic interface module RER 123 for SPA and a third-party fully isolated RS-232/RS-485 converter for Modbus are needed for galvanic isolation	
	Phoenix RS-232/RS-485 converter - converter cable 0.5 m - converter cable 2.0 m	PSM-ME-RS232/RS485-P 1MRS120535-C50 1MRS120535-002
	RER 123	1MRS090715
Rear interface, connector X3.3	RS485 connection	
	Protocol	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, connector X3.4	RJ45 connection	
	galvanically isolated RJ45 connection for an external display panel	
	- communication cable 1.0 m	1MRS 120511.001
	- communication cable 2.0 m	1MRS 120511.002
	- communication cable 3.0 m	1MRS 120511.003
Front panel interface connector	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 LON bus, Modbus RTU/ASCII	

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)

Technical data (cont´d)

Table 18: General

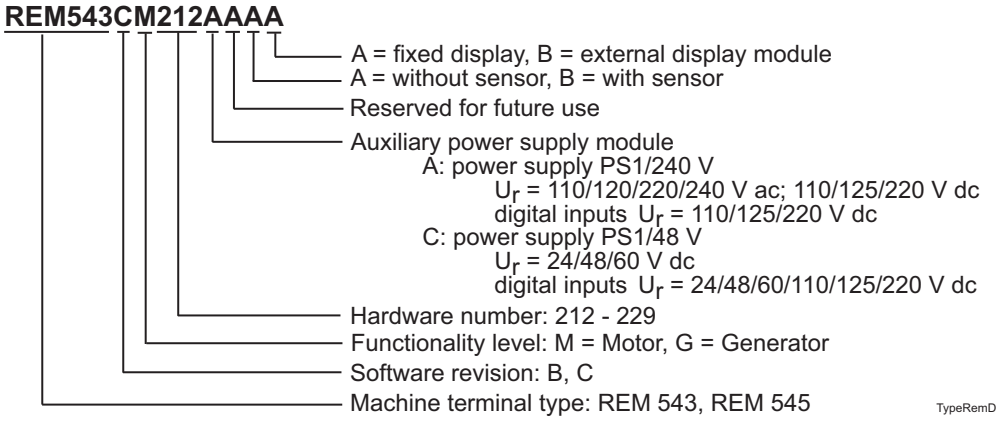
Self-supervision	RAM circuits ROM circuits Parameter memory circuits CPU watchdog Power supply Digital I/O modules HMI module RTD/analogue input module Internal communication bus A/D converters and analogue multiplexers
Mechanical dimensions	Width: 223.7 mm (1/2 of a 19” rack) Height, frame: 265.9 mm (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, quantity of machine terminals and possible Modbus option.

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.

The order number is labelled on the marking strip on the front panel of the machine terminal delivered, e.g.
Order No: REM543CM212AAAA.



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
009	English-Russian

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.

Ordering (cont´d)

Functionality levels, protection functions

				FUNCTIONALITY LEVELS	
ANSI Code	**IEC Symbol**	**Function**	**Code**	**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
67	3I > -->	Three-phase directional overcurrent, low-set stage	DOC6Low		X
	3I >> -->	Three-phase directional overcurrent, high-set stage	DOC6High		X
	3I >>> -->	Three-phase directional overcurrent, inst. stage	DOC6Inst		X
51V	I(U) >	Voltage dependent overcurrent, low-set stage	VOC6Low	X	X
	I(U) >>	Voltage dependent overcurrent, high-set stage	VOC6High	X	X
87G/87M	3∆I>	High-impedance/flux-balance based diff. protection for motors/generators	Diff3	X	X
87G	3∆I>, 3∆I>>	Stabilized three-phase differential protection for generators	Diff6G		X
21G	Z<	Three-phase underimpedance protection, low-set stage	UI6Low		X
	Z<<	Three-phase underimpedance protection, high-set stage	UI6High		X
		Earth-faults:			
51N	Io > / SEF	Non-directional earth-fault, low-set stage	NEF1Low	X	X
50N/51N	Io >>	Non-directional earth-fault, high-set stage	NEF1High	X	X
50N	Io >>> / Io-o >	Non-directional earth-fault, instantaneous stage	NEF1Inst	X	X
67N/51N	Io > / SEF ->	Directional earth-fault, low-set stage	DEF2Low	X	X
67N	Io >> ->	Directional earth-fault, high-set stage	DEF2High	X	X
	Io >>> ->	Directional earth-fault, instantaneous stage	DEF2Inst	X	X
87N	∆Io >, REF	High-impedance based restricted earth-fault protection	REF1A		X
59N	Uo >	Residual overvoltage, low-set stage	ROV1Low	X	X
	Uo >>	Residual overvoltage, high-set stage	ROV1High	X	X
	Uo >>>	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	I2>	Negative-phase-sequence protection, low-set stage	NPS3Low	X	X
	I2>>	Negative-phase-sequence protection, high-set stage	NPS3High	X	X

Ordering (cont´d)

Functionality levels, protection functions

				FUNCTIONALITY LEVELS	
ANSI Code	**IEC Symbol**	**Function**	**Code**	**REM 543/5 Motor**	**REM 543/5 Generator**
		Over-/Undervoltage:			
59	3U >	Three-phase overvoltage, low-set stage	OV3Low	X	X
	3U >>	Three-phase overvoltage, high-set stage	OV3High	X	X
27	3U <	Three-phase undervoltage, low-set stage	UV3Low	X	X
	3U <<	Three-phase undervoltage, high-set stage	UV3High	X	X
27, 47, 59	U1<, U2>, U1>	Three-phase phase-sequency voltage protection, stage 1	PSV3St1	X	X
	U1<, U2>, U1>	Three-phase phase-sequency 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
	f < / f > / df/dt	Underfrequency or overfrequency incl. rate of change, stage 2	Freq1St2		X
	f < / f > / df/dt	Underfrequency or overfrequency incl. rate of change, stage 3	Freq1St3		X
	f < / f > / df/dt	Underfrequency or overfrequency incl. rate of change, stage 4	Freq1St4		X
	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
	P> -> / Q> ->	Three-phase directional overpower protection, stage 2	OPOW6St2		X
	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
	P< / P> <-	Three-phase underpower or reverse power protection, stage 2	UPOW6St2		X
	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
	U/f>>	Overexcitation protection, high-set stage	OE1High		X
40	X<	Three-phase underexcitation protection, low-set stage	UE6Low		X
	X<<	Three-phase underexcitation protection, high-set stage	UE6High		X
		Additional functions:			
25	ΔU, Δf, $\Delta\varphi$	Synchro-check/Voltage-check, Stage 1	SCVCSt1		X
		Synchro-check/Voltage-check, Stage 2	SCVCSt2		X
68	$3I_2$f>	Three-phase inrush detector	Inrush3	X	X

Ordering (cont´d)

Functionality levels, protection functions

				FUNCTIONALITY LEVELS	
ANSI Code	**IEC Symbol**	**Function**	**Code**	**REM 543/5 Motor**	**REM 543/5 Generator**
60	FUSEF	Fuse failure supervision	FuseFail		X
62BF	CBFP	Circuit breaker failure	-	X	X
48, 14, 66	Is^2t, n<	Start-up supervision for motors	MotStart	X	X
37	3I<	Three-phase non-directional undercurrent protection, stage 1	NUC3St1	X	X
	3I<<	Three-phase non-directional undercurrent protection, stage 2	NUC3St2	X	X
46R	$3I\curvearrowleft$, $3I\curvearrowright$	Phase reversal protection	PREV3	X	X

