# Transformer Terminal

## Buyer's Guide

# RET 541, RET 543, RET 545

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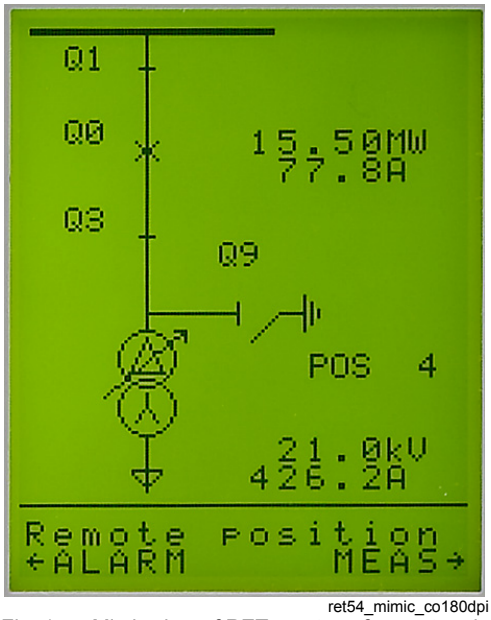
## Features

- Transformer terminal for protection, control, measurement and supervision of two-winding power transformers and generator-transformer blocks in distribution networks
- Designed to withstand harsh environments e.g. in heavy industry, marine and offshore applications
- Three-phase current differential protection with stabilized and instantaneous stages for fast and selective winding short-circuit and interturn fault protection as main protection
- Fast and reliable operation even with saturating CTs
- Numerical implementation of vector group matching allows wye-connection of measuring CTs as standard without interposing CTs, irrespective of transformer vector group
- Restricted earth-fault protection with the conventional high impedance principle or the stabilized numerical principle
- Three-phase overcurrent and earth-fault back-up protection with definite time and IDMT characteristics for both windings
- Thermal overload and negative phase sequence protection
- Additional protection functions available in the Multi –version terminal: overexcitation, overvoltage, undervoltage, residual overvoltage, directional overcurrent and earth-fault, overfrequency, underfrequency and underimpedance line back-up protection
- Large graphic display, either integrated or as an external module
- Control functions including local and remote control of switching objects, including object status indication and interlockings on bay and substation level
- Optional automatic on-load tap-changer control function for single or parallel transformers using the Master-Follower, Negative Reactance or Minimizing Circulating Current principles
- Supports several methods to interface tap-changer position information to differential protection and voltage regulator
- Measurement of two sets of three-phase currents, phase-to-phase or phase to neutral voltages, neutral current, residual voltage, frequency, power factor, active and reactive power and energy
- Condition monitoring including circuit-breaker condition monitoring, trip circuit supervision and internal self-supervision of the transformer terminal
- Extensive set of integrated communication protocols: SPA, LON, IEC 60870-5-103, Modbus RTU/ASCII, DNP 3.0
- Interface to Profibus DP and IEC 61850 based systems via adapters
- Part of ABB's substation automation system




ret54_mimic_co180dpi

Fig. 1 Mimic view of RET 54_ transformer terminal.

## Application

The RET 541/543/545 transformer terminals are designed to be used for the protection, control, measurement and supervision of two-winding power transformers and generator-transformer blocks in distribution networks. RET 54_ terminals can also be used in harsh environments e.g. in heavy industry, marine and offshore applications.

The main protection function is three-phase current differential protection with stabilized and instantaneous stages for fast and selective winding short-circuit and interturn protection. Besides 2nd and 5th harmonic restraints, the stabilized stage also includes a waveform recognition-based blocking-deblocking feature. Reliable operation even with partially saturated current transformers, that is, short operate times at faults occurring in the zone to be protected and high stability at external faults are achieved. Increased sensitivity can be obtained by automatic adaptation to the position changes of the on load tap changer. Interposing current transformers are not needed: Any vector group matching and CT ratio corrections in a wide range are numerically implemented as well as zero-sequence current elimination, which prevents unwanted trips at earth faults occurring outside the protected area.

In addition to the differential protection, the *Basic* version terminals incorporate the following protections: Restricted earth fault protection with stabilized numerical or high impedance principle, unbalance and thermal overload protections, three phase overcurrent and non-directional earth fault back-up protection with definite and IDMT characteristics on both sides of the transformer.

The *Multi*-version terminals, further including overvoltage and undervoltage, residual overvoltage, underfrequency and overfrequency, overexcitation, directional earth-fault, directional overcurrent and under-impedance line back-up protections fulfill the most demanding application requirements.

Enhanced with the optional automatic voltage regulation function, the RET 54_ terminal can be applied as a comprehensive integrated transformer management terminal. The voltage regulator can be applied for a single transformer or for parallel transformers with Master-Follower, Negative Reactance or Minimizing Circulating Current principles.

A special control version terminal with voltage regulator and control functions can be applied, when integration of voltage regulation and protection is not allowed.

The graphical configuration tool, based on the IEC 61131-3 standard, enables easy creation of application-specific configurations and MIMIC pictures corresponding to different switchgear systems. The process status is shown on a dynamic large graphical display. Detailed information, for instance, measured values, events and application-specific alarms, are presented in the display views.

The RET 54_ terminals can measure two sets of three phase currents, phase-to-phase or phase-to-earth voltages, neutral current, residual voltage, frequency and power factor. Active and reactive power is calculated from the measured currents and voltages. Energy can be calculated on the basis of the measured power. The measured values can be indicated locally and remotely as scaled primary values.

With the condition monitoring functions the RET 54_ transformer terminal monitors e.g. trip circuits, gas pressure of the breaker and breaker wear and provides scheduled time intervals for maintenance.

The RTD1 card, available as an option to the RET 541 and RET 543 terminals, provides versatile analog inputs enabling e.g. tap position supervision of the on load tap changer, RTD inputs for top and bottom oil temperature monitoring, and ambient temperature biasing for accurate thermal overload protection. The mA outputs allow transfer of any measurement data e.g. to PLCs.

By means of the graphic HMI display, the control functions in the transformer terminal indicate the position of disconnectors, circuit breakers and tap changer locally. Local control of these objects is possible via the push buttons on the front panel of the terminal. Furthermore, the terminal allows position information of the objects to be transmitted to the remote control system. Controllable objects, such as CBs, can also be opened and closed over the remote control system.

Supporting a wide range of communication protocols, including SPA, LON, IEC 60870-5-103, DNP 3.0 and Modbus RTU/ASCII, commonly used by utilities and industries, the terminals are flexibly integrated into different control systems. Connection to Profibus DP or IEC 61850 based system is possible via the interface adapters SPA-ZC 302 or SPA-ZC 400, respectively.

## Design

The transformer terminals RET 541, RET 543 and RET 545 differ from each other regarding the number of digital inputs and outputs available. Please, refer to section “Ordering” for more details.

The functions of the RET 54_ transformer terminal are categorized as:

- protection functions
- measurement functions
- control functions
- condition monitoring functions
- communication functions
- general functions
- standard functions

The functions are further divided to three subsets that correspond to different functionality levels, refer to section “Ordering Information”

**Protection functions**
Protection is one of the most important functions of the RET 54_ transformer terminal. The protection function blocks (e.g. NOC3Low) are independent of each other and have e.g. their own setting groups and data recording.

The protection function blocks are documented on the CD-ROM “Technical Descriptions of Functions” (1MRS750889-MCD)

**Measurement functions**
The measurement function blocks are documented on the CD-ROM “Technical Descriptions of Functions” (1MRS750889-MCD)

**Control functions**
The control functions are used to indicate the position of switching devices, i.e. circuit breakers and disconnectors, and to execute open and close commands for controllable switching devices in the switchgear. Furthermore, there are supplementary functions for control logic purposes, e.g. on/off switches, MIMIC alarm, LED control, numerical data for the MIMIC and logic controlled position selection.

The control functions configured using the Relay Configuration Tool can be associated with position indicators that are part of the MIMIC configuration picture displayed on the HMI. Position indicators are used to indicate the position of switching devices via the MIMIC picture and to control them locally.

The control function blocks are documented on the CD-ROM “Technical Descriptions of Functions” (1MRS750889-MCD)

**Condition monitoring functions**
The condition monitoring function blocks are documented on the CD-ROM “Technical Descriptions of Functions” (1MRS750889-MCD)

**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 RET 54_ transformer terminal provides the IEC_103, Modbus, DNP 3.0, SPA and LON serial communication protocols.

In a customer-specific transformer terminal configuration, special events can be generated via an EVENT230 event function. EVENT230 is documented on the CD-ROM “Technical descriptions of Functions” (1MRS750889-MCD).

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

The standard function blocks are documented on the CD-ROM “Technical descriptions of Functions” (1MRS750889-MCD).

**Other functions**

**Low auxiliary voltage indication**
The RET 54_ transformer 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 falls about 10% below the lowest rated DC input voltage of the power supply module.

Design (cont´d)

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

**Overtemperature indication**
The RET 54_ transformer 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°...+83°C). Overtemperature indication is available in the transformer terminal configuration and can be connected to any signal output of the RET 54_.

**Analog channels**
The transformer terminal measures the analog signals needed for protection, measuring, etc. via galvanically separated matching transformers.

RET 54_ transformer terminals have 9 analog channels. Furthermore, the transformer terminal includes virtual analog channels for calculating the residual current and residual voltage from phase currents and voltages. Both the amplitude and the phase angle are calculated for the virtual channels.

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.

Analog channels of the transformer terminal are configured with the CAP 505 Relay Product Engineering Tools.

A separate scaling factor can be set for each analog channel. The factors enable differences between the ratings of the protected unit and those of the measuring device (CT and VT ratio corrections). The setting value 1.00 means that the rated value of the protected unit is exactly the same as that of the measuring device.

**Digital inputs**
The digital inputs of the transformer terminals are voltage controlled and optically isolated with three treshold voltages defined by the order, see chapter “Ordering”. 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 can be set for each digital input separately.

Some specific digital inputs can be programmed to operate either as digital inputs, as pulse counters or as used for time synchronization. When a digital input operates as a pulse counter, pulse counting frequency can be up to100 Hz.

**Oscillation suppression**
The transformer 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. Event is generated in case oscillation is detected.

**Attributes of a digital input for transformer 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 transformer terminal configuration and can be used for various purposes.

**RTD/analog inputs**
The RET 541 and RET 543 transformer terminals equipped with an RTD/analog module (RTD1) have eight general purpose analog inputs for DC measurement. The RTD/analog inputs are galvanically isolated from the transformer terminal power supply and enclosure. However, the inputs have a common ground. The general purpose RTD/analog inputs accept voltage-, current- or resistance-type signals. For each measuring mode, a separate parameter is provided for choosing between the available measurement ranges. RTD/analog inputs can be applied for e.g. temperature measurement.

**Digital outputs**
The outputs of the transformer 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.

**Analog outputs**
The RET 541 and RET 543 transformer terminals equipped with an RTD/analog module have four general purpose 0...20 mA analog current outputs. All outputs are galvanically isolated from the supply and enclosure of the transformer terminal and from each other.

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

**Alarm LED indicators**
The transformer 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 flashflashing. Alarms can be acknowledged remotely, locally or by using logic of the transformer terminal.

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 bybass 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 transformer 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
- LED indicator for control 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 transformer terminal
- a button for remote/local control

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 transformer terminal programming. Unauthorized access can be prevented with passwords.

## Serial communication

The transformer terminal has three serial communication ports, one on the front panel and two 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 transformer terminal with the CAP 50_ tools. The front interface uses the SPA bus protocol.

**SPA/IEC_103/DNP 3.0/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 transformer terminal to the distribution automation system via the SPA bus, IEC_103, DNP 3.0 or Modbus. The fibre-optic interface module type RER 123 is used to connect the transformer terminal to the fibre-optic communication bus for SPA and

IEC_103 protocols. RS-485 interface module RER 133 is used to connect the transformer terminal to the RS-485 communication bus for DNP 3.0 and Modbus.

#### 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 transformer terminal to the substation automation system via the SPA bus or the LON bus. The fibre-optic interface module type RER 103 is used to connect the transformer terminal to the fibre-optic communication bus. The RER 103 module supports both SPA bus and LON bus communication. The SPA-ZC 302 is an interface module that provides connectivity to the Profibus DP fieldbus and SPA-ZC 400 interface module provides connectivity to the IEC 61850-8-1 Station bus.

#### Self-supervision

The transformer terminal RET 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 LON/SPA bus communication.

When a fault has been detected, the green Ready indicator starts flashing, a fault indication text is displayed on the HMI and an event 0/E57 is generated. The fault indication text on the HMI consists of two rows: a general message ‘internal fault’, followed by the generated IRF code of the fault.

The relay will try to recover from a fault either by restarting the module (I/O module or HMI) that reported the fault, or by restarting the whole relay. During restarting the IRF state will remain active until the internal self-supervision program has determined that the relay is operating normally. If the fault is still persistent after restarting three times, the relay will be in permanent IRF state.

## Transformer 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 RET 54_ transformer 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 a graphic function block diagram language by using the configuration software.

#### Mimic configuration with Relay Mimic Editor

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

All of the eight alarm function blocks can be configured in the same alarm view of the mimic editor. ON and OFF state texts (only one language version at a 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 flashing

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 transformer terminal units. Typically, LON horizontal communication is used for transferring object status data (open, close, undefined) between units for interlocking purposes. Additionally, LON horizontal communication is used to transfer measured current amplitude and phase angle information between terminals, when parallel control with MCC principle is to be applied.

#### DNP 3.0 and Modbus configuration

The Protocol Mapping Tool is used for configuring the DNP 3.0 and Modbus interfaces of the transformer terminal.

## Transformer terminal parameterization

The parameters of the transformer terminal units can be set either locally over the HMI or externally via the serial communication using the Relay Engineering Tools CAP 501/505.

**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 transformer terminals externally. The parameters can be set off-line on a PC and downloaded to the transformer 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 transformer terminal.

## Auxiliary voltage

For its operation, the RET 54_ terminal, including the external display module, requires a secured auxiliary voltage supply. The terminal's internal power supply module forms the voltages required by the 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 modules**
There are two basic types of power supply modules available for the RET 54_: type PS1/_ and type PS2/_. The operating range of digital inputs depends on the type of the power supply module. See Technical data.

## Terminal connections

All external circuits are connected to the terminal blocks on the rear panel, see figures 2...4. The terminal block for the measuring transformers consists of fixed screw terminals.

The serial interface RS-232 on the rear panel is used for connecting the transformer terminal to the SPA bus, the IEC_103, DNP 3.0 or Modbus. The SPA/IEC_103 is connected via a connection module type RER 123 fitted to the 9-pin D-type subminiature connector and screwed to the rear panel. DNP 3.0/Modbus is connected via a connection module, type RER 133.

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

The digital input and output contacts of the transformer terminal are connected to the multi-pole connectors.