Functionality levels, other functions

			FUNCTIONALITY LEVELS	
IEC Symbol	**Function**	**Code**	**REM543/5 Motor**	**REM543/5 Generator**
	Measurement functions			
	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	MEAI1…8	X	X
	Scaling of analogue outputs (Note! Only in products with an RTD/analogue module)	MEAO1…4	X	X
	Condition monitoring functions			
	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:			

Ordering (cont´d)

Functionality levels, other functions

			FUNCTIONALITY LEVELS	
IEC Symbol	**Function**	**Code**	**REM543/5 Motor**	**REM543/5 Generator**
MCS	Supervision of the energizing current input circuit	CMCU3	X	X
MCS	Supervision of the energizing voltage input circuit	CMVO3	X	X
	Control functions			
	Circuit breaker, disconnector/earthing switch:			
	Circuit breaker 1, 2 (2 state inputs / 2 control outputs)	COCB1...2	X	X
	Disconnector 1….5 (2 state inputs / 2 control outputs)	CODC1…5	X	X
	Three state disconnector 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 HMI (single- line diagram)	MMIDATA 1…5	X	X
	Alarm 1…8 on HMI (alarm view)	MMIALAR 1…8	X	X
	On/off switch 1…4 on HMI (single-line diagram)	COSW1…4	X	X
	Direct open for CBs via HMI	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 HMI 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
	MODBUS	-	X[1)]	X[1)]
	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

1) Only for REM 543

Ordering (cont´d)

Overview of REM hardware configurations

REM 543	Order number											
Hardware numbers	REM543C_212AAAA	REM543C_212CAAA	REM543C_212AABA	REM543C_212CABA	REM543C_212AAAB	REM543C_212AABB	REM543B_213AAAA	REM543B_213CAAA	REM543B_213AABA	REM543B_213CABA	REM543B_213AAAB	REM543B_213AABB
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 board												
PS1/240 V: 110/120/265 Vac, 110/125/220 Vdc	1		1		1	1	1		1		1	1
PS1/48 V: 24/48/60 Vdc		1		1				1		1		
Digital I/O boards												
Threshold voltage 80 V dc	1		1		1	1	1		1		1	1
Threshold voltage 18 Vdc		1		1				1		1		
Analogue I/O board												
RTD/analogue module							1	1	1	1	1	1
Display boards												
Graphic HMI display, fixed	1	1	1	1			1	1	1	1		
Graphic HMI 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					

Ordering (cont´d)

REM 543	Order number											
Hardware numbers	REM543C_214AAAA	REM543C_214CAAA	REM543C_214AABA	REM543C_214CABA	REM543C_214AAAB	REM543C_214AABB	REM543B_215AAAA	REM543B_215CAAA	REM543B_215AABA	REM543B_215CABA	REM543B_215AAAB	REM543B_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												
PS1/240 V: 110/120/265 Vac, 110/125/220 Vdc	1		1		1	1	1		1		1	1
PS1/48 V: 24/48/60 Vdc		1		1				1		1		
Digital I/O boards												
Threshold voltage 80 V dc	1		1		1	1	1		1		1	1
Threshold voltage 18 Vdc		1		1				1		1		
Analogue I/O board												
RTD/analogue module							1	1	1	1	1	1
Display boards												
Graphic HMI display, fixed	1	1	1	1			1	1	1	1		
Graphic HMI 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					

Ordering (cont´d)

REM 543	**Order number**											
Hardware numbers	REM543C_216AAAA	REM543C_216CAAA	REM543C_216AABA	REM543C_216CABA	REM543C_216AAAB	REM543C_216AABB	REM543B_217AAAA	REM543B_217CAAA	REM543B_217AABA	REM543B_217CABA	REM543B_217AAAB	REM543B_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												
PS1/240 V: 110/120/265 Vac, 110/125/220 Vdc	1		1		1	1	1		1		1	1
PS1/48 V: 24/48/60 Vdc		1		1				1		1		
Digital I/O boards												
Threshold voltage 80 V dc	1		1		1	1	1		1		1	1
Threshold voltage 18 Vdc		1		1				1		1		
Analogue I/O board												
RTD/analogue module							1	1	1	1	1	1
Display boards												
Graphic HMI display, fixed	1	1	1	1			1	1	1	1		
Graphic HMI 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					

Ordering (cont´d)

REM 543	Order number											
Hardware numbers	REM543C_218AAAA	REM543C_218CAAA	REM543C_218AABA	REM543C_218CABA	REM543C_218AAAB	REM543C_218AABB	REM543B_219AAAA	REM543B_219CAAA	REM543B_219AABA	REM543B_219CABA	REM543B_219AAAB	REM543B_219AABB
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												
PS1/240 V: 110/120/265 Vac, 110/125/220 Vdc	1		1		1	1	1		1		1	1
PS1/48 V: 24/48/60 Vdc		1		1				1		1		
Digital I/O boards												
Threshold voltage 80 V dc	1		1		1	1	1		1		1	1
Threshold voltage 18 Vdc		1		1				1		1		
Analogue I/O board												
RTD/analogue module							1	1	1	1	1	1
Display boards												
Graphic HMI display, fixed	1	1	1	1			1	1	1	1		
Graphic HMI 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					

Ordering (cont´d)

REM 545	Order number											
Hardware numbers	REM545B_222AAAA	REM545B_222CAAA	REM545B_222AABA	REM545B_222CABA	REM545B_222AAAB	REM545B_222AABB	REM545B_223AAAA	REM545B_223CAAA	REM545B_223AABA	REM545B_223CABA	REM545B_223AAAB	REM545B_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												
PS1/240 V: 110/120/265 Vac, 110/125/220 Vdc	1		1		1	1	1		1		1	1
PS1/48 V: 24/48/60 Vdc		1		1				1		1		
Digital I/O boards												
Threshold voltage 80 V dc	1		1		1	1	1		1		1	1
Threshold voltage 18 Vdc		1		1				1		1		
Analogue I/O board												
RTD/analogue module							1	1	1	1	1	1
Display boards												
Graphic HMI display, fixed	1	1	1	1			1	1	1	1		
Graphic HMI 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					

Ordering (cont´d)

REM 545	Order number											
Hardware numbers	REM545B_224AAAA	REM545B_224CAAA	REM545B_224AABA	REM545B_224CABA	REM545B_224AAAB	REM545B_224AABB	REM545B_225AAAA	REM545B_225CAAA	REM545B_225AABA	REM545B_225CABA	REM545B_225AAAB	REM545B_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												
PS1/240 V: 110/120/265 Vac, 110/125/220 Vdc	1		1		1	1	1		1		1	1
PS1/48 V: 24/48/60 Vdc		1		1				1		1		
Digital I/O boards												
Threshold voltage 80 V dc	1		1		1	1	1		1		1	1
Threshold voltage 18 Vdc		1		1				1		1		
Analogue I/O board												
RTD/analogue module							1	1	1	1	1	1
Display boards												
Graphic HMI display, fixed	1	1	1	1			1	1	1	1		
Graphic HMI 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					

Ordering (cont´d)