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

### Terminal diagrams

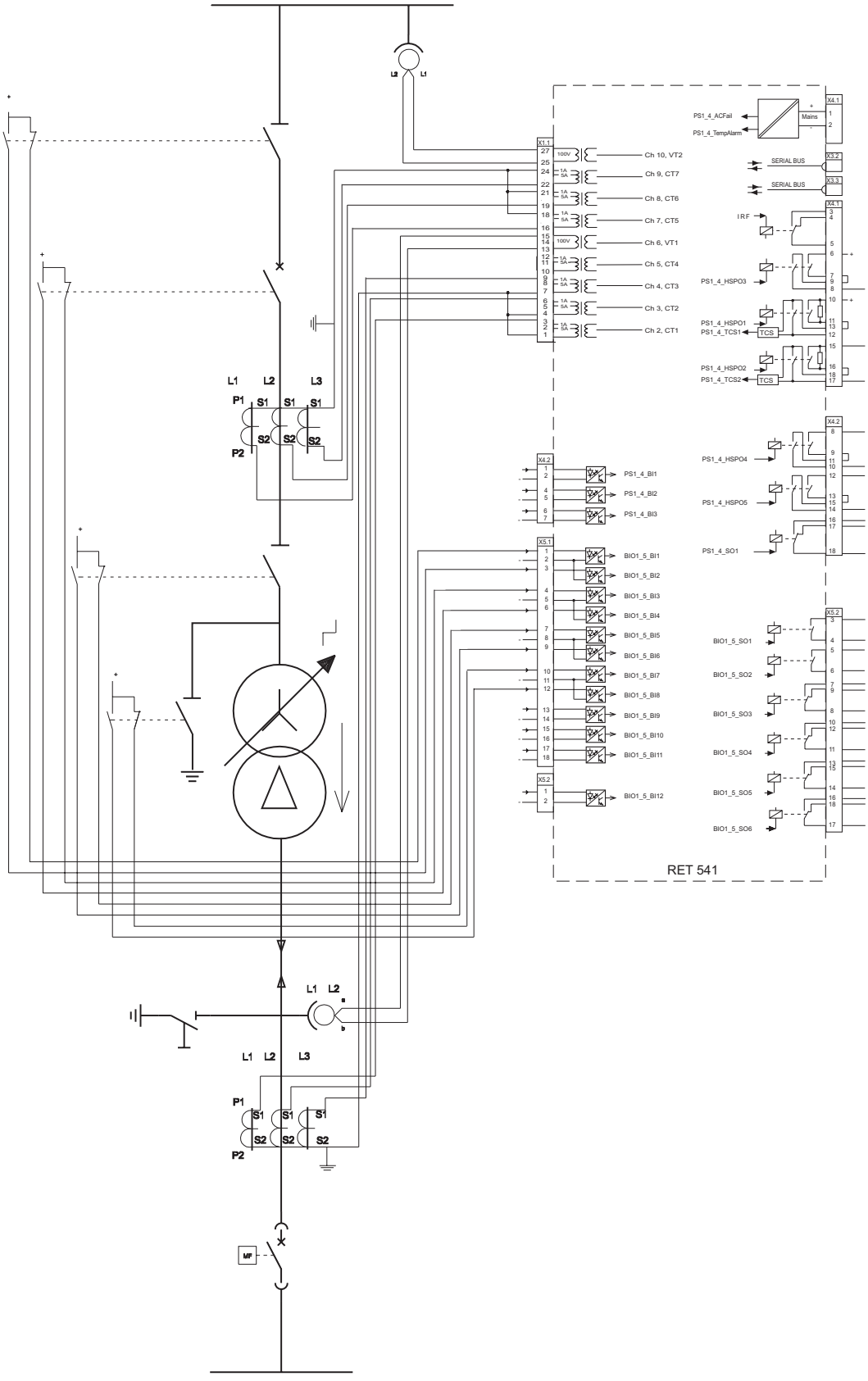



Fig. 2 Sample connection diagram of RET 541

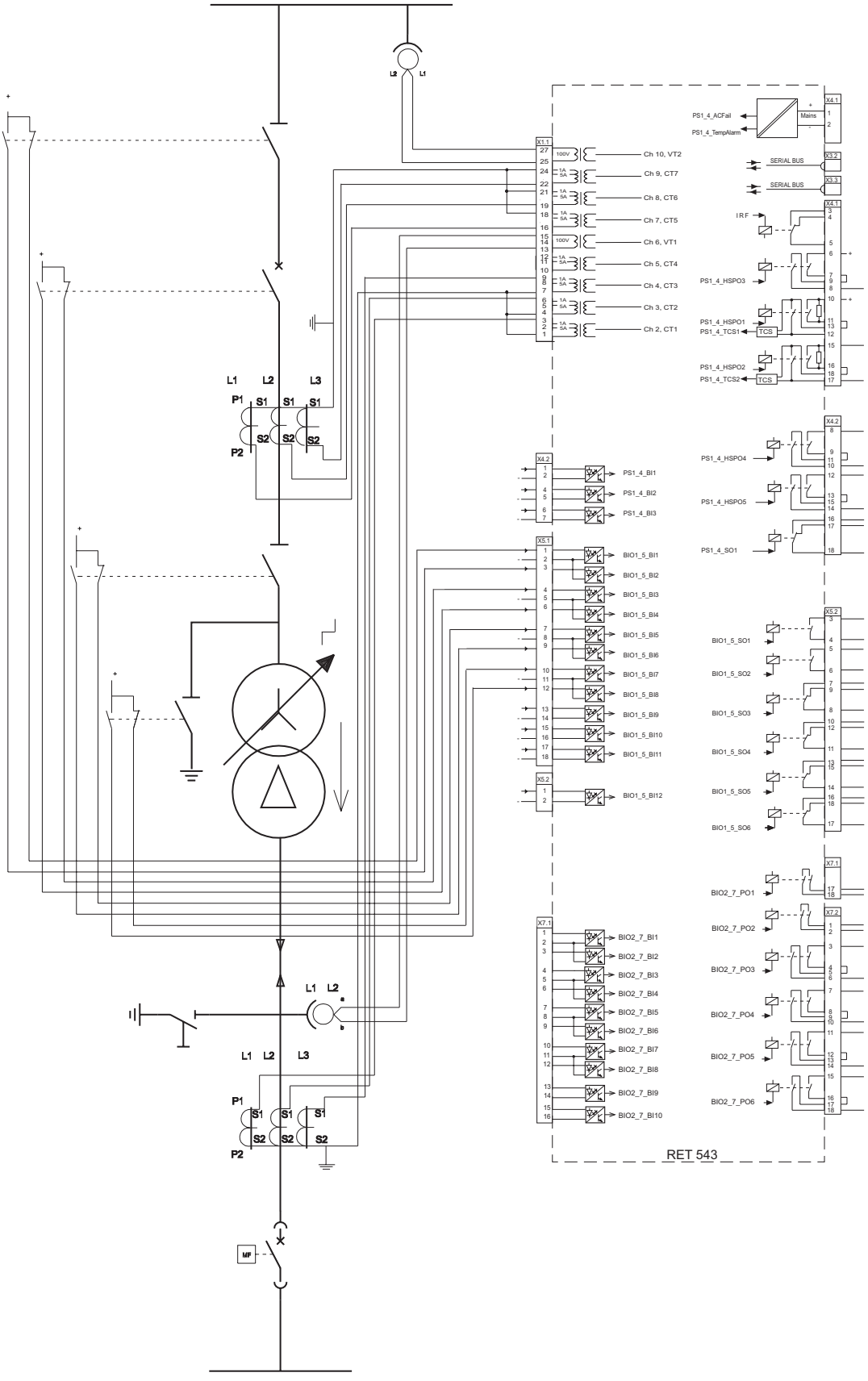



Fig. 3 Sample connection diagram of RET 543

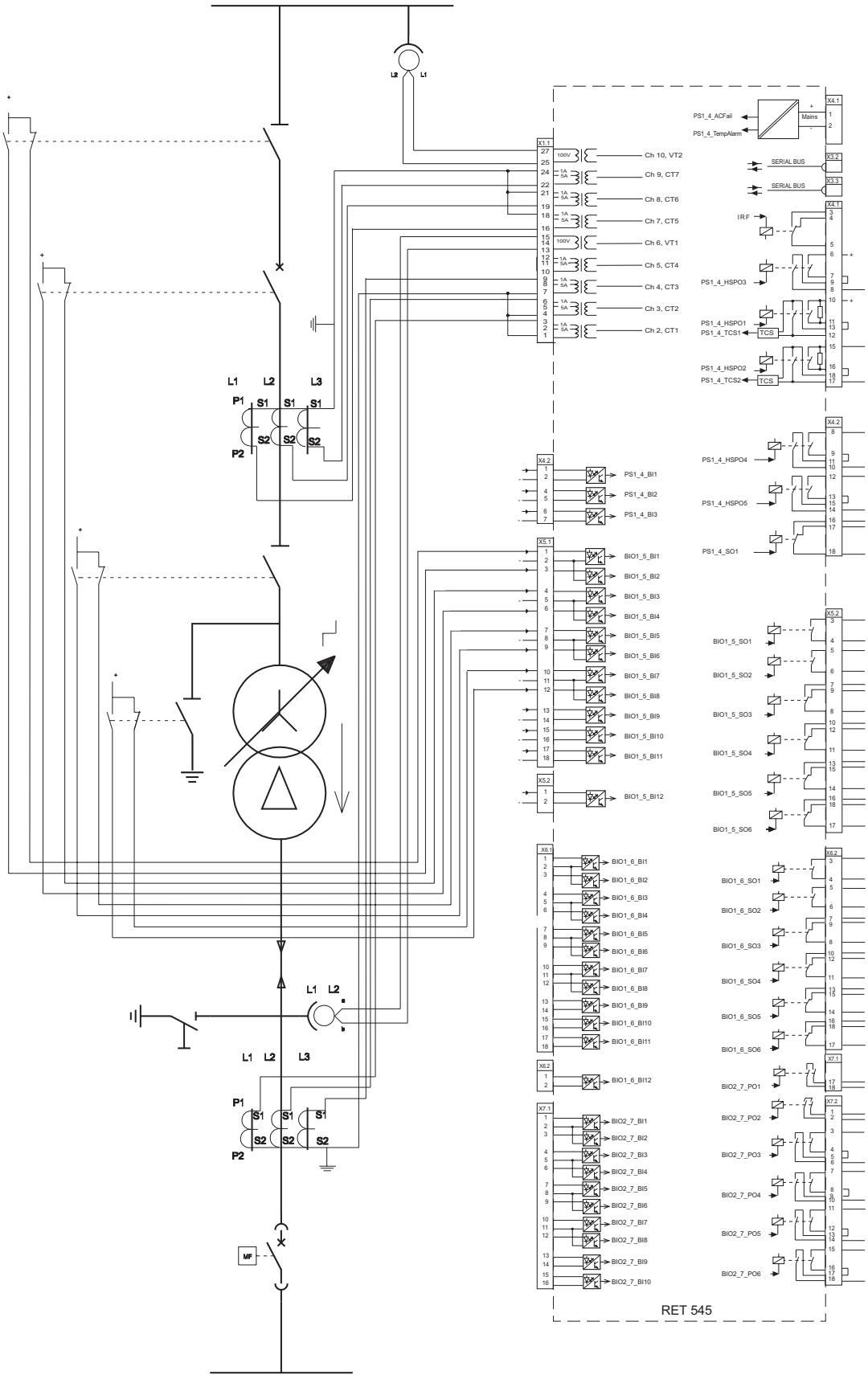



Fig. 4 Sample connection diagram of RET 545

## Technical data

**Table 1: General functions available for the RET 54_**

| Function | Description |
|---|---|
| INDRESET | Resetting of operation indicators, latched output signals, registers and waveforms i.e. the disturbance recorder |
| MMIWAKE | Activation of HMI backlight |
| SWGRP1 | Switchgroup SWGRP1 |
| SWGRP2 | Switchgroup SWGRP2 |
| SWGRP3 | Switchgroup SWGRP3 |
| ..... | |
| SWGRP20 | Switchgroup SWGRP20 |

**Table 2: Standard functions available for the RET 54_**

| Function | Description |
|---|---|
| ABS | Absolute value |
| ACOS | Principal arc cosine |
| ADD | Extensible adder |
| AND | Extensible AND connection |
| ASIN | Principal arc sine |
| ATAN | Principal arc tangent |
| BCD2INT | Type conversion from BCD coded input to SINT (Tap changer) |
| 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 from BOOL inputs to INT output |
| BYTE_TO_* | Type conversion from BYTE to WORD / DWORD |
| COMH | Hysteresis comparator |
| COS | Cosine in radians |
| CTD | Down-counter |
| CTUD | Up-down counter |
| CTU | Up-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 |
| GRAY2INT | Type conversion from GRAY coded input to SINT (Tap changer) |
| 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 |

**Table 2: Standard functions available for the RET 54_**

| Function | Description |
|---|---|
| MUL | Extensible multiplier |
| MUX | Extensible multiplexer |
| NAT2INT | Type conversion from natural binary coded input to SINT (Tap changer) |
| 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 |
| SHR | Bit-shift to right |
| SIN | Sine in radians |
| SINT_TO_* | Type conversion from SINT to REAL / INT / DINT |
| SUB | Subtractor |
| SQRT | Square root |
| SR | Set dominant bistable function block |
| XOR | Extensible exclusive OR connection |
| TAN | Tangent in radians |
| TIME_TO_* | Type conversion from TIME to UDINT / TOD / REAL |
| TOD_TO_* | Type conversion from TOD to UDINT / TIME / REAL |
| TOF | Off-delay timer |
| TON | On-delay timer |
| TP | Pulse |
| TRUNC_REAL_TO* | Truncation toward zero from REAL to DINT / INT / SINT / UDINT / UINT / USINT |
| 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: Conditioning monitoring functions available for the RET 54_**

| Function | 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 |
| 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 functions available for the RET 54_**

| Function | Description |
|---|---|
| CO3DC1 | Three-state disconnector 1 with indication |
| CO3DC2 | Three-state disconnector 2 with indication |
| COCB1 | Circuit breaker 1 control with indication |
| COCB2 | Circuit breaker 2 control with indication |
| COCBDIR | Direct open for CBs via HMI |
| CODC1 | Disconnector 1 control with indication |
| CODC2 | Disconnector 2 control with indication |
| CODC3 | Disconnector 3 control with indication |
| CODC4 | Disconnector 4 control with indication |
| CODC5 | Disconnector 5 control with indication |
| COIND1 | Switching device 1 indication |
| COIND2 | Switching device 2 indication |
| COIND3 | Switching device 3 indication |
| COIND4 | Switching device 4 indication |
| COIND5 | Switching device 5 indication |
| COIND6 | Switching device 6 indication |
| COIND7 | Switching device 7 indication |
| COIND8 | Switching device 8 indication |
| COLOCAT | Logic-controlled control position selector |
| COLTC | On-load tap changer controller (voltage regulator) |
| COSW1 | On/off switch 1 |
| COSW2 | On/off switch 2 |
| COSW3 | On/off switch 3 |
| COSW4 | On/off switch 4 |
| MMIALAR1 | Alarm channel 1, LED indicator |
| MMIALAR2 | Alarm channel 2, LED indicator |
| MMIALAR3 | Alarm channel 3, LED indicator |
| MMIALAR4 | Alarm channel 4, LED indicator |
| MMIALAR5 | Alarm channel 5, LED indicator |
| MMIALAR6 | Alarm channel 6, LED indicator |
| MMIALAR7 | Alarm channel 7, LED indicator |
| MMIALAR8 | Alarm channel 8, LED indicator |
| MMIDATA1 | MIMIC data monitoring point 1 |
| MMIDATA2 | MIMIC data monitoring point 2 |
| MMIDATA3 | MIMIC data monitoring point 3 |
| MMIDATA4 | MIMIC data monitoring point 4 |
| MMIDATA5 | MIMIC data monitoring point 5 |

### Table 5: On-load tap changer controller function block

| On load tap changer control function (voltage regulator), COLTC | |
|---|---|
| Reference voltage | 0.000 ... 2.000 xUn |
| Delay time for the 1st control pulse | 1.0 ... 300.0 s |
| Delay time for the 2nd control pulse | 1.0 ... 300.0 s |
| Resistive line-drop compens. factor (Ur) | 0.0 ... 25.0 %Un |
| Reactive line-drop compens. factor (Ux) | 0.0 ... 25.0 %Un |
| Load phase angle (in NRP mode) | -89 ... +89 deg |
| Stability factor in parallel operation | 0.0 ... 70.0 %Un |
| Operation mode | Not in use<br>Manual<br>Automatic single<br>Automatic master<br>Automatic follower<br>Negative Reactance Principle<br>Minimizing Circulating Current<br>Controlled via op.mode inputs |
| Delay mode | Definite time<br>Inverse time |
| Raise and lower pulse duration | 0.5 ... 10.0 s |
| Bandwith | 0.60 ... 9.00 %Un |
| Overcurrent blocking limit | 0.10 ... 5.00 xIn |
| Undervoltage blocking limit | 0.10 ... 1.20 xUn |
| Overvoltage blocking limit | 0.80 ... 1.60 xUn |
| High circ. current blocking limit | 0.10 ... 5.00 xIn |
| Max limit for LDC term | 0.00 ... 2.00 xUn |
| Reduce Set Voltage step | 0.00 ... 9.00 %Un |
| Max volt tap | -36 ... 36 |
| Min volt tap | -36 ... 36 |
| Max parallel trafos in MCC mode | 4 |
| Operation accuracies<br>- voltage measurement:<br><br><br>- operation time DT mode:<br>- operation time IDMT mode:<br><br>- lower and raise output pulse duration: | <br>Depends on the frequency of the voltage measured:<br>f/fn = 0.95 ... 1.05: ±1.0% of the set value or ±0.01xUn<br>±1% of the set value or ±250 ms<br>250ms and an inaccuracy which occurs when voltage varies ±0.5%<br>±100 ms |
| Reset ratio (hysteresis) | 20% of the set Bandwith |

### Table 6: Measurement function blocks

| General measurement/ analog input on RTD/analog 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/analog module. | |
| GE1…3 (V dc/ac)<br>General REAL type input | -10000.00000...10000.00000<br>-10000.00000...10000.00000 |

| Analog output on RTD/analog module, MEAO1...4 | |
|---|---|
| The analog 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/analog module. | |
| General REAL type input | -10000.00000...10000.00000 |

| Neutral current measurement, MECU1A and MECU1B | |
|---|---|
| Io (A)<br>Io (%) | 0.0…20000.0 A<br>0.0…80.0% In |

| **Three-phase current measurement, MECU3A and MECU3B** | |
|---|---|
| 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 analog 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 transformer terminals. Maximum 16 analog inputs and 16 logic signal inputs are available. One fundamental cycle contains 40 samples.

| | |
|---|---|
| Operation mode | Saturation<br>Overwrite<br>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
- 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 (60 Hz):

| # recordings \ # inputs | 1 | 3 | 10 |
|---|---|---|---|
| 1 | 1163 cyc.<br>23.3 s (19.4 s) | 412 cyc.<br>8.2 s (6.9 s) | 126 cyc.<br>2.5 s (2.1 s) |
| 5 | 232 cyc.<br>4.6 s (3.9 s) | 82 cyc.<br>1.6 s (1.4 s) | 25 cyc.<br>0.5 s (0.4 s) |
| 10 | 115 cyc.<br>2.3 s (1.9 s) | 41 cyc.<br>0.8 s (0.7 s) | 12 cyc.<br>0.24 s (0.2 s) |

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

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

| Residual voltage measurement, MEVO1A and MEVO1B | |
|---|---|
| Uo | 0…150000 V |
| Uo | 0.0…120.0% Un |

| Three-phase voltage measurement, MEVO3A and MEVO3B | |
|---|---|
| UL1_U12 | 0.00…999.99 kV |
| UL2_U23 | 0.00…999.99 kV |
| UL3_U31 | 0.00…999.99 kV |
| UL1_U12 | 0.00…2.00 x Un |
| UL2_U23 | 0.00…2.00 x Un |
| UL3_U31 | 0.00…2.00 x Un |
| UL1_U12 average | 0.00…999.99 kV |
| UL2_U23 average | 0.00…999.99 kV |
| UL3_U31 average | 0.00…999.99 kV |
| UL1_U12 average | 0.00…2.00 x Un |
| UL2_U23 average | 0.00…2.00 x Un |
| UL3_U31 average | 0.00…2.00 x Un |

## Table 7: Protection function blocks

| **Three-phase non-directional overcurrent protection, low-set stages, NOC3Low, 3I>, NOC3LowB,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<br>Definite time<br>Extremely inverse<br>Very inverse<br>Normal inverse<br>Long time inverse<br>RI-type inverse<br>RD-type inverse<br>IEEE curves |
| Measuring mode | Peak-to-peak<br>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<br>Definite time<br>Instantaneous |
| Measuring mode | Peak-to-peak<br>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<br>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 |

| **Three-phase directional overcurrent function, low-set stage, DOC6Low, I>→** | |
|---|---|
| Operation mode | Not in use<br>Definite time<br>Extremely inverse<br>Very inverse<br>Normal inverse<br>Long-time inverse<br>RI-type inverse<br>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 $\varphi_b$ | 0…90° |
| Operation direction | Forward<br>Reverse |
| Earth-fault protection | Disabled<br>Enabled |
| Measuring mode | Phase-to-phase voltages, peak-to-peak measurement<br>Phase-to-phase voltages, fundamental freq. measurement<br>Phase-to-earth voltages, peak-to-peak measurement<br>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<br>0.1...10 x In: ±2.5% of set value or ±0.01 x In<br>10...40 x In: ±5.0% of set value<br>±2.5% of measured voltage or ±0.01 x Un<br>±2° |
| Start time:<br>- injected currents<br>- internal time<br>- total time | <br>>2.0 x start current:<br><42 ms<br><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<br>Definite time<br>Instantaneous |
| Start current | 0.05…40.00 x In |
| Operate time | 0.05…300.00 s |
| Basic angle $\varphi_b$ | 0…90° |
| Operation direction | Forward<br>Reverse |
| Earth-fault protection | Disabled<br>Enabled |
| Non-directional operation (when the direction cannot be determined) | Disabled<br>Enabled |
| Measuring mode | Phase-to-phase voltages, peak-to-peak measurement<br>Phase-to-phase voltages, fundamental freq. measurement<br>Phase-to-earth voltages, peak-to-peak measurement<br>Phase-to-earth voltages, fundamental freq. measurement |
| 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<br>10...40 x In: ±5.0% of set value<br>±2.5% of measured voltage or ±0.01 x Un<br>±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 |

| **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<br>7 selections for ph-ph voltages<br>(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 and instantaneous differential protection for transformers, Diff6T, 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 | 0.5 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°<br>Stabilized stage: ±4% of set value or ±2% x In<br>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 | 0.98 |
| Retardation time | < 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<br>Definite time<br>Extremely inverse<br>Very inverse<br>Normal inverse<br>Long time inverse<br>RI-type inverse<br>RD-type inverse<br>IEEE curves |
| Measuring mode | Peak-to-peak<br>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 |

| **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<br>Definite time<br>Instantaneous |
| Measuring mode | Peak-to-peak<br>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 |

| **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<br>Definite time<br>Extremely inverse<br>Very inverse<br>Normal inverse<br>Long time inverse |
| Operation criteria | Basic angle & Uo<br>Basic angle<br>IoSin/Cos & Uo<br>IoSin/Cos<br>Non-directional Io<br>Non-directional Uo |
| Operation direction | Forward<br>Reverse |
| Basic angle $\varphi_b$ | -90°<br>-60°<br>-30°<br>0° |
| Operation characteristic | IoSin(φ)<br>IoCos(φ) |
| Intermittent E/F | Not active<br>Active |
| Measuring mode | Peak-to-peak<br>Fundamental frequency |
| Drop-off time of the operate time counter | 0...1000 ms |
| Operation accuracy | Note! The values below apply when f/fn = 0.95...1.05<br>±2.5% of set value + 0.0005 x In<br>±2.5% of set value or + 0.01 x Un<br>Phase angle ±2° |
| Start time:<br>- Injected neutral current and residual voltage | <br>>2.0 x start current and<br>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 |

| **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 $\varphi_b$ | -90° |
| | -60° |
| | -30° |
| | 0° |
| Operation characteristic | IoSin($\varphi$) |
| | IoCos($\varphi$) |
| Intermittent E/F | Not active |
| | Active |
| Measuring mode | Peak-to-peak |
| | Fundamental frequency |
| Drop-off time of the operate time counter | 0...1000 ms |
| | 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 and residual voltage | 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 |

| **High-impedance based restricted earth-fault protection, REF1A, $\Delta I_0$>** | |
|---|---|
| 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 |

| **Stabilized restricted earth-fault protection, REF4A, $\Delta I_0>$ and REF4B, $\Delta I_0>$** | |
|---|---|
| Basic setting | 0.5...50% |
| Operate time | 0.04...300.00 s |
| Ratio I2f/I1f> | 10...50 % |
| 2nd harmonic blocking | Not in use / In use |
| | Note! The values below apply when f/fn = 0.95...1.05 |
| Operation accuracy of differential current measurement | ±4% of set value or ±0.02 x In |
| Operation accuracy of phase angle measurement | ±2% |
| Start time: | |
| -injected currents | ≥2.0 x operating current: |
| - internal time | <30 ms |
| - total time | <40 ms |
| Reset time | 40...1000 ms (depends on the minimum pulse width set for the trip output) |
| Reset ratio, typically | 0.98 (0.90...0.98) |
| Retardation time (Total retardation time when the current drops below the start value) | <50 ms |
| Operation time accuracy at definite time mode | ±2% of set value or ±20 ms |

| **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<br>Definite time |
| Measuring mode | Peak-to-peak<br>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<br>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<br>Definite time |
| Measuring mode | Peak-to-peak<br>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<br>Total time when voltage drops below start value: < 50 ms |
| Operate time accuracy at DT mode | ±2% of set value or ±20 ms |

| **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<br>Motor; through-ventilated, rated power > 1500 kW<br>Motor; surface cooling, rated power < 500 kW<br>Motor; surface cooling, rated power > 500 kW<br>Generator; hydro or small air-cooled turbine generators<br>Generator; large turbine generators<br>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 | 0.0...350.0 °C |
| Maximum temperature of stator | 0.0...350.0 °C |
| Short time-constant for rotor | 0.0...999.0 min |
| Long time-constant for rotor | 0.0...999.0 min |
| Weighting factor of the short time-constant for rotor | 0.00...1.00 |
| Temperature rise of rotor at rated current | 0.0...350.0 °C |
| Maximum temperature of rotor | 0.0...350.0 °C |
| Operation mode (principle of ambient temperature compensation) | Not in use<br>No sensors; the set ambient temperature<br>1 sensor used<br>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 |
| | Note! The values below apply when f/fn = 0.95...1.05 |
| Operation accuracy | ±1.0%, I = 0.1...10.0 x In |
| Reset ratio: | |
| - trip | (Calculated temp. rise - 0.1) / Trip temperature |
| - start | (Calculated temp. rise - 0.1) / Prior alarm temperature |
| - restart | (Calculated temp. rise - 0.1) / Restart inhibit temperature limit |

| **Negative phase-sequence protection, low-set stage, NPS3Low, $I_2$>, and high-set stage, NPS3High, $I_2$>>** | |
|---|---|
| Operation mode | Not in use<br>Definite time<br>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<br>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<br>Definite time<br>A curve<br>B curve |
| Measuring mode | Phase-to-phase voltages; peak-to-peak measurement<br>Phase-to-phase voltages; fundamental freq. measurement<br>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 |

| 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<br>Definite time |
| Measuring mode | Phase-to-phase voltages; peak-to-peak measurement<br>Phase-to-phase voltages; fundamental freq. measurement<br>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<br>Definite time<br>C curve |
| Measuring mode | Phase-to-phase voltages; peak-to-peak measurement<br>Phase-to-phase voltages; fundamental freq. measurement<br>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<br>Definite time |
| Measuring mode | Phase-to-phase voltages; peak-to-peak measurement<br>Phase-to-phase voltages; fundamental freq. measurement<br>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 |

| 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> |
| Rotation direction 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-sequency voltage | = 1.1 x start value |
| - internal time | <42 ms |
| - total time | <50 ms |
| Trip time, U1< operation: | |
| - injected positive-sequency voltage | = 0.50 x start value |
| - internal time | <32 ms |
| - total time | <40 ms |
| Trip time, U1> operation: | |
| - Injected positive-sequency 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<br>U1< operation: 1.04<br>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<br>f</f> 1 timer<br>f</f> 2 timers<br>f</f> OR df/dt><br>f</f> AND df/dt><br>f</f> OR df/dt<<br>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 |

| 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% |

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

| Fuse failure supervision, FuseFail, FUSEF | |
|---|---|
| Ratio U2/U1><br>Ratio I2/I1< | 10...50%<br>10...50% |
| Operation accuracy:<br>- when f/fn = 0.98...1.02:<br>- when f/fn = 0.95...1.05:<br>- injected negative-sequence voltage<br>BSOUT activation time:<br>- f/fn=0.98...1.02<br>Reset time<br>Reset ratio:<br>- for Ratio U2/U1><br>- for Ratio I2/I1< | <br>±2.0 percentage units (of settings Ratio U2/U1> and Ratio I2/I1<)<br>±4.0 percentage units (of settings Ratio U2/U1> and Ratio I2/I1<)<br>= 2.00 x Ratio U2/U1><br><br>< 35 ms (within the same task and when the task interval is 10 ms)<br>20 ms (within the same task)<br><br>0.8...0.96<br>1.04...1.2 |

### Table 8: 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 (parameterization) | | 100 V/110 V/115 V/120 V |
| | voltage withstand, continuously | | 2 x $U_n$ (240 V) |
| | burden at rated voltage | | <0.5 VA |

### Table 9: Auxiliary power supplies

| Type | PS1/240V (RET 541, RET 543) | PS2/240V (RET 545 only) | External display module | PS1/48V (RET 541, RET 543) | PS2/48V (RET 545 only) |
|---|---|---|---|---|---|
| Input voltage, ac | 110/120/220/240 V | | | - | |
| Input voltage, dc | 110/125/220 V | | | 24/48/60 V | |
| Voltage variation | 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 | <40 ms, 110 V and <100 ms, 200 V | | | <60 ms, 48 V and <100 ms, 60 V | |
| Internal overtemperature indication | +78°C (+75…+83°C) | | | | |

### Table 10: Digital inputs

| | | | |
|---|---|---|---|
| Power supply version | PS1/240 V (High) | PS1/240 V (Medium), PS2/240 V | PS1/48 V (Low), PS2/48V |
| Input voltage, dc | 220 V | 110/125/220 V | 24/48/60/110/125/ 220 V |
| Nominal treshold voltage, dc<br>- operating range, dc | 155 V<br>155…265 V | 80 V<br>80...265 V | 18 V<br>18...265 V |
| Current drain | ~2…25 mA | | |
| Power consumption/input | <0.8 W | | |
| Pulse counting (specific digital inputs), frequency range | 0…100 Hz | | |
| Time synchronization (specific digital inputs) synchronization rate | once per minute or once per second | | |

### Table 11: RTD/analog inputs

| | | |
|---|---|---|
| Supported RTD sensors | 100 Ω Platinum | TCR 0.00385 (DIN 43760) |
| | 250 Ω Platinum | TCR 0.00385 |
| | 1000 Ω Platinum | TCR 0.00385 |
| | 100 Ω Nickel | TCR 0.00618 (DIN 43760) |
| | 120 Ω Nickel | TCR 0.00618 |
| | 250 Ω Nickel | TCR 0.00618 |
| | 1000 Ω Nickel | TCR 0.00618 |
| | 10 Ω Copper | TCR 0.00427 |
| | 120 Ω Nickel | TCR 0.00672 (MIL-T-24388C) |
| Max lead resistance (three-wire measurement) | 200 Ω per lead | |
| Accuracy | ±0.5% of full scale<br>±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<br>6.2 mA RMS for 10 Ω Copper | |
| Current input impedance | 274 Ω ±0.1% | |

### Table 12: Analog 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 13: 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 14: Power outputs

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

### Table 15: 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 |
| Dry cold test | | according to IEC 60068-2-1 |
| Damp heat test, cyclic | | according to IEC 60068-2-30<br>r.h. = 95%, T = 20°…55°C |
| Storage temperature tests | | according to IEC 60068-2-48 |

### Table 16: Standard tests

| | | | |
|---|---|---|---|
| Insulation tests | Dielectric test<br>IEC 60255-5 | Test voltage | 2 kV, 50 Hz, 1 min. |
| | Impulse voltage test<br>IEC 60255-5 | Test voltage | 5 kV, unipolar impulses, waveform 1.2/50 μs, source energy 0.5 J |
| | Insulation resistance measurements<br>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 test | | IEC 60255-21-3, class 2 |

### Table 17: 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 IEC 60255-22-2 | for contact discharge | 6 kV |
| | for air discharge | 8 kV |
| Radio frequency interference test | conducted, common mode<br>IEC 61000-4-6 | 10 V (rms), f = 150 kHz…80 MHz |
| | radiated, amplitude-modulated<br>IEC 61000-4-3 | 10 V/m (rms),<br>f = 80…1000 MHz |
| | radiated, pulse-modulated<br>ENV 50204 | 10 V/m, f = 900 MHz |
| | radiated, test with a portable transmitter<br>IEC 60255-22-3, method C | f = 77.2 MHz, P = 6 W;<br>f = 172.25 MHz, P = 5 W |

### Table 17: Electromagnetic compatibility tests

| | | |
|---|---|---|
| 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<br>2 kV, differential mode |
| | I/O ports | 2 kV, common mode<br>1 kV, differential mode |
| Power frequency (50 Hz) magnetic field, IEC 61000-4-8 | 100 A/m | |
| Voltage dips and short interruptions, IEC 61000-4-11 | 30%, 10 ms<br>>90%, 5000 ms | |
| Electromagnetic emission tests EN 55011 and EN 50081-2 | conducted RF emission (mains terminal) | EN 55011, class A |
| | radiated RF emission | EN 55011, class A |
| CE approval | Complies with the EMC directive 89/336/EEC and the LV directive 73/23/EEC | |

### Table 18: Data communication

| | | |
|---|---|---|
| Rear interface, connector X3.1 | not used, reserved for future purposes | |
| Rear interface, connector X3.2 | RS-232 connection | |
| | the fibre-optic interface module RER 123 for SPA and IEC_103 | |
| | protocol | SPA, IEC_103 |
| | RS-485 connection | |
| | the RS-485 interface module RER 133 for DNP 3.0 and Modbus | |
| | protocol | DNP 3.0, Modbus |
| | data transfer rates | DNP 3.0 and Modbus:<br>300 bps...19.2 kbps, selectable |
| Rear interface, connector X3.3 | RS-485 connection | |
| | LON bus or SPA bus, selectable | |
| | the fibre-optic interface module RER 103 is needed for galvanic isolation | |
| | data transfer rates | SPA bus: 4.8/9.6/19.2 kbps<br>LON bus: 78.0 kbps/1.2 Mbps |
| | protocol | SPA, LON |
| Rear interface, connector X3.4 | RJ45 connection | |
| | galvanically isolated RJ45 connection for an external display module | |
| | communication cable | 1MRS 120511.001 (1 m)<br>1MRS 120511.003 (3 m) |
| Front panel | optical connection | |
| | protocol | SPA |
| | serial communication cable | 1MRS 120511.001 (1 m) |
| SPA protocol | baud rates | 4.8/9.6/19.2 kbps |
| | start bits | 1 |
| | data bits | 7 |
| | parity | even |
| | stop bits | 1 |
| LON protocol | bit rates | 78.0 kbps/1.2 Mbps |
| IEC_103 protocol | baud rates | 9.6/19.2 kbps |
| | data bits | 8 |
| | parity | even |
| | stop bits | 1 |
| DNP 3.0 | bit rates | 300, 600, 1200, 2400, 4800, 9600, 19200 bps |
| | data bits | 8 |
| | stop bits | 1, 2 |
| | parity | none, odd, even |

**Table 18: Data communication**

| | | |
|---|---|---|
| Modbus RTU/ASCII | bit rates | 300, 600, 1200, 2400, 4800, 9600, 19200 bps |
| | data bits | 5, 6, 7, 8 |
| | stop bits | 1, 2 |
| | parity | none, odd, even |

**Table 19: General**

| | | |
|---|---|---|
| Toolboxes | CAP 501<br>CAP 505<br>LNT 505 | |
| Event recording | all events are recorded in higher level syntax: reason, time, date<br>the last 100 events are recorded | |
| Data recording | records operate values | |
| Protection functions<br>Control functions<br>Condition monitoring functions<br>Measurement functions | see Technical Descriptions of Functions, CD-ROM (1MRS 750889-MCD) | |
| Self-supervision | RAMs<br>ROMs<br>EEPROMs<br>all analog reference voltages<br>automatic test sequences for I/Os and HMI modules<br>output contact condition monitoring (all contacts) | |
| Mechanical dimensions | Width: 223.7 mm (1/2 of a 19” rack)<br>Height, frame: 265.9 mm (6U)<br>Height, box: 249.8 mm<br>Depth: 235 mm | |
| | External display module | Width: 223.7 mm<br>Height: 265.9 mm<br>Depth: 74 mm |
| Weight of the unit | ~8 kg | |

## Ordering

The following is to be specified when ordering RET 54_ transformer terminals:

- Order number (see figure below)
- Display language combination (e.g. English-German)
- Quantity of transformer terminals

Each RET 54_ transformer terminal has a specific order number that identifies the transformer terminal type as well as the hardware and the software as described in the figure below. The order number is printed on the marking strip on the front panel of the transformer terminal delivered, e.g. Order No: RET543AB230AAAA.