REM 545	**Order number**											
Hardware numbers	REM545B_226AAAA	REM545B_226CAAA	REM545B_226AABA	REM545B_226CABA	REM545B_226AAAB	REM545B_226AABB	REM545B_227AAAA	REM545B_227CAAA	REM545B_227AABA	REM545B_227CABA	REM545B_227AAAB	REM545B_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												
PS1/240 V: 110/120/265 Vac, 110/125/220 Vdc	1		1		1	1	1		1		1	1
PS1/48 V: 24/48/60 Vdc		1		1				1		1		
Digital I/O boards												
Threshold voltage 80 V dc	1		1		1	1	1		1		1	1
Threshold voltage 18 Vdc		1		1				1		1		
Analogue I/O board												
RTD/analogue module							1	1	1	1	1	1
Display boards												
Graphic HMI display, fixed	1	1	1	1			1	1	1	1		
Graphic HMI 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					

Ordering (cont´d)

REM 545	Order number											
Hardware numbers	REM545B_228AAAA	REM545B_228CAAA	REM545B_228AABA	REM545B_228CABA	REM545B_228AAAB	REM545B_228AABB	REM545B_229AAAA	REM545B_229CAAA	REM545B_229AABA	REM545B_229CABA	REM545B_229AAAB	REM545B_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												
PS1/240 V: 110/120/265 Vac, 110/125/220 Vdc	1		1		1	1	1		1		1	1
PS1/48 V: 24/48/60 Vdc		1		1				1		1		
Digital I/O boards												
Threshold voltage 80 V dc	1		1		1	1	1		1		1	1
Threshold voltage 18 Vdc		1		1				1		1		
Analogue I/O board												
RTD/analogue module							1	1	1	1	1	1
Display boards												
Graphic HMI display, fixed	1	1	1	1			1	1	1	1		
Graphic HMI 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					

Ordering (cont´d)

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

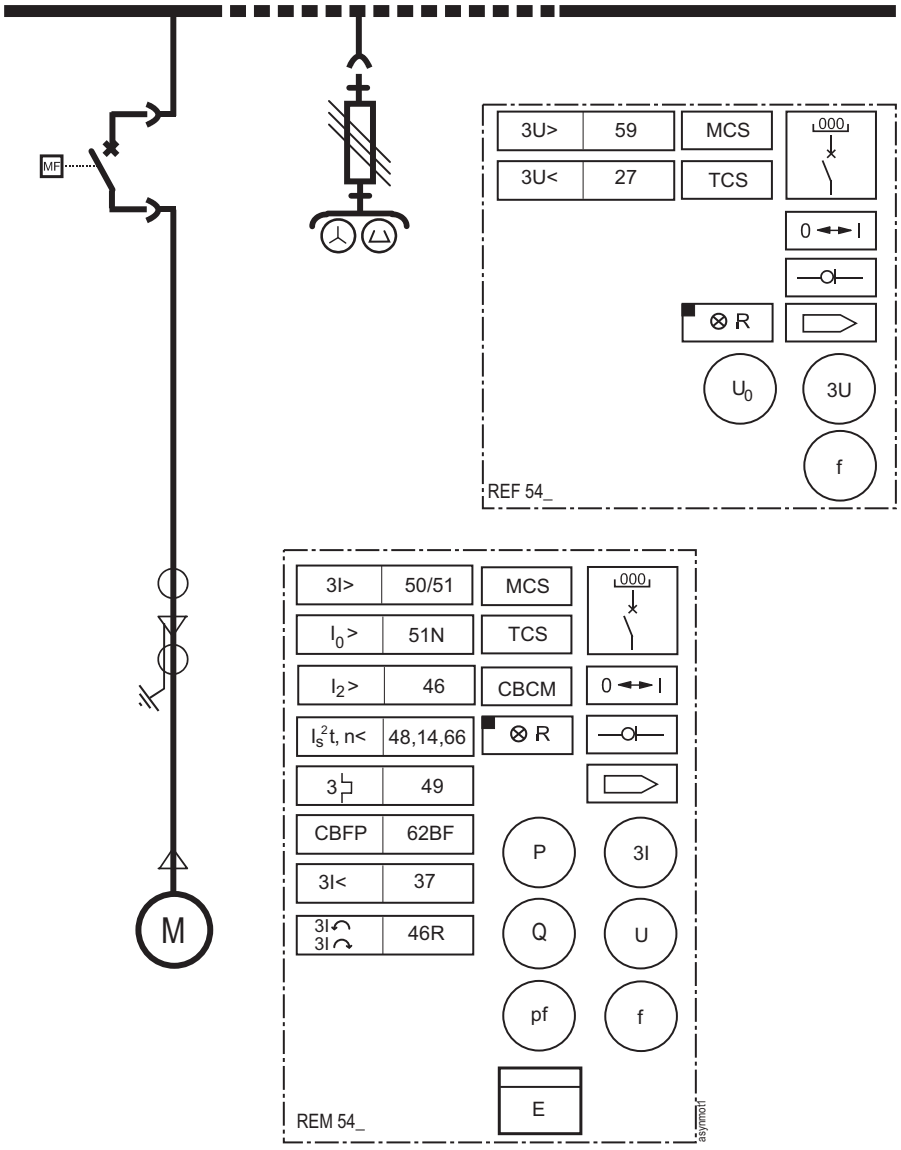


Fig. 4 REM 54_ used for the protection of a directly started asynchronous motor.

Application examples
(cont´d)