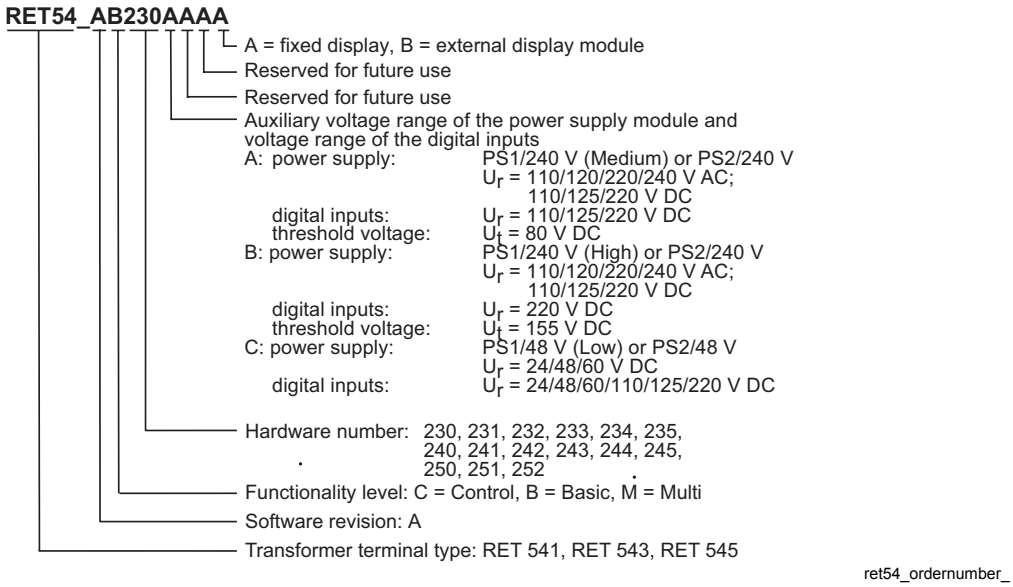



Fig. 5 Order number of RET 54_ transformer terminal.

### Language combinations

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 transformer terminal, e.g. Software 1MRS110028-0_.

| Suffix | Language combination |
|---|---|
| 001 | English-German |
| 002 | English-Swedish |
| 003 | English-Finnish |
| 007 | English-Portuguese |
| 008 | English-Polish |
| 009 | English-Russian |
| 010 | English-Spanish |

### Number of digital inputs/outputs

The RET 541, RET 543 and RET 545 transformer terminals differ from each other as to the number of digital inputs and outputs as follows:

| Number of inputs/outputs | RET 541 | RET 543 | RET 545 |
|---|---|---|---|
| Digital inputs | 15 | 25 | 34 |
| Trip circuit supervision inputs | 2 | 2 | 2 |
| Power outputs (NO single-pole) | 0 | 2 | 3 |
| Power outputs (NO double-pole) | 5 | 9 | 11 |
| Signal outputs (NO) | 2 | 2 | 4 |
| Signal outputs (NO/NC) | 5 | 5 | 8 |
| Self-supervision outputs | 1 | 1 | 1 |

### Functionality levels

The functionality level determines the extent of the selection of function blocks available for the transformer terminal. For more detailed information on the separate function blocks included in each selection, please consult your relay supplier.

| Functionality level | Selection of function blocks |
|---|---|
| C (Control) | All control[1], condition monitoring and measurement functions |
| B (Basic) | All control[1], condition monitoring and measurement functions, basic protection functions |
| M (Multi) | All control[1], condition monitoring, measurement and protection functions |

1) The COLTC Tap Changer control function block comes as standard in the Control version. In the Basic and the Multi versions, COLTC is available as an option.

## Table 20: Transformer terminal functionality levels

| | | | | FUNCTIONALITY LEVELS | | |
|---|---|---|---|---|---|---|
| IEEE Code | IEC Symbol | Functions available in RET 541/543/545 Transformer Terminals. Processor capacity to be checked with "CPU load" tool | Code | RET541/3/5 CONTROL | RET541/3/5 BASIC | REF541/3/5 MULTI |
| | | **Short circuit and overcurrent** | | | | |
| 87T | 3ΔI >, 3ΔI >> | Three-phase differential protection for transformers, stabilized and instantaneous stages | Diff6T | | X | X |
| 51 | 3I > | Three-phase non-directional overcurrent, low-set stage | NOC3Low | | | |
| 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 | | | |
| | | Three-phase non-directional overcurrent function, low-set stage (B) | NOC3LowB | | | |
| 67 | 3I > -> | Three-phase directional o/c, low-set stage | DOC6Low | | | |
| 67 | 3I >> -> | Three-phase directional o/c, high-set stage / blockable overcurrent | DOC6High | | | X |
| 67 | 3I >>> -> | Three-phase directional o/c, high-set stage / blockable overcurrent | DOC6Inst | | | |
| 21G | Z< | Three-Phase Underimpedance Protection, Low-Set Stage | UI6Low | | | X |
| 21G | Z<< | Three-Phase Underimpedance Protection, High-Set Stage | UI6High | | | |
| | | **Earth-fault** | | | | |
| 51N | Io > / SEF | Non-directional earth-fault, low-set stage | NEF1Low | | | |
| 50N / 51N | Io >> | Non-directional earth-fault, high-set stage | NEF1High | | X | X |
| 50N | Io >>> | Non-directional earth-fault, instantaneous stage | NEF1Inst | | | |
| 67N / 51N | Io > / SEF -> | Directional earth-fault, low-set stage | DEF2Low | | | |
| 67N | Io >> -> | Directional earth-fault, high-set stage | DEF2High | | | X |
| 67N | Io >>> -> | Directional earth-fault, instantaneous stage | DEF2Inst | | | |
| 59N | Uo > | Residual overvoltage, low-set stage | ROV1Low | | | |
| 59N | Uo >> | Residual overvoltage, high-set stage | ROV1High | | | X |
| 59N | Uo >>> | Residual overvoltage, instantaneous stage | ROV1Inst | | | |
| 87N | Δ Io > | Stabilized restricted earth-fault protection (high voltage side) | REF4A | | | |
| 87N | Δ Io > | Stabilized restricted earth-fault protection (low voltage side) | REF4B | | X | X |
| 87N | Δ Io >, REF | High-impedance based restricted earth-fault protection | REF1A | | | |
| | | **Overload / unbalanced load** | | | | |
| 49T | 3 ⌐ | Three-phase thermal overload protection | TOL3Dev | | X | X |
| 46 | $I_2$ > | Negative-phase-sequence (NPS) protection, low-set stage | NPS3Low | | X | X |
| 46 | $I_2$ >> | Negative phase sequence (NPS) protection, high-set stage | NPS3High | | | |
| | | **Over / undervoltage** | | | | |
| 59 | 3U > | Three-phase overvoltage, low-set stage | OV3Low | | | X |
| 59 | 3U >> | Three-phase overvoltage, high-set stage | OV3High | | | |
| 27 | 3U < | Three-phase undervoltage, low-set stage | UV3Low | | | X |
| 27 | 3U << | Three-phase undervoltage, high-set stage | UV3High | | | |
| 47 | U1< & U2> & U1> | Three-phase phase sequency voltage protection, stage 1 | PSV3St1 | | | X |
| 47 | U1< & U2> & U1> | Three-phase phase sequency voltage protection, stage 2 | PSV3St2 | | | |
| | | **Over/under frequency** | | | | |
| 81U / 81O | f < / f > / df/dt | Underfrequency or overfrequency inc. rate of change, stage 1 | Freq1St1 | | | |
| 81U / 81O | f < / f > / df/dt | Underfrequency or overfrequency inc. rate of change, stage 2 | Freq1St2 | | | |
| 81U / 81O | f < / f > / df/dt | Underfrequency or overfrequency inc. rate of change, stage 3 | Freq1St3 | | | X |
| 81U / 81O | f < / f > / df/dt | Underfrequency or overfrequency inc. rate of change, stage 4 | Freq1St4 | | | |
| 81U / 81O | f < / f > / df/dt | Underfrequency or overfrequency inc. rate of change, stage 5 | Freq1St5 | | | |
| | | **Over / under excitation** | | | | |
| 24 | U/f> | Overexcitation Protection, Low-Set Stage U/f> | OE1Low | | | X |
| 24 | U/f>> | Overexcitation Protection, High-Set Stage U/f>> | OE1High | | | |
| | | **Additional functions** | | | | |
| 68 | 3I2f > | Three-phase inrush detector | Inrush3 | | X | X |
| 60 | FUSEF | Fuse failure supervision | FuseFail | | | X |
| 62BF | CBFP | Circuit breaker failure | - | | X | X |
| | | **Measurement function** | | | | |
| | | ***Current*** | | | | |
| | 3I | Three-phase current | MECU3A | | | |
| | 3I | Three-phase current, B -stage | MECU3B | X | X | X |
| | Io | Neutral current | MECU1A | | | |
| | Io | Neutral current, B -stage | MECU1B | | | |
| | | ***Voltage*** | | | | |
| | 3U | Three-phase voltage | MEVO3A | | | |
| | 3U | Three-phase voltage, B -stage | MEVO3B | X | X | X |
| | Uo | Residual voltage | MEVO1A | | | |
| | Uo | Residual voltage, B -stage | MEVO1B | | | |
| | | ***Energy / Power*** | | | | |
| | E / P / Q / pf | Three-phase power and energy (incl. cos φ) | MEPE7 | X | X | X |
| | | ***Frequency*** | | | | |
| | f | System frequency | MEFR1 | X | X | X |
| | | ***Recording*** | | | | |
| | ⇨ | Transient disturbance recorder | MEDREC16 | X | X | X |
| | | ***In versions with RTD1 -card*** | | | | |
| | | Measurement of RTD/analog -inputs, general measurement | MEAI1…8 | X | X | X |
| | | Control of analog -outputs | MEAO1…4 | | | |

Transformer Terminals functionality levels, cont.

| IEEE Code | IEC Symbol | Condition monitoring function | Code | | | |
|---|---|---|---|---|---|---|
| | | ***Circuit breaker*** | | | | |
| | CBCM | CB electric wear 1 | CMBWEAR1 | | | |
| | CBCM | CB electric wear 2 | CMBWEAR2 | | | |
| | CBCM | Operation Time Counter 1 (e.g. motors) | CMTIME1 | | | |
| | CBCM | Operation Time Counter 2 (e.g. motors) | CMTIME2 | | | |
| | CBCM | Gas density supervision | CMGAS1 | x | x | x |
| | CBCM | Gas density supervision for three poles | 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 | x | x | x |
| | TCS | Trip Circuit Supervision 2 | CMTCS2 | | | |
| | | ***Measuring circuit*** | | | | |
| | MCS | Supervision of the energizing current input circuit | CMCU3 | x | x | x |
| | MCS | Supervision of the energizing voltage input circuit | CMVO3 | | | |
| | | **Control function** | | | | |
| | | ***Circuit breakers, disconnectors / earthing switch*** | | | | |
| | | Circuit breaker 1, 2 (2 state inputs / 2 control outputs) | COCB1...2 | | | |
| | | Disconnector 1….5 (2 state inputs / 2 control outputs) | CODC1…5 | | | |
| | | Three state disconnector 1, 2 (3 state inputs / 4 control outputs) | CO3DC1...2 | | | |
| | | Object indication 1...8 (2 state inputs) | COIND1...8 | | | |
| | | MIMIC dynamic data point 1…5 on MMI (single line diagram) | MMIDATA1…5 | x | x | x |
| | | Alarm 1…8 on MMI (alarm view) | MMIALAR1…8 | | | |
| | | On/off switch 1…4 on MMI (single line diagram) | COSW1…4 | | | |
| | | Direct open for CBs via MMI | COCBDIR | | | |
| | | Logic control position selector | COLOCAT | | | |
| | | ***Additional functions*** | | | | |
| | | Interlocking | - | x | x | x |
| | | Command control | - | | | |
| | | **Standard functions** | | | | |
| | | Operation indication, relay and register reset | INDRESET | | | |
| | | Activation of MMI backlight | MMIWAKE | x | x | x |
| | | Switchgroups SWGRP1...SWGRP20 | SWGRP1....20 | | | |
| | | PLC logics (AND, OR, timers etc.) acc. to IEC 1131-3 | - | | | |
| | | **Data communication** | | | | |
| | | Event to be defined by the customer, E0...E63 | EVENT230 | | | |
| | | SPA bus | - | x | x | x |
| | | LON bus | - | | | |
| | | **General functions** | | | | |
| | | Main / secondary setting<br>Remote setting<br>Selfsupervision<br>Annunciating, event generating and value recording<br>Measurement, parameter and switching device status display<br>Remote-end binary signal transfer<br>Binary signal interbay transfer | | x | x | x |
| | | | | | | |
| | | **Options** | | | | |
| | | Dual HMI language, desired language combination must be stated in the purchase order | | o | o | o |
| | | On-load tap changer controller (voltage regulator), to be ordered as a separate item (1MRS 100144) | COLTC | x | o | o |

RET54_ Functionality2.xls

### Hardware versions of RET 541, RET 543 and RET 545

For the number of digital inputs and outputs of RET 54_ transformer terminals, refer to section “Order number” above. The number of matching transformers and analog inputs and outputs, and the auxiliary voltage range vary between the different hardware versions of RET 54_. Moreover, RET 541 and RET 543 can be supplied with an RTD/analog module. For more detailed information about the hardware of RET 54_, refer to the tables 20...28 below.

**Table 21:** ***Hardware versions of RET 541, 6I/3U transformers***

| HW modules | Order number | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | RET541A_230AAAA | RET541A_230BAAA | RET541A_230CAAA | RET541A_230AAAB | RET541A_230BAAB | RET541A_233AAAA | RET541A_233BAAA | RET541A_233CAAA | RET541A_233AAAB | RET541A_233BAAB |
| **Analog interface** | | | | | | | | | | |
| Current rafo 1/5 A | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| Voltage trafo 100 V | 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 |
| **Power supply boards** | | | | | | | | | | |
| PS1: 80...265 VDC/AC (High) | | 1 | | | 1 | | 1 | | | 1 |
| PS1: 80...265 VDC /AC (Medium) | 1 | | | 1 | | 1 | | | 1 | |
| PS1: 18...80 VDC/AC (Low) | | | 1 | | | | | 1 | | |
| PS2: 80...265 VDC | | | | | | | | | | |
| PS2: 18...80 VDC | | | | | | | | | | |
| **Digital I/O boards** | | | | | | | | | | |
| BIO1:Threshold voltage 155 VDC | | 1 | | | 1 | | 1 | | | 1 |
| BIO1: threshold voltage 80 VDC | 1 | | | 1 | | 1 | | | 1 | |
| BIO1: threshold voltage 18 VDC | | | 1 | | | | | 1 | | |
| BIO2: Threshold voltage 155 VDC | | | | | | | | | | |
| BIO2: threshold voltage 80 VDC | | | | | | | | | | |
| BIO2: threshold voltage 18 VDC | | | | | | | | | | |
| **Analog I/O board** | | | | | | | | | | |
| RTD/analog module | | | | | | 1 | 1 | 1 | 1 | 1 |
| **Display boards** | | | | | | | | | | |
| Graphic HMI display, fixed | 1 | 1 | 1 | | | 1 | 1 | 1 | | |
| Graphic HMI display, external | | | | 1 | 1 | | | | 1 | 1 |
| **Mechanic** | | | | | | | | | | |
| 1/2 enclosure | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | | | | | | | | | | |
| **Digital inputs** | 15 | | | | | 15 | | | | |
| **Power outputs, single pole** | 0 | | | | | 0 | | | | |
| **Power outputs, double pole** | 5 | | | | | 5 | | | | |
| **Signal outputs (NO)** | 2 | | | | | 2 | | | | |
| **Signal outputs (NO/NC)** | 5 | | | | | 5 | | | | |
| **Supervised trip circuits** | 2 | | | | | 2 | | | | |
| **IRF outputs** | 1 | | | | | 1 | | | | |
| **RTD/analog inputs** | 0 | | | | | 8 | | | | |
| **Analog outputs** | 0 | | | | | 4 | | | | |

**Table 22:** ***Hardware versions of RET 541, 7I/2U transformers***

| HW modules | Order number | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | RET541A_231AAAA | RET541A_231BAAA | RET541A_231CAAA | RET541A_231AAAB | RET541A_231BAAB | RET541A_234AAAA | RET541A_234BAAA | RET541A_234CAAA | RET541A_234AAAB | RET541A_234BAAB |
| **Analog interface** | | | | | | | | | | |
| Current trafo 1/5 A | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| Voltage trafo 100 V | 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 |
| **Power supply boards** | | | | | | | | | | |
| PS1: 80...265 VDC/AC (High) | | 1 | | | 1 | | 1 | | | 1 |
| PS1: 80...265 VDC /AC (Medium) | 1 | | | 1 | | 1 | | | 1 | |
| PS1: 18...80 VDC/AC (Low) | | | 1 | | | | | 1 | | |
| PS2: 80...265 VDC | | | | | | | | | | |
| PS2: 18...80 VDC | | | | | | | | | | |
| **Digital I/O boards** | | | | | | | | | | |
| BIO1:threshold voltage 155 VDC | | 1 | | | 1 | | 1 | | | 1 |
| BIO1: threshold voltage 80 VDC | 1 | | | 1 | | 1 | | | 1 | |
| BIO1: threshold voltage 18 VDC | | | 1 | | | | | 1 | | |
| BIO2: threshold voltage 155 VDC | | | | | | | | | | |
| BIO2: threshold voltage 80 VDC | | | | | | | | | | |
| BIO2: threshold voltage 18 VDC | | | | | | | | | | |
| **Analog I/O board** | | | | | | | | | | |
| RTD/analog module | | | | | | 1 | 1 | 1 | 1 | 1 |
| **Display boards** | | | | | | | | | | |
| Graphic HMI display, fixed | 1 | 1 | 1 | | | 1 | 1 | 1 | | |
| Graphic HMI display, external | | | | 1 | 1 | | | | 1 | 1 |
| **Mechanic** | | | | | | | | | | |
| 1/2 enclosure | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | | | | | | | | | | |
| **Digital inputs** | 15 | | | | | 15 | | | | |
| **Power outputs, single pole** | 0 | | | | | 0 | | | | |
| **Power outputs, double pole** | 5 | | | | | 5 | | | | |
| **Signal outputs (NO)** | 2 | | | | | 2 | | | | |
| **Signal outputs (NO/NC)** | 5 | | | | | 5 | | | | |
| **Supervised trip circuits** | 2 | | | | | 2 | | | | |
| **IRF outputs** | 1 | | | | | 1 | | | | |
| **RTD/analog inputs** | 0 | | | | | 8 | | | | |
| **Analog outputs** | 0 | | | | | 4 | | | | |

**Table 23:** ***Hardware versions of RET 541, 8I/1U transformers***

| HW modules | Order number | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | RET541A_232AAAA | RET541A_232BAAA | RET541A_232CAAA | RET541A_232AAAB | RET541A_232BAAB | RET541A_235AAAA | RET541A_235BAAA | RET541A_235CAAA | RET541A_235AAAB | RET541A_235BAAB |
| **Analog interface** | | | | | | | | | | |
| Current rafo 1/5 A | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| Voltage trafo 100 V | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **Main processor boards** | | | | | | | | | | |
| CPU module | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **Power supply boards** | | | | | | | | | | |
| PS1: 80...265 VDC/AC (High) | | 1 | | | 1 | | 1 | | | 1 |
| PS1: 80...265 VDC /AC (Medium) | 1 | | | 1 | | 1 | | | 1 | |
| PS1: 18...80 VDC/AC (Low) | | | 1 | | | | | 1 | | |
| PS2: 80...265 VDC | | | | | | | | | | |
| PS2: 18...80 VDC | | | | | | | | | | |
| **Digital I/O boards** | | | | | | | | | | |
| BIO1: threshold voltage 155 VDC | | 1 | | | 1 | | 1 | | | 1 |
| BIO1: threshold voltage 80 VDC | 1 | | | 1 | | 1 | | | 1 | |
| BIO1: threshold voltage 18 VDC | | | 1 | | | | | 1 | | |
| BIO2: threshold voltage 155 VDC | | | | | | | | | | |
| BIO2: threshold voltage 80 VDC | | | | | | | | | | |
| BIO2: threshold voltage 18 VDC | | | | | | | | | | |
| **Analog I/O board** | | | | | | | | | | |
| RTD/analog module | | | | | | 1 | 1 | 1 | 1 | 1 |
| **Display boards** | | | | | | | | | | |
| Graphic HMI display, fixed | 1 | 1 | 1 | | | 1 | 1 | 1 | | |
| Graphic HMI display, external | | | | 1 | 1 | | | | 1 | 1 |
| **Mechanic** | | | | | | | | | | |
| 1/2 enclosure | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | | | | | | | | | | |
| **Digital inputs** | 15 | | | | | 15 | | | | |
| **Power outputs, single pole** | 0 | | | | | 0 | | | | |
| **Power outputs, double pole** | 5 | | | | | 5 | | | | |
| **Signal outputs (NO)** | 2 | | | | | 2 | | | | |
| **Signal outputs (NO/NC)** | 5 | | | | | 5 | | | | |
| **Supervised trip circuits** | 2 | | | | | 2 | | | | |
| **IRF outputs** | 1 | | | | | 1 | | | | |
| **RTD/analog inputs** | 0 | | | | | 8 | | | | |
| **Analog outputs** | 0 | | | | | 4 | | | | |

**Table 24: Hardware versions of RET 543, 6I/3U transformers**

| HW modules | Order number | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | RET543A_240AAAA | RET543A_240BAAA | RET543A_240CAAA | RET543A_240AAAB | RET543A_240BAAB | RET543A_243AAAA | RET543A_243BAAA | RET543A_243CAAA | RET543A_243AAAB | RET543A_243BAAB |
| **Analog interface** | | | | | | | | | | |
| Current trafo 1/5 A | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| Voltage trafo 100 V | 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 |
| **Power supply boards** | | | | | | | | | | |
| PS1: 80...265 VDC/AC (High) | | 1 | | | 1 | | 1 | | | 1 |
| PS1: 80...265 VDC/AC (Medium) | 1 | | | 1 | | 1 | | | 1 | |
| PS1: 18...80 VDC/AC (Low) | | | 1 | | | | | 1 | | |
| PS2: 80...265 VDC | | | | | | | | | | |
| PS2: 18...80 VDC | | | | | | | | | | |
| **Digital I/O boards** | | | | | | | | | | |
| BIO1: threshold voltage 155 VDC | | 1 | | | 1 | | 1 | | | 1 |
| BIO1: threshold voltage 80 VDC | 1 | | | 1 | | 1 | | | 1 | |
| BIO1: threshold voltage 18 VDC | | | 1 | | | | | 1 | | |
| BIO2: threshold voltage 155 VDC | | 1 | | | 1 | | 1 | | | 1 |
| BIO2: threshold voltage 80 VDC | 1 | | | 1 | | 1 | | | 1 | |
| BIO2: threshold voltage 18 VDC | | | 1 | | | | | 1 | | |
| **Analog I/O board** | | | | | | | | | | |
| RTD/analog module | | | | | | 1 | 1 | 1 | 1 | 1 |
| **Display boards** | | | | | | | | | | |
| Graphic HMI display, fixed | 1 | 1 | 1 | | | 1 | 1 | 1 | | |
| Graphic HMI display external | | | | 1 | 1 | | | | 1 | 1 |
| **Mechanic** | | | | | | | | | | |
| 1/2 enclosure | 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/analog inputs** | 0 | | | | | 8 | | | | |
| **Analog outputs** | 0 | | | | | 4 | | | | |

**Table 25: Hardware versions of RET 543, 7I/2U transformers**

| HW modules | Order number | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | RET543A_241AAAA | RET543A_241BAAA | RET543A_241CAAA | RET543A_241AAAB | RET543A_241BAAB | RET543A_244AAAA | RET543A_244BAAA | RET543A_244CAAA | RET543A_244AAAB | RET543A_244BAAB |
| **Analog interface** | | | | | | | | | | |
| Current trafo 1/5 A | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| Voltage trafo 100 V | 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 |
| **Power supply boards** | | | | | | | | | | |
| PS1: 80...265 VDC/AC (High) | | 1 | | | 1 | | 1 | | | 1 |
| PS1: 80...265 VDC/AC (Medium) | 1 | | | 1 | | 1 | | | 1 | |
| PS1: 18...80 VDC/AC (Low) | | | 1 | | | | | 1 | | |
| PS2: 80...265 VDC | | | | | | | | | | |
| PS2: 18...80 VDC | | | | | | | | | | |
| **Digital I/O boards** | | | | | | | | | | |
| BIO1: threshold voltage 155 VDC | | 1 | | | 1 | | 1 | | | 1 |
| BIO1: threshold voltage 80 VDC | 1 | | | 1 | | 1 | | | 1 | |
| BIO1: threshold voltage 18 VDC | | | 1 | | | | | 1 | | |
| BIO2: threshold voltage 155 VDC | | 1 | | | 1 | | 1 | | | 1 |
| BIO2: threshold voltage 80 VDC | 1 | | | 1 | | 1 | | | 1 | |
| BIO2: threshold voltage 18 VDC | | | 1 | | | | | 1 | | |
| **Analog I/O board** | | | | | | | | | | |
| RTD/analog module | | | | | | 1 | 1 | 1 | 1 | 1 |
| **Display boards** | | | | | | | | | | |
| Graphic HMI display, fixed | 1 | 1 | 1 | | | 1 | 1 | 1 | | |
| Graphic HMI display, external | | | | 1 | 1 | | | | 1 | 1 |
| **Mechanic** | | | | | | | | | | |
| 1/2 enclosure | 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/analog inputs** | 0 | | | | | 8 | | | | |
| **Analog outputs** | 0 | | | | | 4 | | | | |

**Table 26: Hardware versions of RET 543, 8I/1U transformers**

| HW modules | Order number | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | RET543A_242AAAA | RET543A_242BAAA | RET543A_242CAAA | RET543A_242AAAB | RET543A_242BAAB | RET543A_245AAAA | RET543A_245BAAA | RET543A_245CAAA | RET543A_245AAAB | RET543A_245BAAB |
| **Analog interface** | | | | | | | | | | |
| Current trafo 1/5 A | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| Voltage trafo 100 V | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **Main processor boards** | | | | | | | | | | |
| CPU module | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **Power supply boards** | | | | | | | | | | |
| PS1: 80...265 VDC/AC (High) | | 1 | | | 1 | | 1 | | | 1 |
| PS1: 80...265 VDC/AC (Medium) | 1 | | | 1 | | 1 | | | 1 | |
| PS1: 18...80 VDC/AC (Low) | | | 1 | | | | | 1 | | |
| PS2: 80...265 VDC | | | | | | | | | | |
| PS2: 18...80 VDC | | | | | | | | | | |
| **Digital I/O boards** | | | | | | | | | | |
| BIO1: threshold voltage 155 VDC | | 1 | | | 1 | | 1 | | | 1 |
| BIO1: threshold voltage 80 VDC | 1 | | | 1 | | 1 | | | 1 | |
| BIO1: threshold voltage 18 VDC | | | 1 | | | | | 1 | | |
| BIO2: threshold voltage 155 VDC | | 1 | | | 1 | | 1 | | | 1 |
| BIO2: threshold voltage 80 VDC | 1 | | | 1 | | 1 | | | 1 | |
| BIO2: threshold voltage 18 VDC | | | 1 | | | | | 1 | | |
| **Analog I/O board** | | | | | | | | | | |
| RTD/analog module | | | | | | 1 | 1 | 1 | 1 | 1 |
| **Display boards** | | | | | | | | | | |
| Graphic HMI display, fixed | 1 | 1 | 1 | | | 1 | 1 | 1 | | |
| Graphic HMI display external | | | | 1 | 1 | | | | 1 | 1 |
| **Mechanic** | | | | | | | | | | |
| 1/2 enclosure | 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/analog inputs** | 0 | | | | | 8 | | | | |
| **Analog outputs** | 0 | | | | | 4 | | | | |

**Table 27: Hardware versions of RET 545, 6I/3U transformers**

| HW modules | Order number | | | | |
|---|---|---|---|---|---|
| | RET545A_250AAAA | RET545A_250BAAA | RET545A_250CAAA | RET545A_250AAAB | RET545A_250BAAB |
| **Analog interface** | | | | | |
| Current trafo 1/5 A | 6 | 6 | 6 | 6 | 6 |
| Voltage trafo 100 V | 3 | 3 | 3 | 3 | 3 |
| **Main processor boards** | | | | | |
| CPU module | 1 | 1 | 1 | 1 | 1 |
| **Power supply boards** | | | | | |
| PS1: 80...265 VDC/AC (High) | | | | | |
| PS1: 80...265 VDC/AC (Medium) | | | | | |
| PS1: 18...80 VDC/AC (Low) | | | | | |
| PS2: 80...265 VDC | 1 | 1 | | 1 | 1 |
| PS2: 18...80 VDC | | | 1 | | |
| **Digital I/O boards** | | | | | |
| BIO1: threshold voltage 155 VDC | | 2 | | | 2 |
| BIO1: threshold voltage 80 VDC | 2 | | | 2 | |
| BIO1: threshold voltage 18 VDC | | | 2 | | |
| BIO2: threshold voltage 155 VDC | | 1 | | | 1 |
| BIO2: threshold voltage 80 VDC | 1 | | | 1 | |
| BIO2: threshold voltage 18 VDC | | | 1 | | |
| **Analog I/O board** | | | | | |
| RTD/analog module | | | | | |
| **Display boards** | | | | | |
| Graphic HMI display, fixed | 1 | 1 | 1 | | |
| Graphic HMI display, external | | | | 1 | 1 |
| **Mechanic** | | | | | |
| 1/2 enclosure | 1 | 1 | 1 | 1 | 1 |
| | | | | | |
| **Digital inputs** | 34 | | | | |
| **Power outputs, single pole** | 3 | | | | |
| **Power outputs, double pole** | 11 | | | | |
| **Signal outputs (NO)** | 4 | | | | |
| **Signal outputs (NO/NC)** | 8 | | | | |
| **Supervised trip circuits** | 2 | | | | |
| **IRF outputs** | 1 | | | | |
| **RTD/analog inputs** | 0 | | | | |
| **Analog outputs** | 0 | | | | |