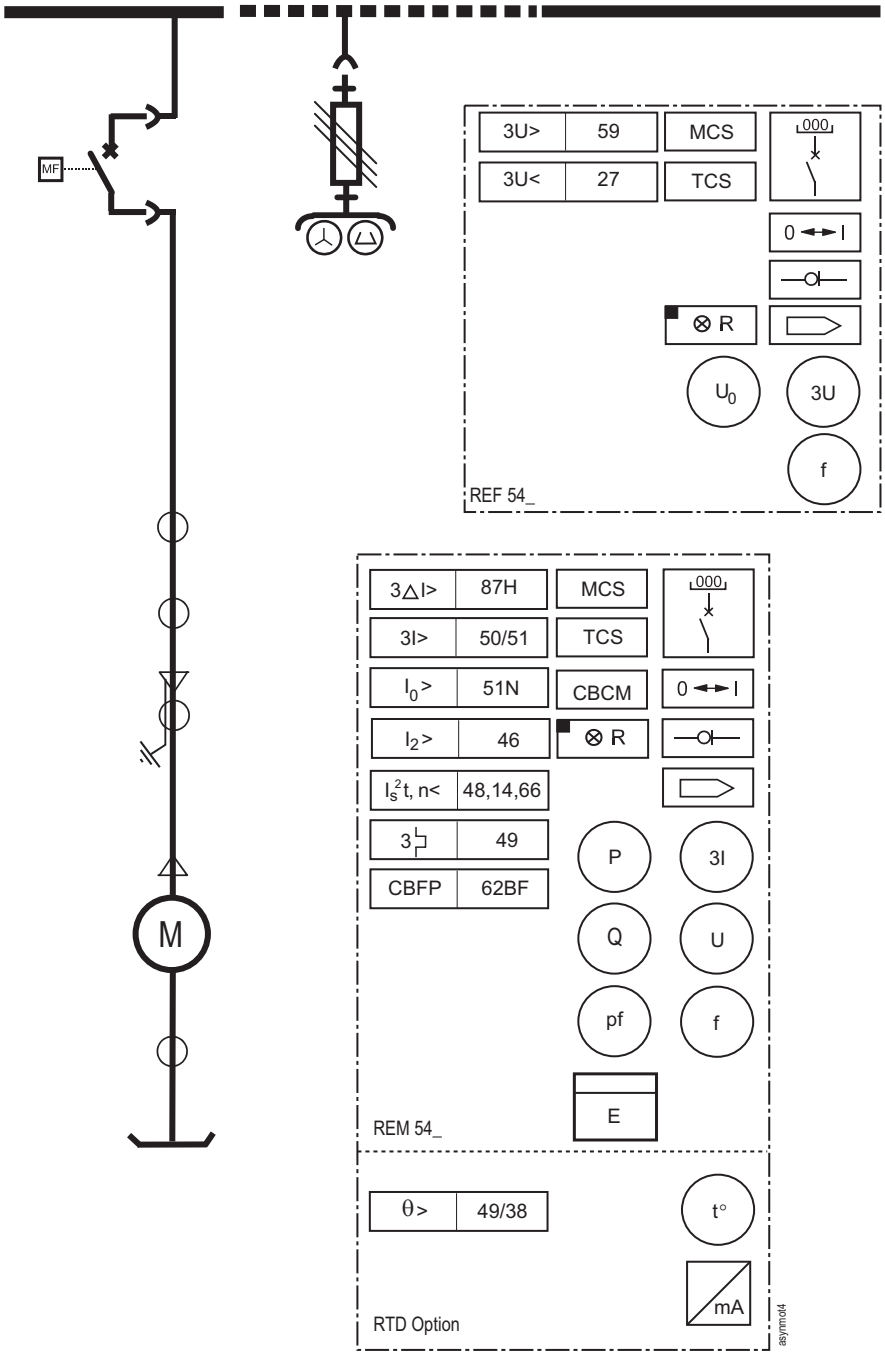


Fig. 5 REM 54_ used for the protection of a directly started asynchronous motor. High-impedance principle applied for differential protection.

Application examples
(cont´d)

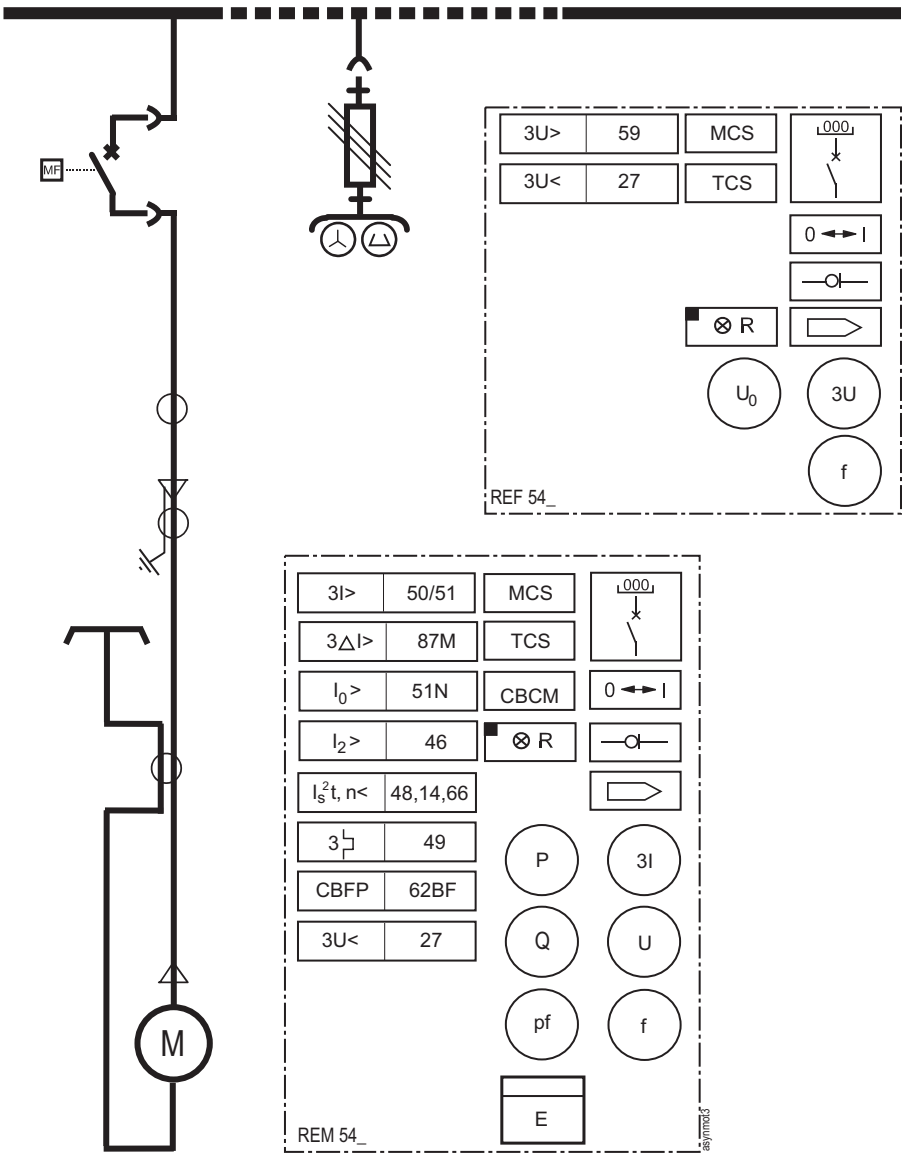


Fig. 6 REM 54_ used for the protection of a directly started asynchronous motor. Flux-balance principle applied for differential protection.

Application examples
(cont´d)