**Table 28: Hardware versions of RET 545, 7I/2U transformers**

| HW modules | Order number | | | | |
|---|---|---|---|---|---|
| | RET545A_251AAAA | RET545A_251BAAA | RET545A_251CAAA | RET545A_251AAAB | RET545A_251BAAB |
| **Analog interface** | | | | | |
| Current trafo 1/5 A | 7 | 7 | 7 | 7 | 7 |
| Voltage trafo 100 V | 2 | 2 | 2 | 2 | 2 |
| **Main processor boards** | | | | | |
| CPU module | 1 | 1 | 1 | 1 | 1 |
| **Power supply boards** | | | | | |
| PS1: 80...265 VDC/AC (High) | | | | | |
| PS1: 80...265 VDC/AC (Medium) | | | | | |
| PS1: 18...80 VDC/AC (Low) | | | | | |
| PS2: 80...265 VDC | 1 | 1 | | 1 | 1 |
| PS2: 18...80 VDC | | | 1 | | |
| **Digital I/O boards** | | | | | |
| BIO1: threshold voltage 155 VDC | | 2 | | | 2 |
| BIO1: threshold voltage 80 VDC | 2 | | | 2 | |
| BIO1: threshold voltage 18 VDC | | | 2 | | |
| BIO2: threshold voltage 155 VDC | | 1 | | | 1 |
| BIO2: threshold voltage 80 VDC | 1 | | | 1 | |
| BIO2: threshold voltage 18 VDC | | | 1 | | |
| **Analog I/O board** | | | | | |
| RTD/analog module | | | | | |
| **Display boards** | | | | | |
| Graphic HMI display, fixed | 1 | 1 | 1 | | |
| Graphic HMI display, external | | | | 1 | 1 |
| **Mechanic** | | | | | |
| 1/2 enclosure | 1 | 1 | 1 | 1 | 1 |
| | | | | | |
| **Digital inputs** | 34 | | | | |
| **Power outputs, single pole** | 3 | | | | |
| **Power outputs, double pole** | 11 | | | | |
| **Signal outputs (NO)** | 4 | | | | |
| **Signal outputs (NO/NC)** | 8 | | | | |
| **Supervised trip circuits** | 2 | | | | |
| **IRF outputs** | 1 | | | | |
| **RTD/analog inputs** | 0 | | | | |
| **Analog outputs** | 0 | | | | |

**Table 29: Hardware versions of RET 545, 8I/1U transformers**

| HW modules | Order number | | | | |
|---|---|---|---|---|---|
| | RET545A_252AAAA | RET545A_252BAAA | RET545A_252CAAA | RET545A_252AAAB | RET545A_252BAAB |
| **Analog interface** | | | | | |
| Current trafo 1/5 A | 8 | 8 | 8 | 8 | 8 |
| Voltage trafo 100 V | 1 | 1 | 1 | 1 | 1 |
| **Main processor boards** | | | | | |
| CPU module | 1 | 1 | 1 | 1 | 1 |
| **Power supply boards** | | | | | |
| PS1: 80...265 VDC/AC (High) | | | | | |
| PS1: 80...265 VDC/AC (Medium) | | | | | |
| PS1: 18...80 VDC/AC (Low) | | | | | |
| PS2: 80...265 VDC | 1 | 1 | | 1 | 1 |
| PS2: 18...80 VDC | | | 1 | | |
| **Digital I/O boards** | | | | | |
| BIO1: threshold voltage 155 VDC | | 2 | | | 2 |
| BIO1: threshold voltage 80 VDC | 2 | | | 2 | |
| BIO1: threshold voltage 18 VDC | | | 2 | | |
| BIO2: threshold voltage 155 VDC | | 1 | | | 1 |
| BIO2: threshold voltage 80 VDC | 1 | | | 1 | |
| BIO2: threshold voltage 18 VDC | | | 1 | | |
| **Analog I/O board** | | | | | |
| RTD/analog module | | | | | |
| **Display boards** | | | | | |
| Graphic HMI display, fixed | 1 | 1 | 1 | | |
| Graphic HMI display, external | | | | 1 | 1 |
| **Mechanic** | | | | | |
| 1/2 enclosure | 1 | 1 | 1 | 1 | 1 |
| | | | | | |
| **Digital inputs** | 34 | | | | |
| **Power outputs, single pole** | 3 | | | | |
| **Power outputs, double pole** | 11 | | | | |
| **Signal outputs (NO)** | 4 | | | | |
| **Signal outputs (NO/NC)** | 8 | | | | |
| **Supervised trip circuits** | 2 | | | | |
| **IRF outputs** | 1 | | | | |
| **RTD/analog inputs** | 0 | | | | |
| **Analog outputs** | 0 | | | | |

## Software configuration

Each RET 54_ transformer 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 a RET 54_ product 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 transformer terminal supplier.

## Application examples

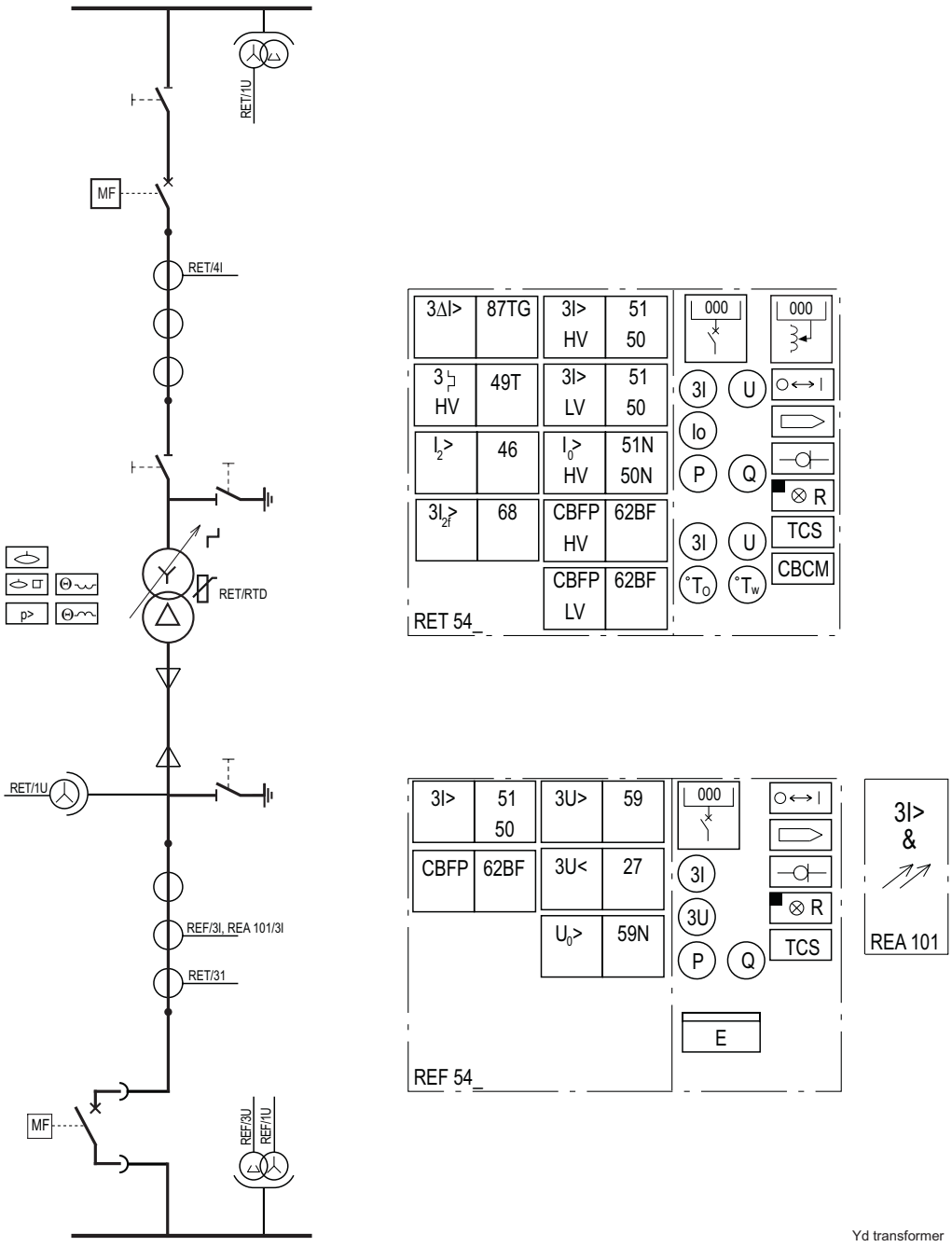



Fig. 6 Protection, control and supervision functions of a Yd-connected power transformer, implemented with RET 543 transformer terminal, REF543 feeder terminal and REA 101 arc protection. Position indication of the on-load tap changer is used to increase the sensitivity of the differential function of the transformer. In this example, the voltage controller is not included in the RET 543 transformer terminal.

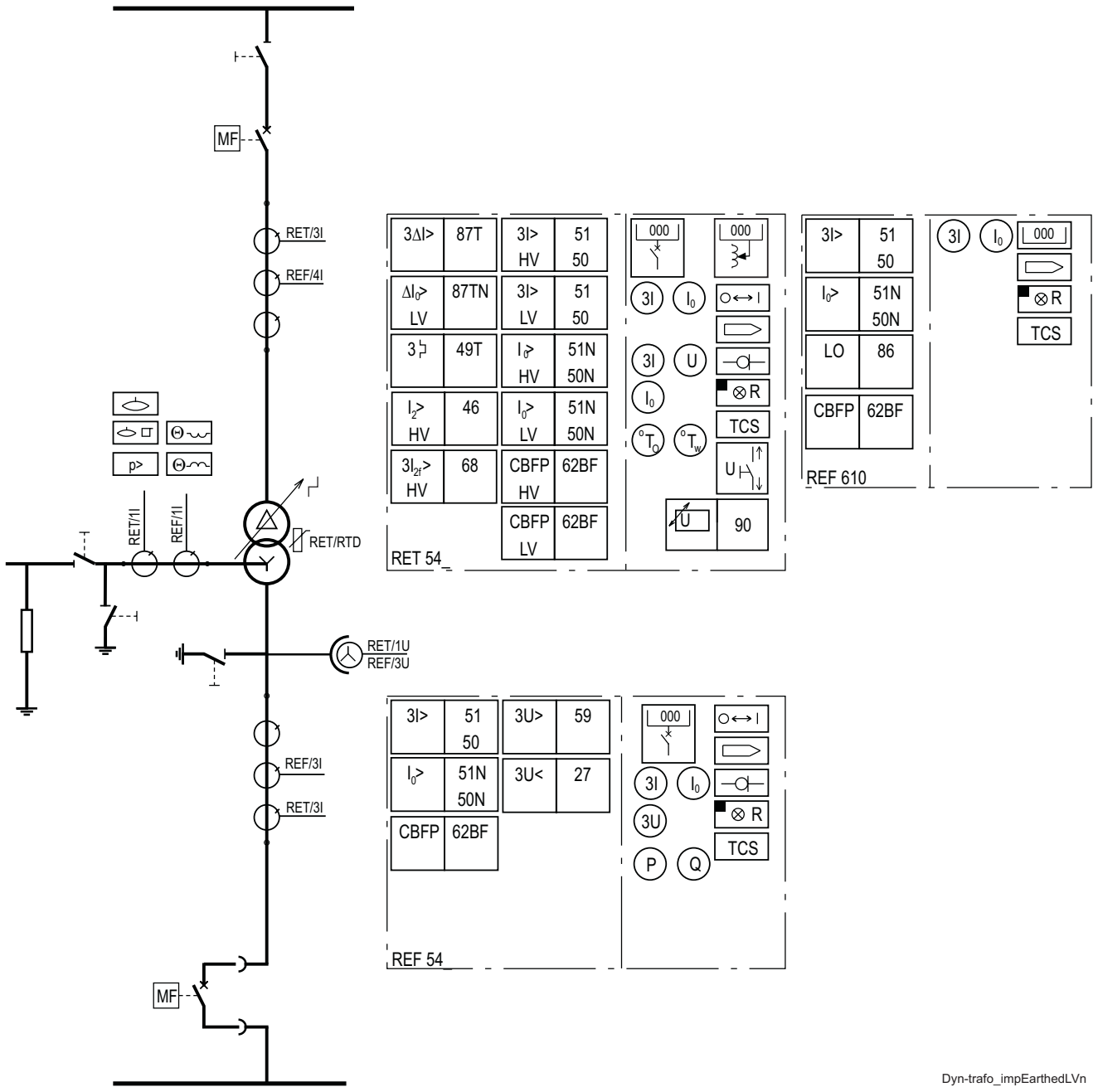
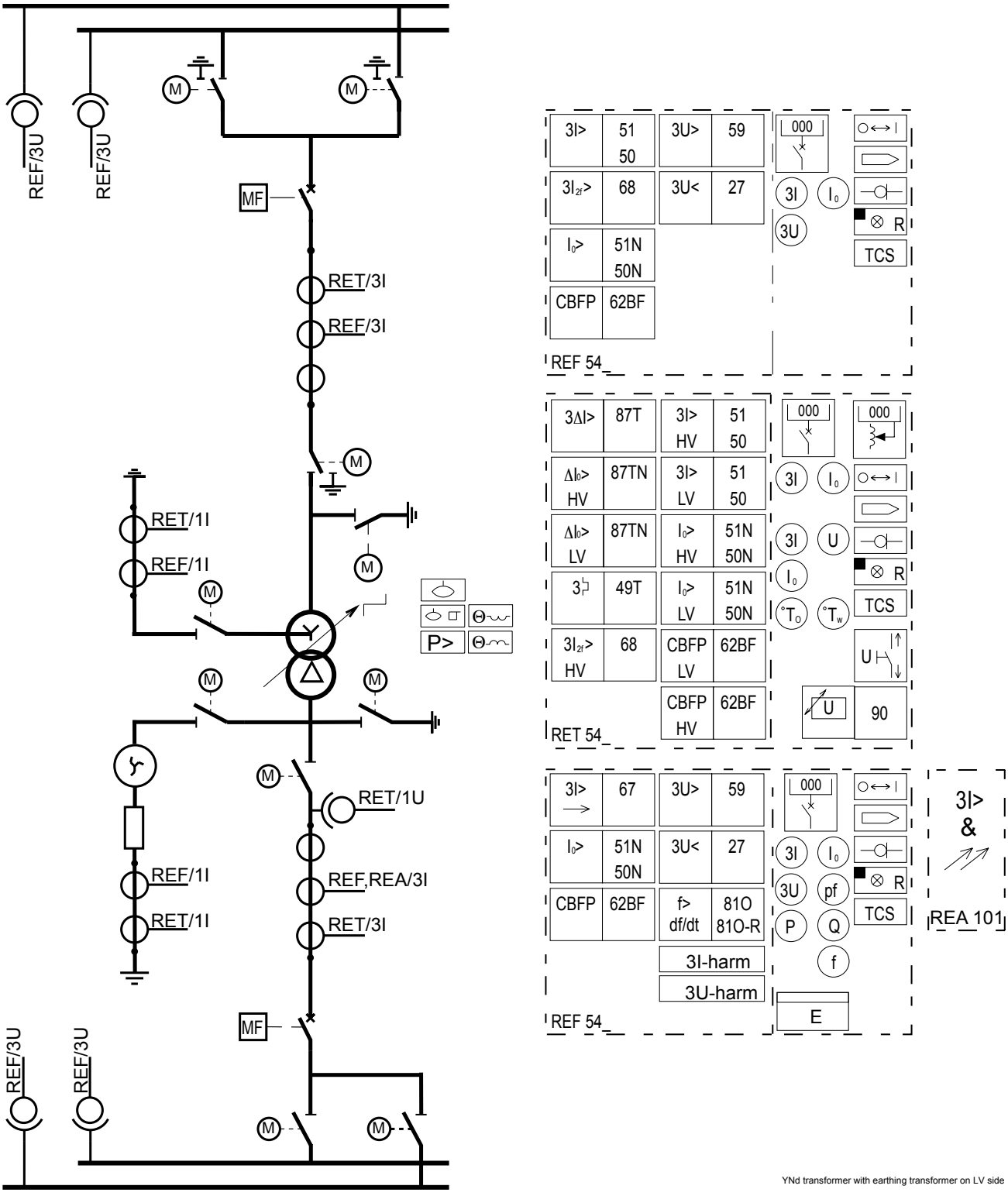



Fig. 7 Protection, control, measurement and supervision functions of an Dyn-connected power transformer, implemented with RET 543 transformer terminal and an REF 543 feeder terminal. The neutral point of the low-voltage network is earthed via a high impedance. REF 610 is used as a backup relay on the high-voltage side. This sceme can be applied also for parallel connected transformers.




YNd transformer with earthing transformer on LV side

Fig. 8 Protection, control, measurement and supervision functions of a YNd-connected power transformer, implemented with an RET 543 transformer terminal, REF 543 feeder terminals and REA 101 arc protection. The low-voltage network is earthed via a zig-zag earthing transformer.