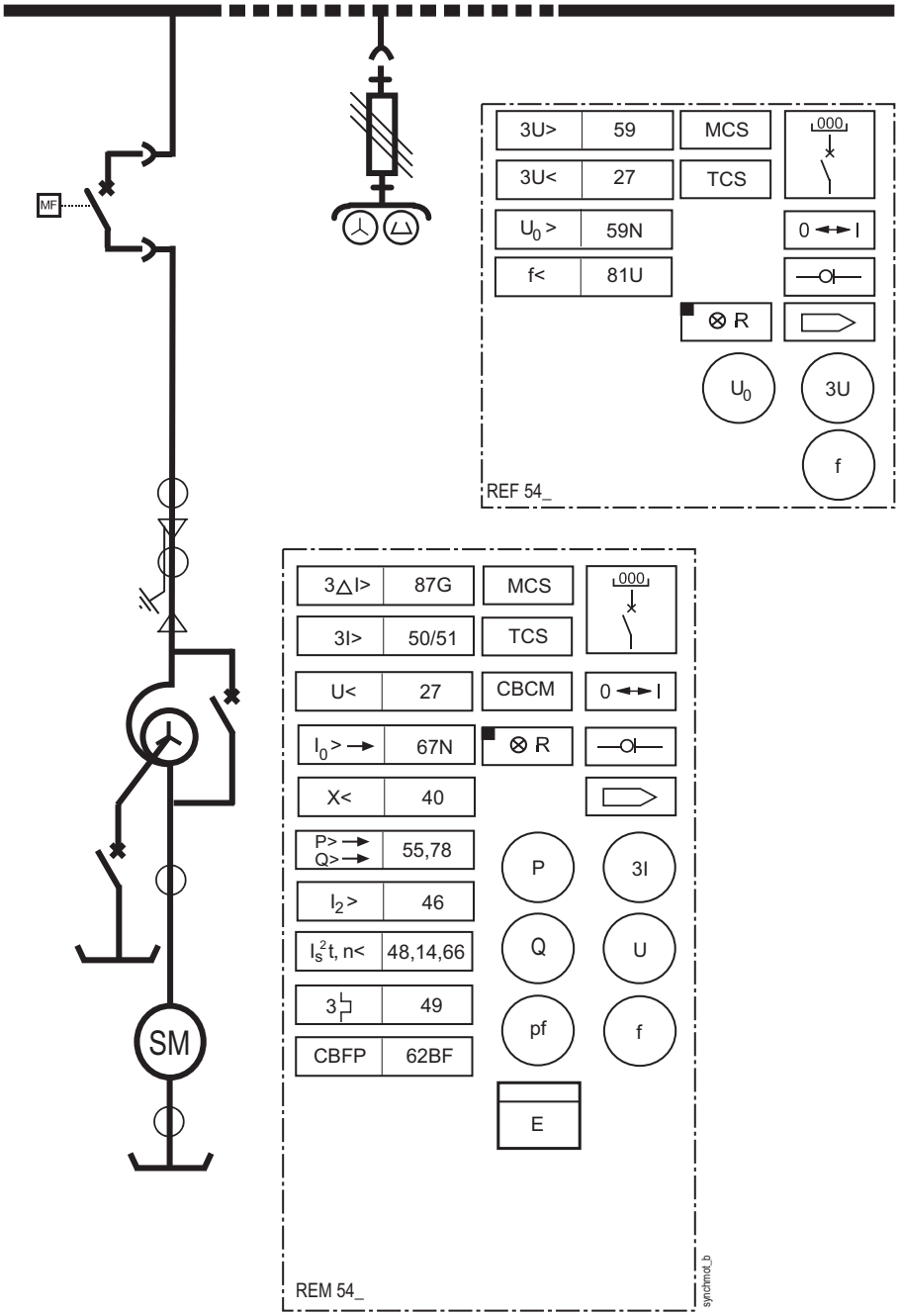


Fig. 7 REM 54_ used for the protection of a synchronous motor started with an autotransformer. Pole slip function implemented with directional power functions.

Application examples
(cont´d)

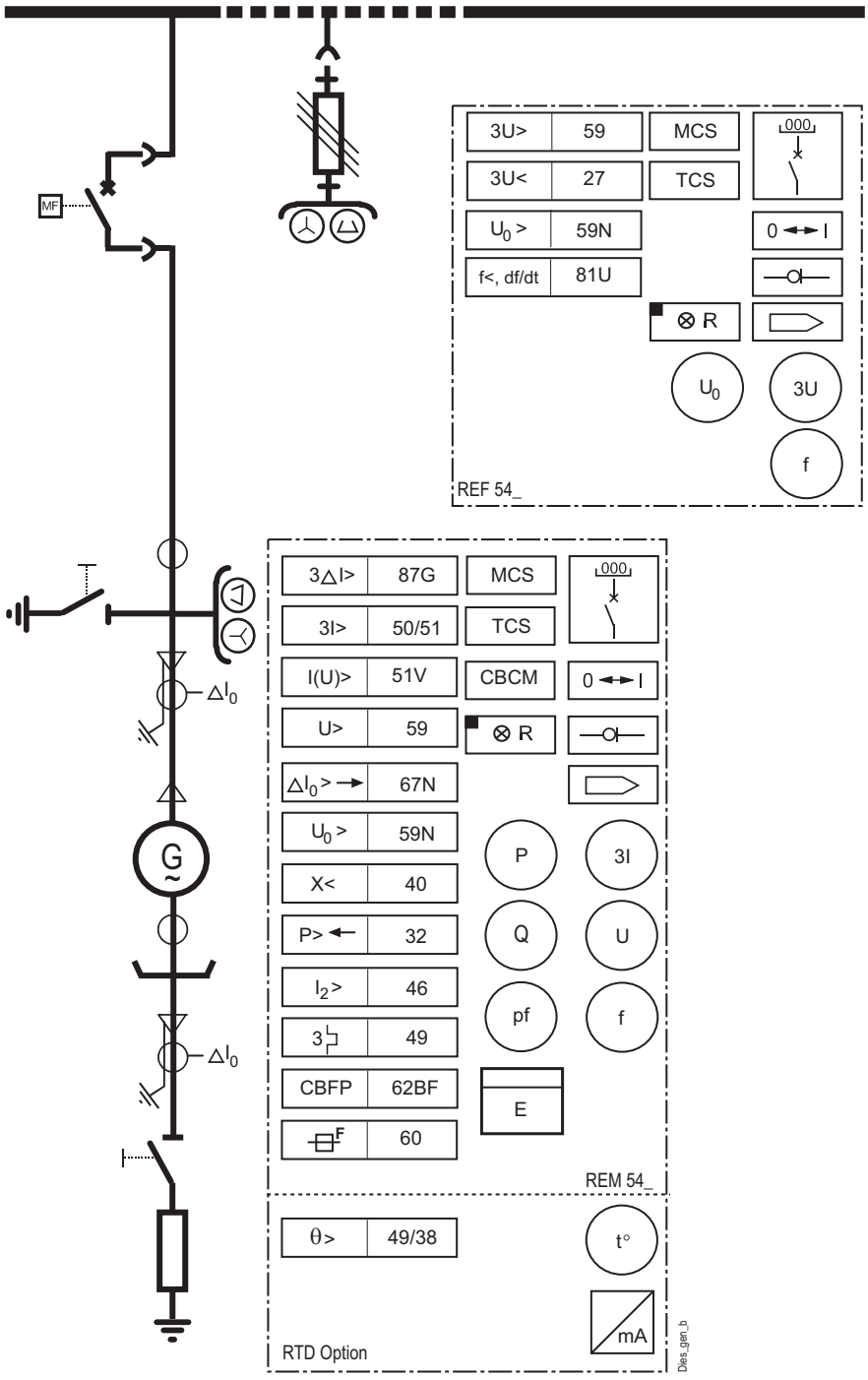


Fig. 8 Diesel generator application, several units in parallel connection, each unit individually earthed. Earth-fault current is small, typically 3-5 A.

Application examples
(cont´d)