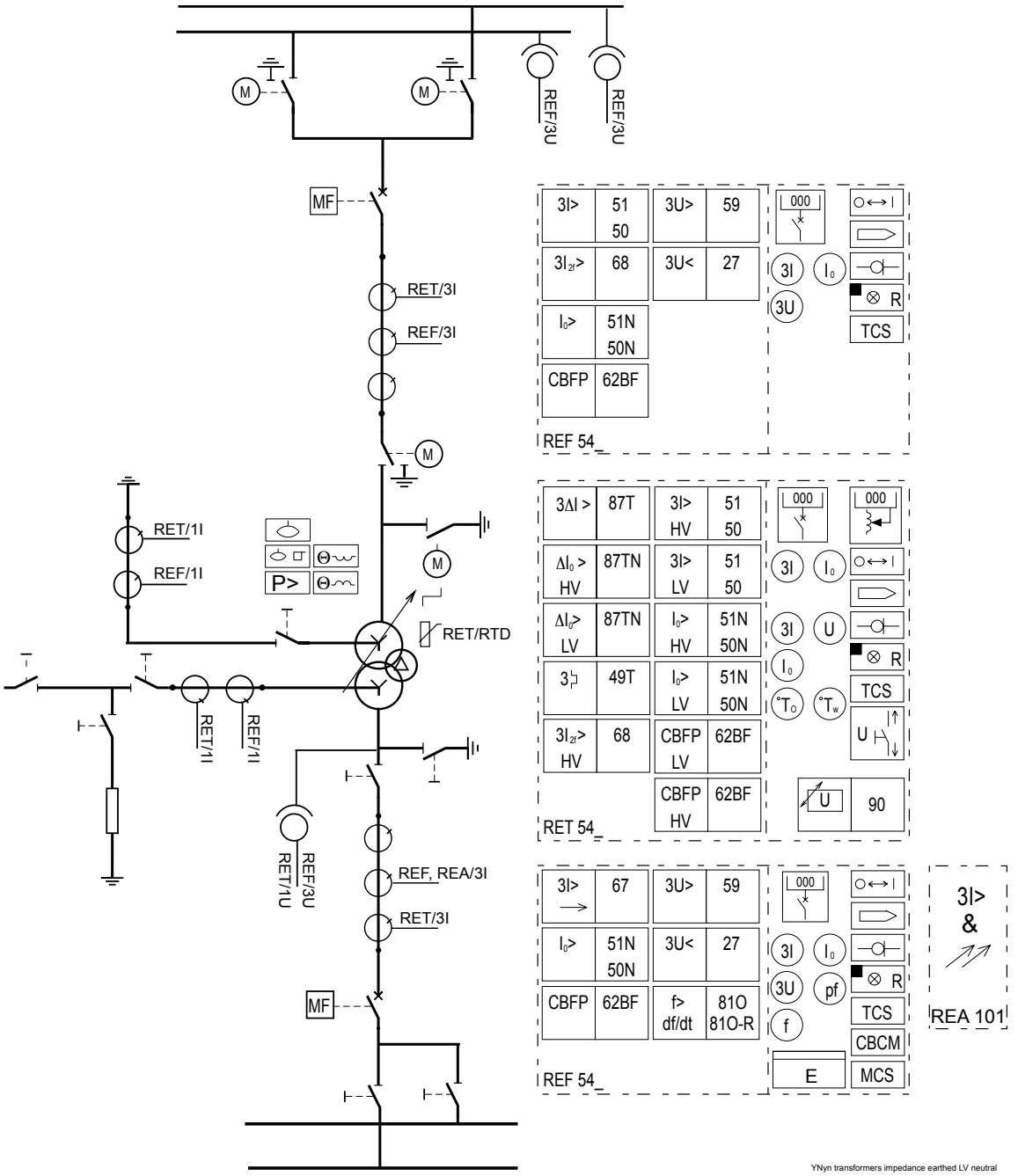



Fig. 9 Protection, control, measurement and supervision functions of YNyn-connected power transformers, implemented with RET 543 transformer terminals, REF 543 feeder terminals and REA 101 arc protection. The neutral point of the low-voltage network is earthed via a low resistance. The scheme is also applicable to other types of low-impedance earthed networks, where the neutral point is earthed effectively or via a low reactance. This sceme can be applied also for parallel connected transformers.

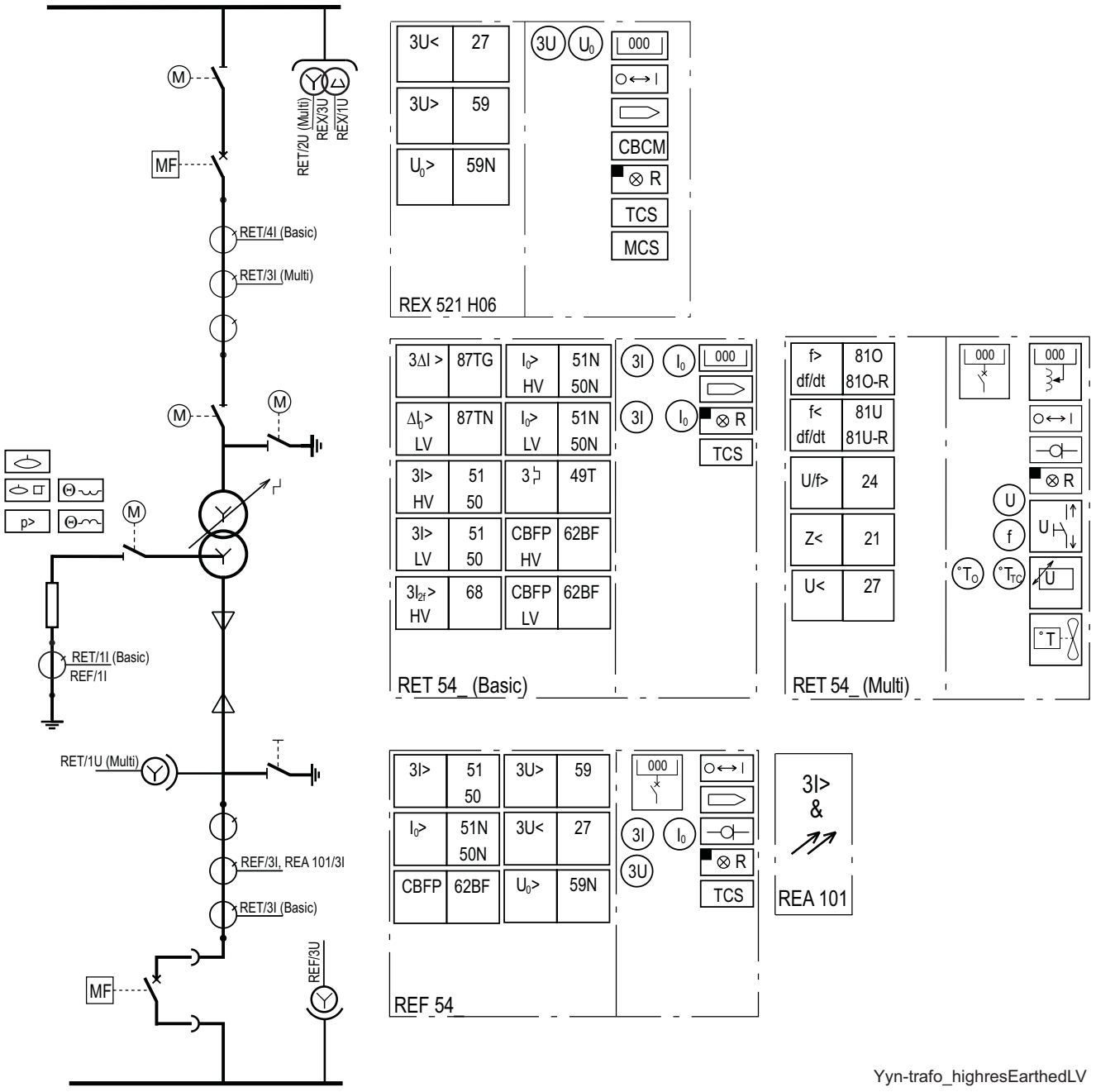



Fig. 10 Protection, control, measurement and supervision functions of an Yyn-connected industrial power transformer, implemented with RET 543 transformer terminals, an REF 543 feeder terminal, an REX 521 protection relay and REA 101 arc protection. The neutral point of the low-voltage network is earthed via a high resistance.

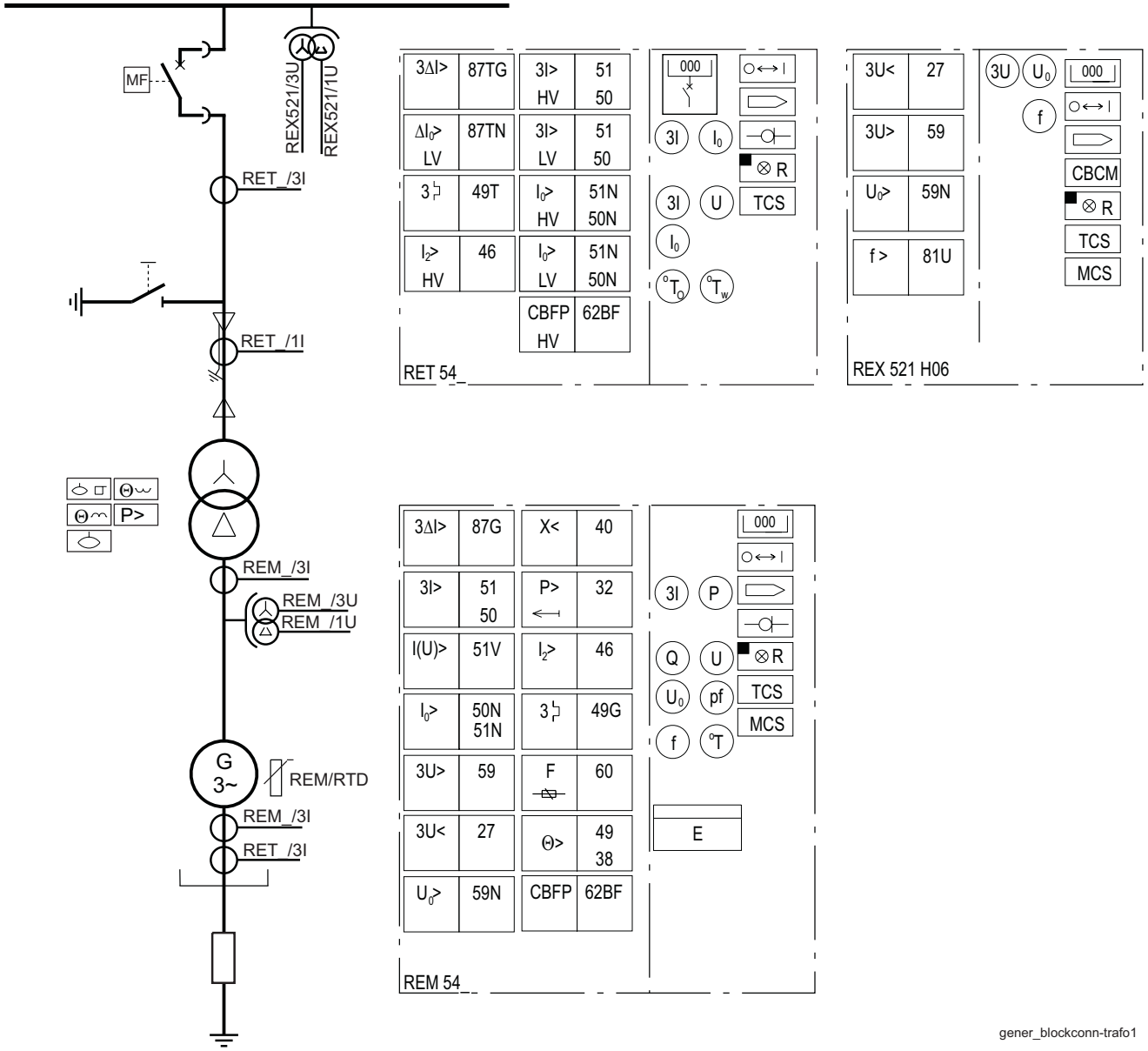



Fig. 11 Transformer in block connection with a generator. The transformer terminal RET 543 is used for overall differential protection. An earthing resistor is recommended for the generator. The REX 521 protection relay is used for abnormal voltage and frequency supervision and protection of the network and the machine.

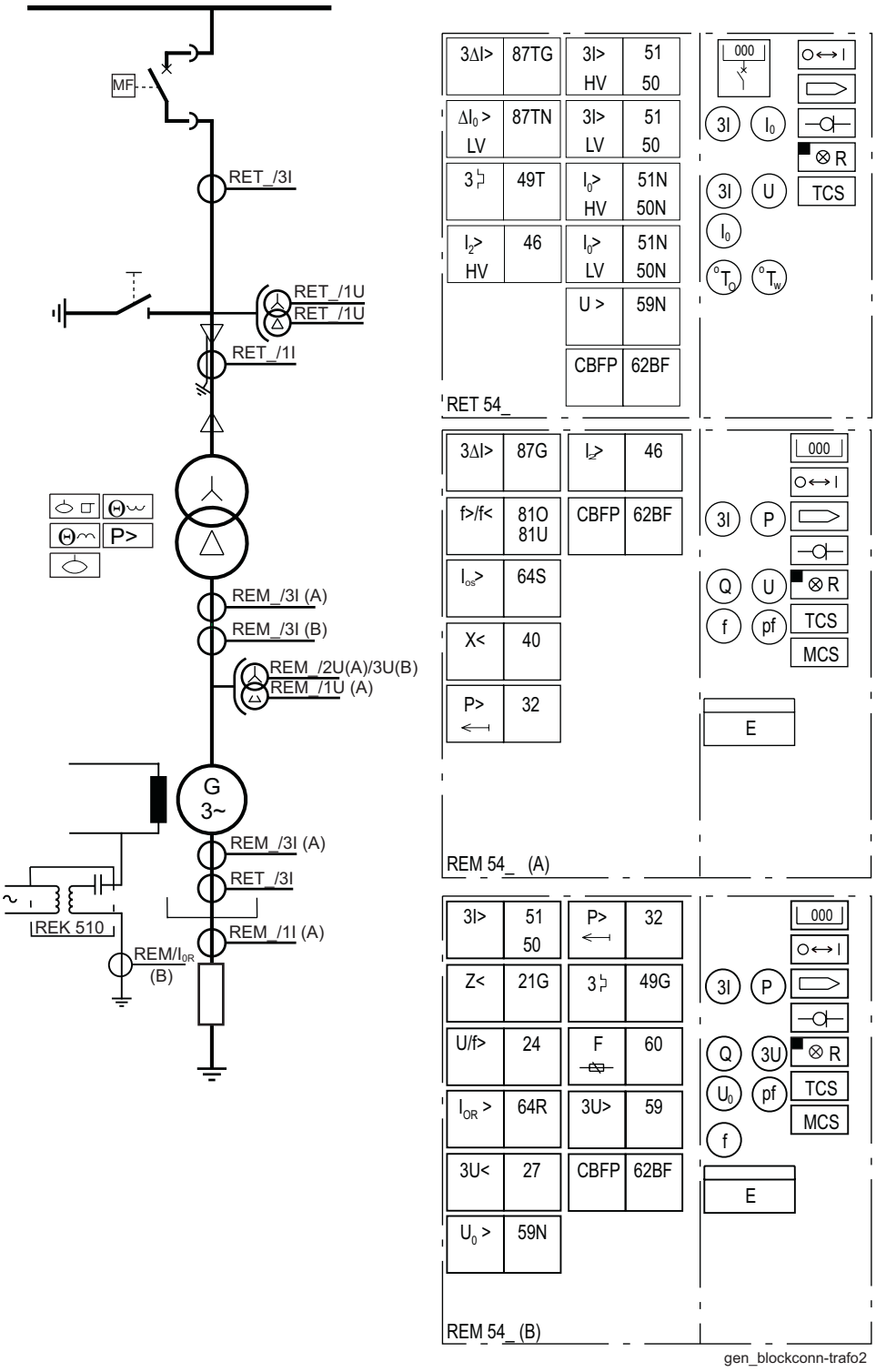



Fig. 12 Transformer in block connection with a generator. The transformer terminal RET 543 is used for overall differential protection. An earthing resistor is recommended for the generator. Generator protection functions are divided for two REM 543 machine terminals (A and B). The current injection device REK 510 is used in the rotor earth-fault protection scheme.