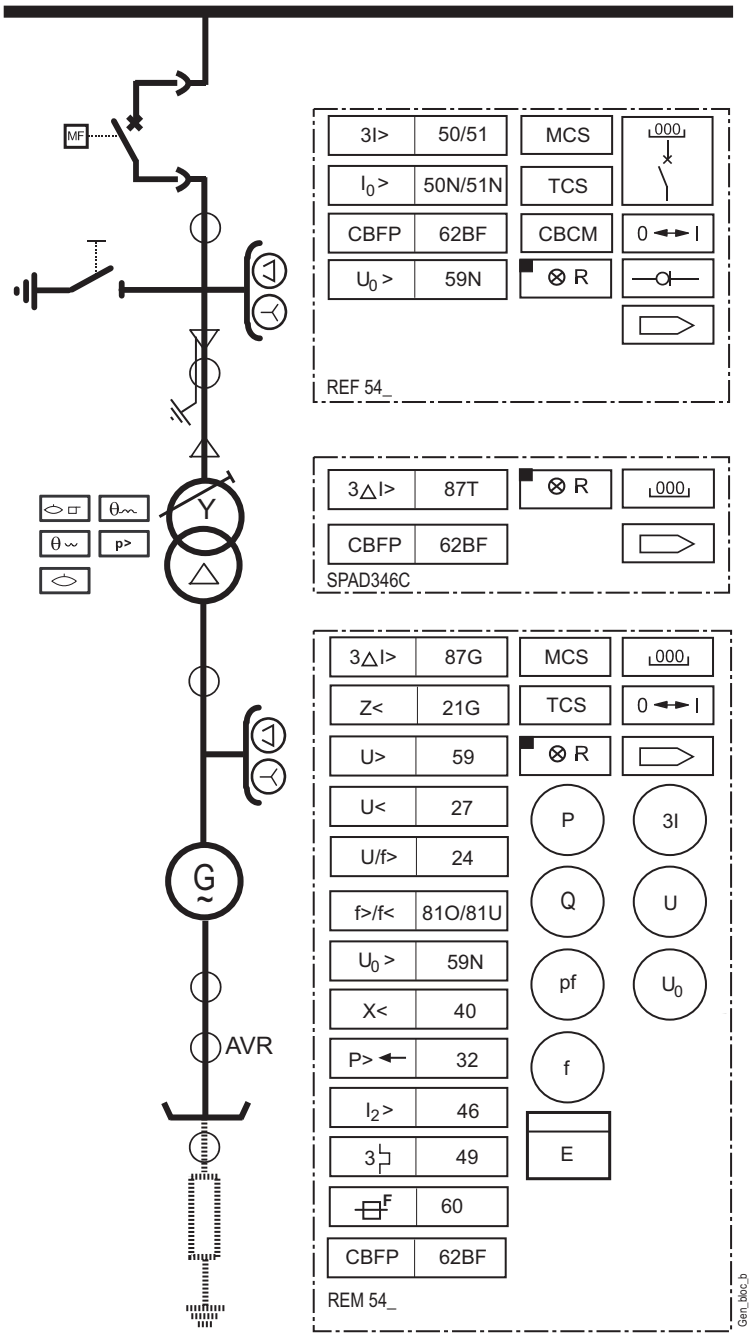


Fig. 9 Generator in block connection with a transformer. The stabilized transformer differential relay SPAD346C is used for overall differential protection. An earthing resistor is recommended.

Application examples
(cont´d)

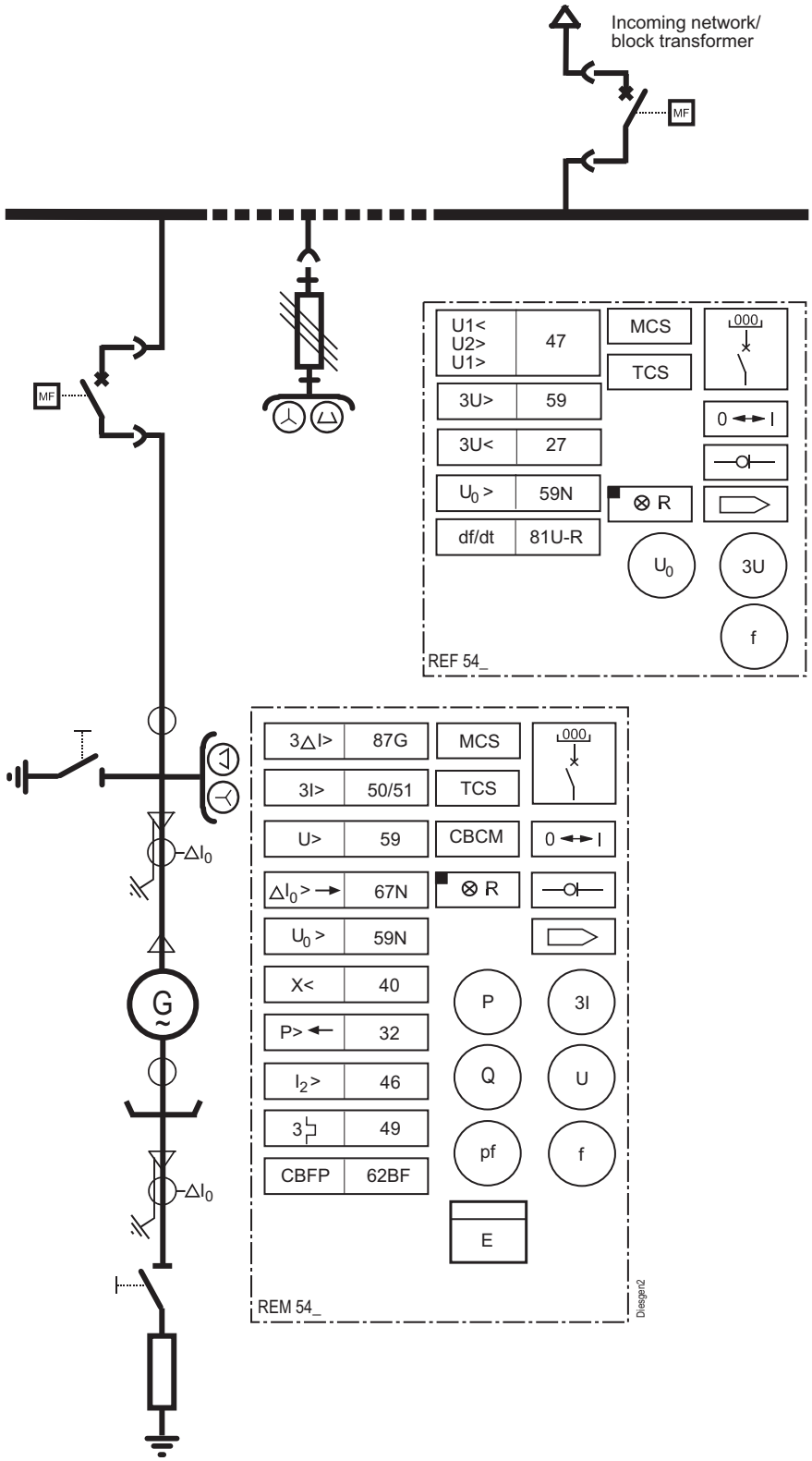


Fig. 10 Embedded power plant generator application, several units in parallel connection.

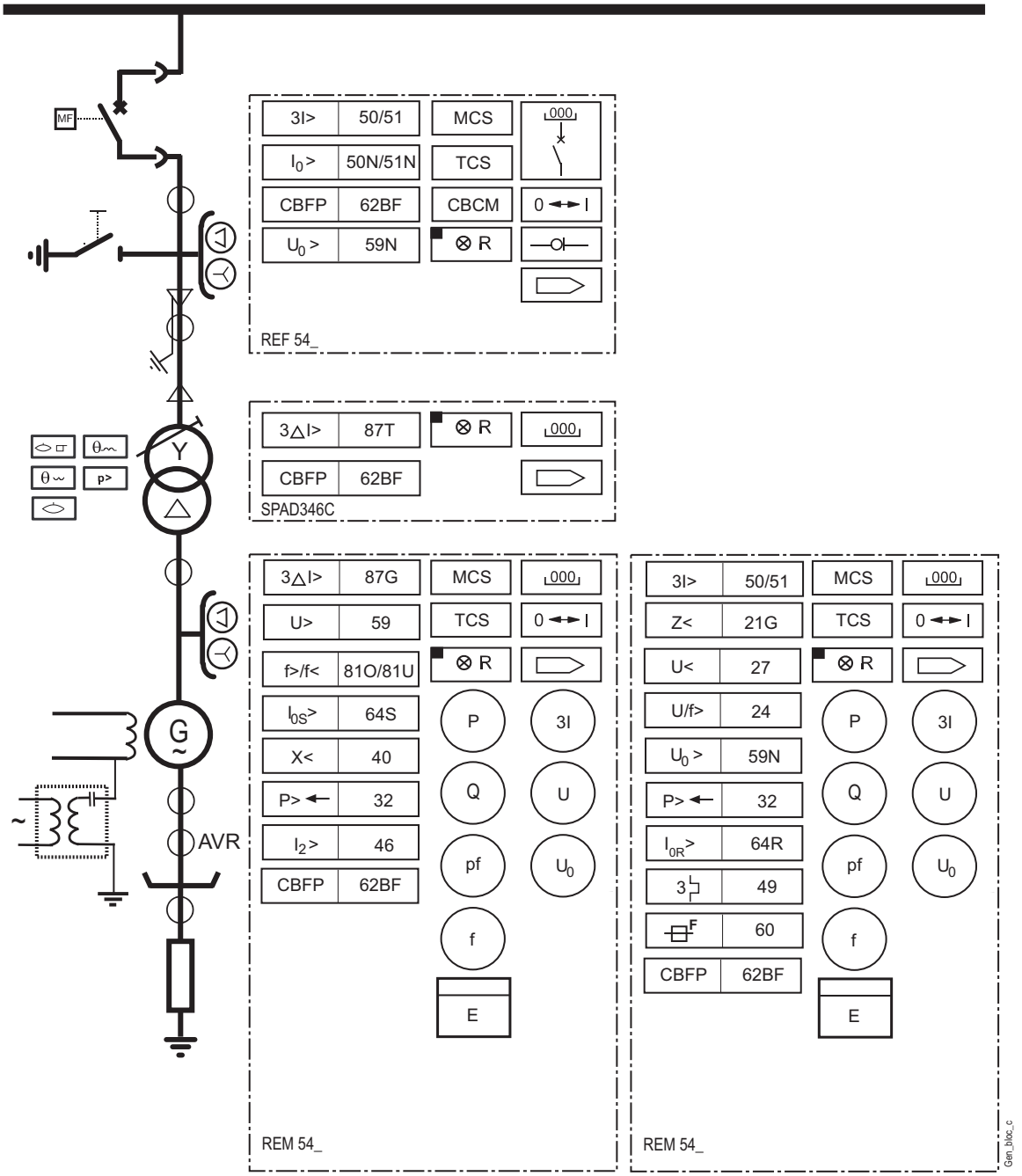


Fig. 11 Generator in block connection with a transformer. The stabilized transformer differential relay SPAD346C is used for overall differential protection. An earthing resistor is recommended. Functionality divided between two REM terminals.

Application examples (cont´d)

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⌙	49	= three-phase thermal overload protection for motors, generators and transformers (TOL3Dev)
3△I>	87T	= stabilized three-phase differential protection for transformers (function of SPAD 346C)
△I_0> →	67N	= directional differentially connected earth-fault protection, low-set, high-set and instantaneous stages available (DEF2_)
I_0> →	67N	= directional earth-fault protection, low-set, high-set and instantaneous stages available (DEF2_)
3△I>	87G	= stabilized three-phase differential protection for generators (Diff6G)
3△I>	87H/87M	= high-impedance or flux-balance based differential protection for generators and motors (Diff3)
3△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> ←	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

Application examples (cont´d)

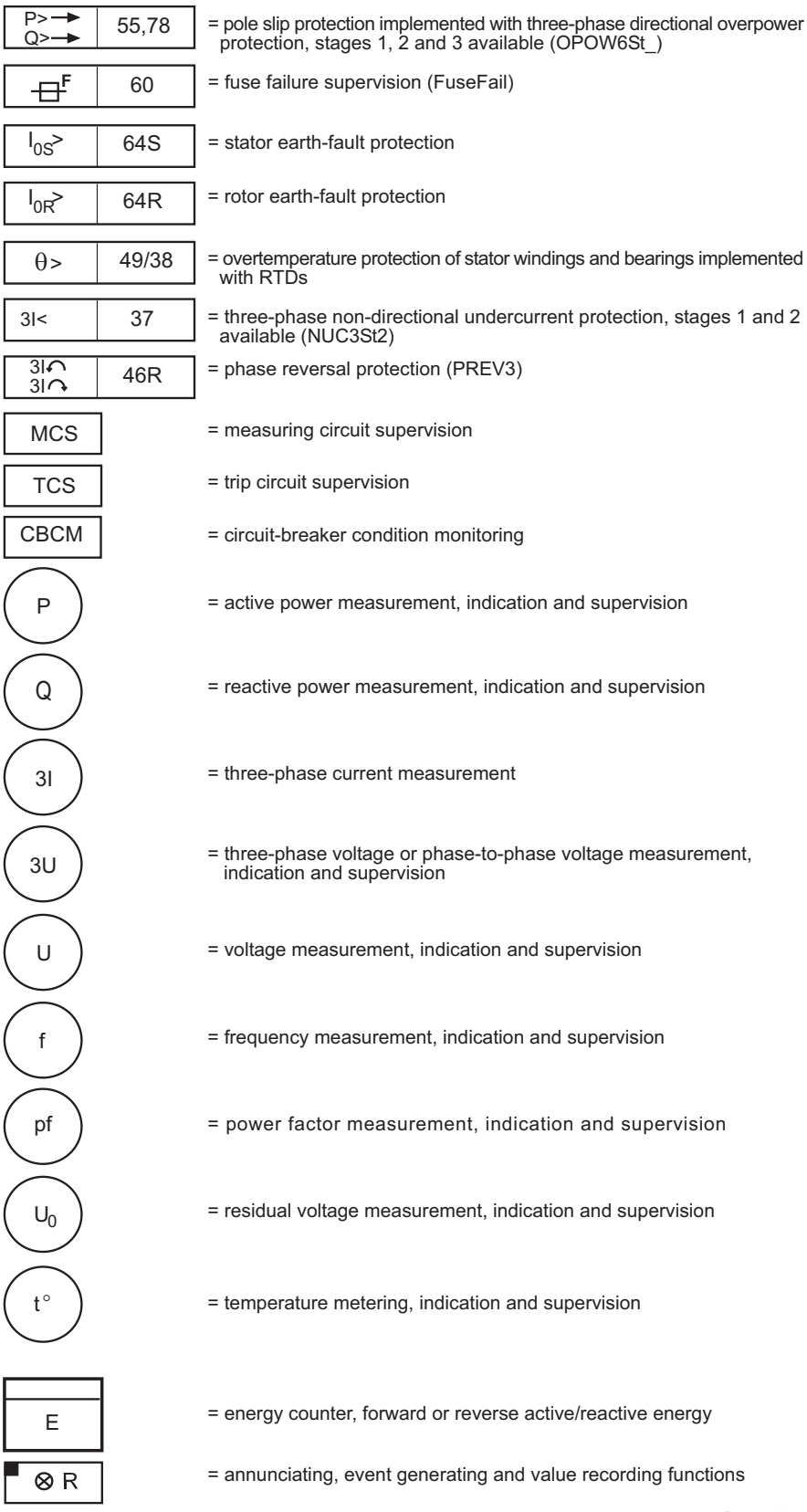


Fig. 13 Symbol notations, part II

Application examples (cont´d)