| | | |
|---|---|---|
| 3I > | 50/51 | = multiple-stage three-phase overcurrent protection, double low-set, high-set and instantaneous stages available (NOC3_) |
| 3I> → | 67 | = multiple-stage three-phase directional overcurrent protection, low-set, high-set and instantaneous stage available (DOC6_) |
| $I_0$> | 50N/51N | = multiple-stage earth-fault protection, low-set, high-set and instantaneous stage available (NEF1_) |
| $I_2$> | 46 | = negative phase sequence (NPS) protection, low-set and high-set stages available (NPS3_) |
| $3I_{2f}$ > | 68 | = inrush detection based on the 2nd harmonic content of phase currents, applied for preventing possible unnecessary operation of overcurrent or earth-fault protection during transformer switching-in or to start cold load pick-up logic (Inrush3_) |
| 3Δ I > | 87T | = three phase differential protection for transformers, stabilized and instantaneous stages (Diff3) |
| 3Δ I > | 87TG | = overall differential protection for generator and transformer blocks, stabilized and instantaneous stages (Diff6T) |
| $\Delta I_0$> | 87TN | = restricted earth-fault (REF) protection, low- or high-impedance type (Diff3) |
| I(U)> | 51V | = voltage-dependent overcurrent protection, low-set and high-set stages available (VOC6_) |
| $I_{0S}$> | 64S | = stator earth-fault protection (NEF1_) |
| $I_{0R}$> | 64R | = rotor earth-fault protection (NEF1_) |
| U/f | 24 | = overexcitation protection, low-set and high-set stages available (OE1_) |
| U < | 27 | = undervoltage protection, low-set and high-set stage available (UV3_) |
| 3U < | 27 | = three-phase undervoltage protection, low-set and high-set stage available (UV3_) |
| 3U > | 59 | = three-phase overvoltage protection, low-set and high-set stage available (OV3_) |
| $U_0$> | 59N | = multiple-stage residual overvoltage protection, low-set, high-set and instantaneous stage available (ROV1_) |
| f > | 81U | = overfrequency protection (incl. in Freq1St_) |
| f > df/dt | 81U 81U-R | = overfrequency protection and frequency rate of change function (incl. in Freq1St_) |
| f < df/dt | 81O 81O-R | = underfrequency protection and frequency rate of change function (incl. in Freq1St_) |
| f>/f< | 81O 81U | = over/underfrequency protection (incl. in Freq1St_) |
| 3θ | 49G | = three-phase thermal overload protection for generator (TOL3Dev) |
| 3θ | 49T | = three-phase thermal overload protection for transformers (TOL3Dev) |
| Θ> | 49 38 | = thermal supervision for generator windings and bearings with RTDs (MEAI_) |
| CBFP | 62BF | = circuit-breaker failure protection (included in all current-based short circuit and earth-fault protection function blocks) |

SYMNOT1_RET

Fig. 13 Symbol notations, part I

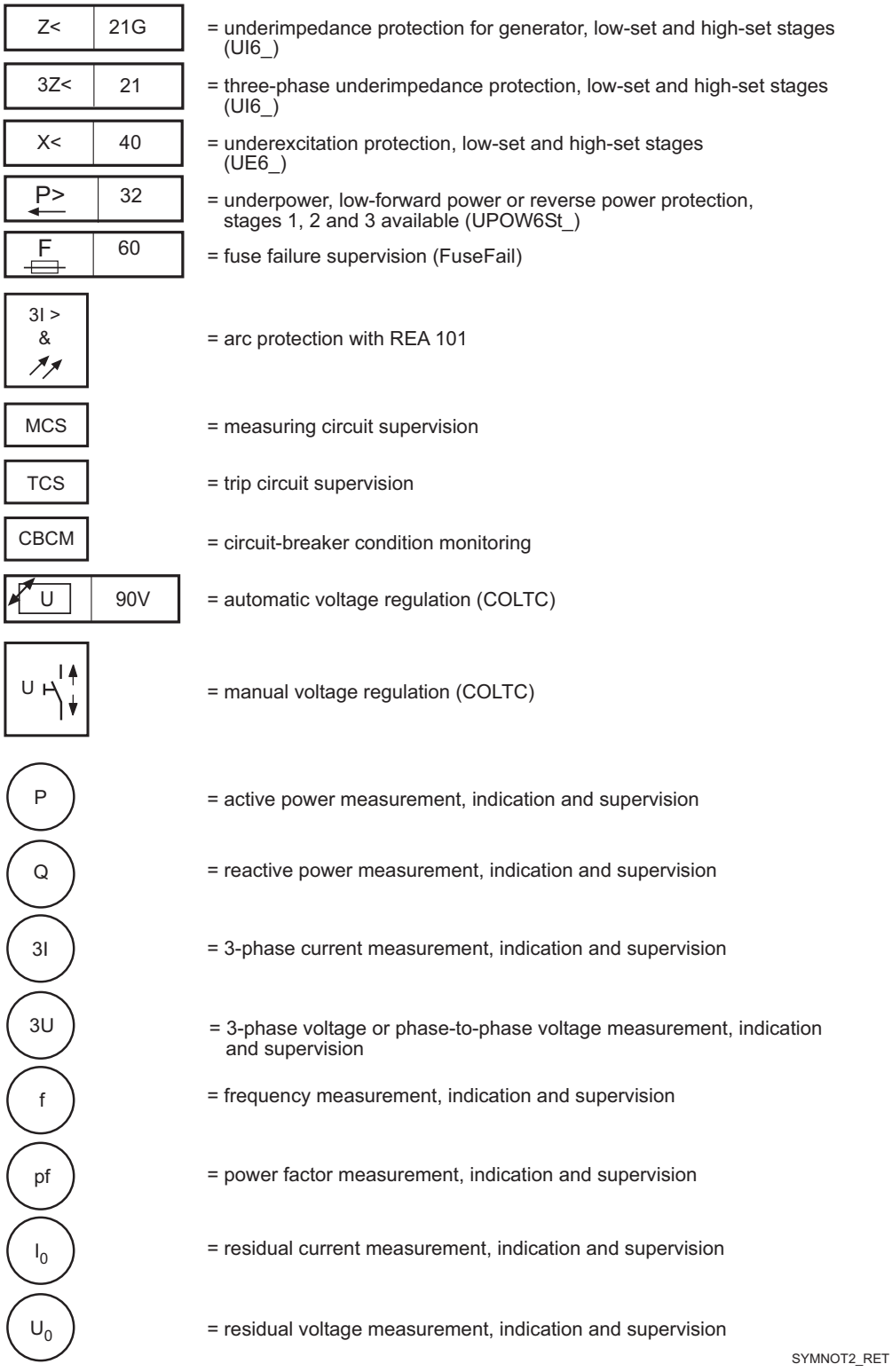



Fig. 14 Symbol notations, part II

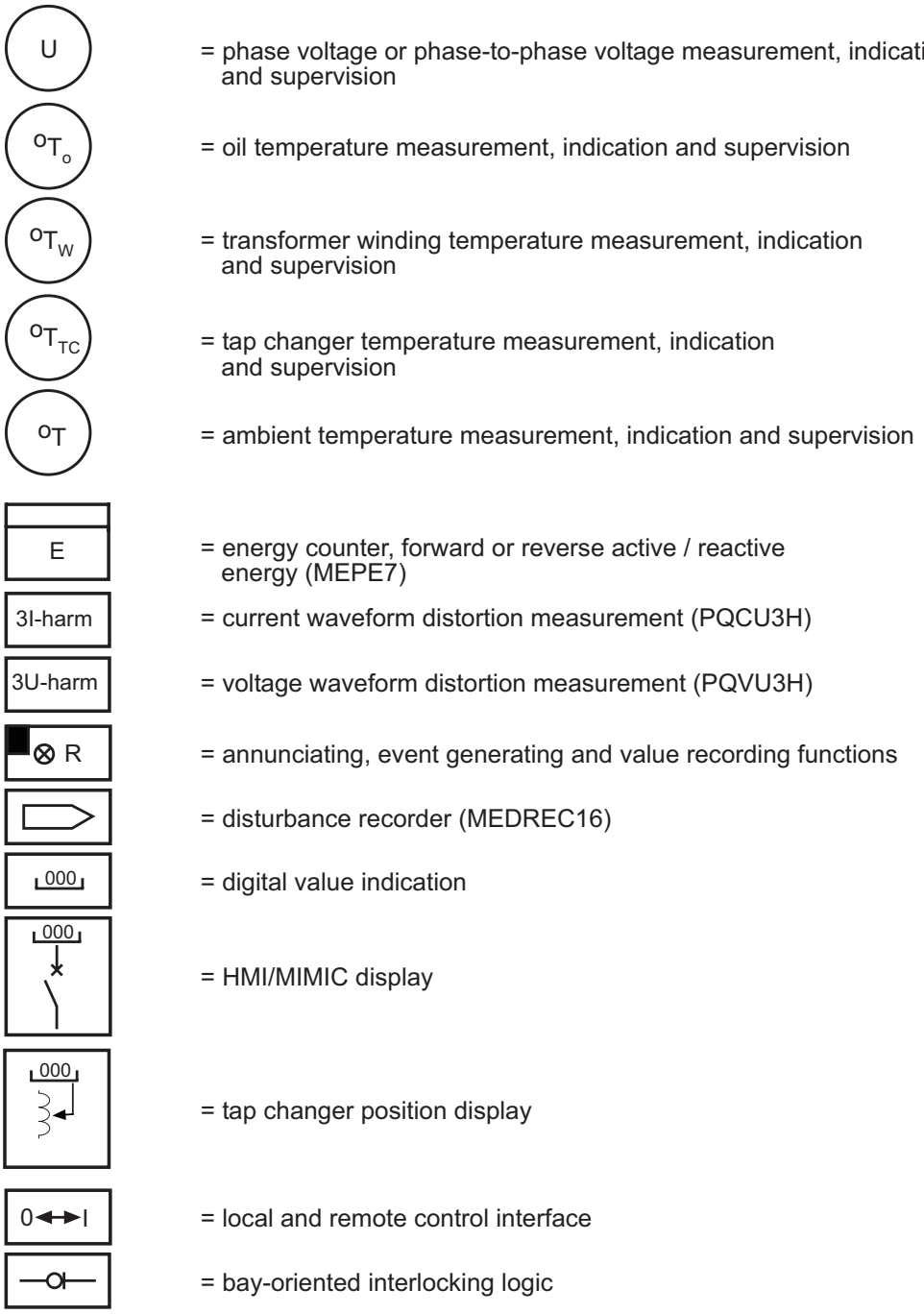



Fig. 15 Symbol notations, part III

## Application selection tables for RET 541, RET 543 and RET 545 functions

### Table 30: Protection functions

| Types of fault | IEEE Device No. | IEC Symbol | Protection function | Function block code |
|---|---|---|---|---|
| Differential protection | 87T | 3ΔI>, 3ΔI>> | Stabilized and instantaneous differential protection for transformers | Diff6T |
| Short circuit and overcurrent | 51 | 3I> | Three-phase non-directional overcurrent, low-set stage | NOC3Low |
| | 51 | 3I> | Three-phase non-directional overcurrent, low-set stage | NOC3LowB |
| | 50/51/51B | 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 o/c, low-set stage | DOC6Low |
| | 67 | 3I>>→ | Three-phase directional o/c, high-set stage | DOC6High |
| | 67 | 3I>>>→ | Three-phase directional o/c, instantaneous stage | DOC6Inst |
| Underimpedance | 21 | Z< | Three-phase underimpedance,low-set stage | UI6Low |
| | 21 | Z<< | Three-phase underimpedance, high-set stage | UI6High |
| Earth fault | 51N | Io>/SEF | Non-directional earth-fault, low-set stage (or SEF = sensitive earth-fault protection) | NEF1Low |
| | 50N/51N | Io>> | Non-directional earth-fault, high-set stage | NEF1High |
| | 50N | Io>>> | Non-directional earth-fault, instantaneous stage | NEF1Inst |
| | 67N/51N | Io>→/SEF | Directional earth-fault, low-set stage (or SEF = sensitive earth-fault protection) | DEF2Low |
| | 67N | Io>>→ | Directional earth-fault, high-set stage | DEF2High |
| | 67N | Io>>>→ | Directional earth-fault, instantaneous stage | DEF2Inst |
| | 59N | Uo> | Residual overvoltage, low-set stage | ROV1Low |
| | 59N | Uo>> | Residual overvoltage, high-set stage | ROV1High |
| | 59N | Uo>>> | Residual overvoltage, instantaneous stage | ROV1Inst |
| | 87N | ΔIo> | High-impedance based restricted earth-fault protection | REF1A |

### Table 30: Protection functions

| Types of fault | IEEE Device No. | IEC Symbol | Protection function | Function block code |
|---|---|---|---|---|
| Earth-fault | 87TN | ΔIo> | Stabilized restricted earth-fault protection | REF4A |
| | 87TN | ΔIo> | Stabilized restricted earth-fault protection | REF4B |
| Overload | 49M/49G/49T | 3 ⌙ | Three-phase thermal protection for devices (motors, generators and transformers) | TOL3Dev |
| Negative phase-seguence | 46 | $I_2$> | Negative phase-seguence protection, low-set stage | NPS3Low |
| | 46 | $I_2$>> | Negative phase-seguence protection, high-set stage | NPS3High |
| Overvoltage/ undervoltage | 59 | 3U> | Three-phase overvoltage, low-set stage | OV3Low |
| | 59 | 3U>> | Three-phase overvoltage, high-set stage | OV3High |
| | 27 | 3U< | Three-phase undervoltage, low-set stage | UV3Low |
| | 27 | 3U<< | Three-phase undervoltage, high-set stage | UV3High |
| | 27, 47, 59 | $U_1$<<br>$U_2$><br>$U_1$> | Phase-sequence voltage protection, stage 1 | PSV3St1 |
| | 27, 47, 59 | $U_1$<<br>$U_2$><br>$U_1$> | Phase-sequence voltage protection, stage 2 | PSV3St2 |
| Overfrequency/ underfrequency | 81U/81O | f</f>, df/dt | Underfrequency or overfrequency, stage 1 (incl. rate of change) | Freq1St1 |
| | 81U/81O | f</f>, df/dt | Underfrequency or overfrequency, stage 2 (incl. rate of change) | Freq1St2 |
| | 81U/81O | f</f>, df/dt | Underfrequency or overfrequency, stage 3 (incl. rate of change) | Freq1St3 |
| | 81U/81O | f</f>, df/dt | Underfrequency or overfrequency, stage 4 (incl. rate of change) | Freq1St4 |
| | 81U/81O | f</f>, df/dt | Underfrequency or overfrequency, stage 5 (incl. rate of change) | Freq1St5 |
| Overexcitation | 24 | U/f> | Overexcitation protection, low-set stage | OE1Low |
| | 24 | U/f>> | Overexcitation protection, high-set stage | OE1High |
| Additional func-tions | 68 | $3I_{2f}$> | Three-phase transformer inrush and motor start-up current detector | Inrush3 |
| | 60 | FUSEF | Fuse failure supervision | FuseFail |

**Table 31: Measurement functions**

| Types of measurement | IEC Symbol | Measurement function | Function block code |
|---|---|---|---|
| General measurement/ analog input or analog output | mA/V/°C/Ω | General measurement/ analog input on RTD/analog module | MEAI1...8 |
| | mA | Analog output on RTD/analog module | MEAO1...4 |
| Current | 3I | Three-phase current measurement, stage A | MECU3A |
| | 3I | Three-phase current measurement, stage B | MECU3B |
| | Io | Neutral current measurement, stage A | MECU1A |
| | Io | Neutral current measurement, stage B | MECU1B |
| Voltage | 3U | Three-phase voltage measurement, stage A | MEVO3A |
| | 3U | Three-phase voltage measurement, stage B | MEVO3B |
| | Uo | Residual voltage measurement, stage A | MEVO1A |
| | Uo | Residual voltage measurement, stage B | MEVO1B |
| Energy / Power | E, P, Q, pf | Three-phase power and energy measurement | MEPE7 |
| Frequency | f | System frequency measurement | MEFR1 |
| Recording |  | Transient disturbance recorder | MEDREC16 |

**Table 32: 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 |

### Table 32: Control functions

| Types of control | Symbol | Control function | Function block code |
|---|---|---|---|
| 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 |
| | | On-load tap changer controller (voltage regul.) | COLTC |
| | | MIMIC dynamic data point 1...5 | MMIDATA1...MMIDATA5 |
| | | Alarm 1...8 (HMI, remote) | MMIALAR1...MMIALAR8 |

### Table 33: Condition monitoring functions

| Types 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 for used operate time (motors) | CMTIME1 |
| | CBCM | Operate time counter 2 for used operate time (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 function of the energizing current input circuit | CMCU3 |
| | MCS | Supervision function of the energizing voltage input circuit | CMVO3 |

# References

## Additional information

| | |
|---|---|
| Transformer Terminal RET 54_ Technical Reference Manual, General | 1MRS755225 |
| Technical Descriptions of Functions | 1MRS750889-MCD (CD-ROM only) |
| Installation Manual | 1MR 750526-MUM |
| Operator's Manual | 1MR 750500-MUM |
| Technical Reference Manual RER 103 | 1MRS750532-MUM |
| Technical Reference Manual RER 123 | 1MRS751143-MUM |
| Protection & Control Terminals REF 54_, REM 54_, RET 54_ and REC 523 Configuration Guideline | 1MRS750745-MUM |
| Bus Connection Module RER 133 Technical Description | 1MRS755163 |

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