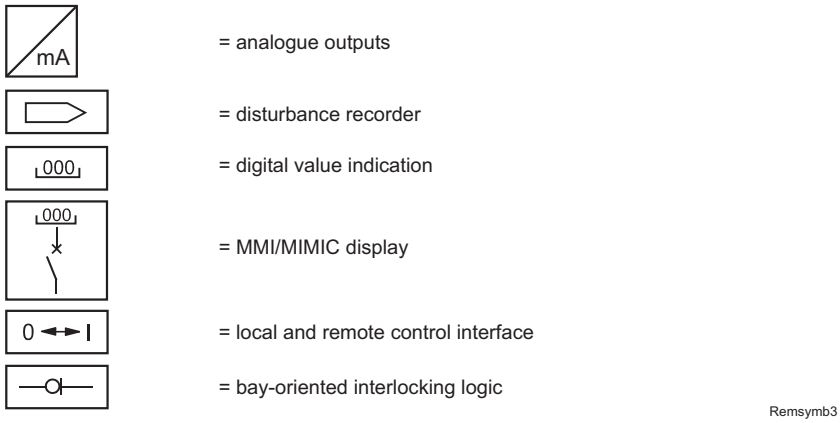


Fig. 14 Symbol notations, part III

Application examples (cont´d)

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
	67	3I> -->	Three-phase directional overcurrent, low-set stage	DOC6Low
		3I>> -->	Three-phase directional overcurrent, high-set stage	DOC6High
		3I>>> -->	Three-phase directional overcurrent, instantaneous stage	DOC6Inst
	51V	I(U)>	Voltage-dependent overcurrent, low-set stage	VOC6Low
		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
Earth faults	51N	I_0> / 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 > → / SEF	Directional earth-fault, low-set stage	DEF2Low
	67N	I_0>> →	Directional earth-fault, high-set stage	DEF2High
		I_0>>> →	Directional earth-fault, instantaneous stage	DEF2Inst
	87N	ΔI_0>, REF	High-impedance based restricted earth-fault	REF1A
	59N	U_0>	Residual overvoltage, low-set stage	ROV1Low
		U_0>>	Residual overvoltage, high-set stage	ROV1High
		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
		I_2>>	Negative-phase sequence, high-set stage	NPS3High

Application examples (cont´d)

Table 19: Protection functions

Types of fault	IEEE Device No.	IEC Symbol	Protection function	Function block code
Overvoltage/ undervoltage	59	3U>	Three-phase overvoltage, low-set stage	OV3Low
		3U>>	Three-phase overvoltage, high-set stage	OV3High
	27	3U<	Three-phase undervoltage, low-set stage	UV3Low
		3U<<	Three-phase undervoltage, high-set stage	UV3High
	27/ 47/ 59	U, <, U_2>, U_1>	Phase-sequence voltage protection, stage 1	PSV3St1
		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
		f</f>, df/dt	Underfrequency or overfrequency (incl. rate of change), stage 2	Freq1St2
		f</, df/dtf>	Underfrequency or overfrequency (incl. rate of change), stage 3	Freq1St3
		f</f>, df/dt	Underfrequency or overfrequency (incl. rate of change), stage 4	Freq1St4
		f</f>, df/dt	Underfrequency or overfrequency (incl. rate of change), stage 5	Freq1St5
	25	ΔU, Δf, $\Delta\varphi$	Synchro-check/voltage-check, stage 1	SCVCSt1
			Synchro-check/voltage-check, stage 2	SCVCSt2
Underexcitation / overexcitation	40	X<	Three-phase underexcitation protection, low-set stage	UE6Low
		X<<	Three-phase underexcitation protection, high-set stage	UE6High
	24	U/f>	Overexcitation, low-set stage	OE1Low
		U/f>>	Overexcitation, high-set stage	OE1High
Under-impedance	21G	Z<	Three-phase underimpedance protection, low-set stage	UI6Low
		Z<<	Three-phase underimpedance protection, high-set stage	UI6High
Overpower/underpower	32P / 32Q	P>$\rightarrow$/ Q>$\rightarrow$	Three-phase directional overpower, stage1	OPOW6St1
		P>$\rightarrow$/ Q>$\rightarrow$	Three-phase directional overpower, stage2	OPOW6St2
		P>$\rightarrow$/ Q>$\rightarrow$	Three-phase directional overpower, stage2	OPOW6St3
	32	P< /P>$\leftarrow$	Three-phase underpower or reverse power, stage 1	UPOW6St1
		P< /P>$\leftarrow$	Three-phase underpower or reverse power, stage 2	UPOW6St2
		P< /P>$\leftarrow$	Three-phase underpower or reverse power, stage 3	UPOW6St3

Application examples (cont´d)

Table 19: Protection functions

Types of fault	IEEE Device No.	IEC Symbol	Protection function	Function block code
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
		3I<	Three-phase non-directional undercurrent, stage 2	NUC3St2
	46R	3I↶, 3I↷	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
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

Application examples (cont´d)

Table 22: Control functions

Types of control	Symbol	Control function	Function block code
Circuit breaker	0 ↔ 1	Circuit breaker 1 (2 state inputs / 2 control outputs)	COCB1
	0 ↔ 1	Circuit breaker 2 (2 state inputs / 2 control outputs)	COCB2
	0 ↔ 1	Direct open for CBs via HMI	COCBDIR
Disconnector	0 ↔ 1	Disconnector 1...5 (2 state inputs / 2 control outputs)	CODC1... CODC5
	0 ↔ 1	Three state disconnector 1 (3 state inputs/ 4 control outputs)	CO3DC1
	0 ↔ 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 (HMI, remote)	MMIALAR1... MMIALAR8

References

Manuals for the REM 54 _

Installation Manual [1]	1MRS750526-MUM
Operator's Manual [1]	1MRS750500-MUM
Technical Reference Manual, General [1]	1MRS750915-MUM
Modbus Remote Communication Protocol for REM 54_ Technical Description	1MRS750781-MUM
Configuration Guideline [1]	1MRS750745-MUM
Technical Descriptions of Functions (CD-ROM)	1MRS750889-MCD
REM 543 Modbus Configurations (CD-ROM)[4]	1MRS752267-MCD

Parameter and event lists for the REM 54_

Parameter List for REM 543 and REM 545 [1]	1MRS751784-MTI
Event List for REM 543 and REM 545 [1]	1MRS751785-MTI

Manual for the fibre-optic interface module

Technical Description of the RER 103 [1]	1MRS750532-MUM
Technical Description of the RER 123 [1]	1MRS751143-MUM

Tool-specific manuals

CAP505 Installation and Commissioning Manual [2]	1MRS751273-MEN
CAP505 Operator's Manual [2]	1MRS751709-MUM
CAP501 Installation and Commissioning Manual [3]	1MRS751270-MEN
CAP501 Operator's Manual [3]	1MRS751271-MUM
Relay Configuration Tool, Quick Start Reference [2]	1MRS751275-MEN
Relay Configuration Tool, Tutorial [2]	1MRS751272-MEN
Relay Mimic Editor, Configuration Manual [2]	1MRS751274-MEN
Tools for Relays and Terminals, User's Guide	1MRS752008-MUM

[1] Included on the CD-ROM Technical Descriptions of Functions, 1MRS750889-MCD

[2] Included on the CD-ROM Relay Product Engineering Tools, 1MRS751788-MCD

[3] Included on the CD-ROM Relay Setting Tools, 1MRS751787-MCD

[4] Included when ordering the REM 543 with Modbus communication

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Distribution Automation
P.O. Box 699
FI-65101 Vaasa, FINLAND
Tel +358 10 22 11
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