PRODUCT GUIDE

# REM615 ANSI 5.0 FP1
## Motor protection and control

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# Motor protection & control

## 1. Description

REM615 is a dedicated motor protection and control relay designed for the protection, control, measurement and supervision of asynchronous motors in manufacturing and process industry. REM615 is a member of ABB's Relion® product family and part of its 615 protection and control product series. The 615 series relays are characterized by their compactness and withdrawable-unit design.

Re-engineered from the ground up, the 615 series has been designed to unleash the full potential of the IEC 61850 standard for communication and interoperability between substation automation devices. Once the standard configuration relay has been given the application-specific settings, it can directly be put into service.

The 615 series relays support a range of communication protocols including IEC 61850 with Edition 2 support, process bus according to IEC 61850-9-2 LE, Modbus® and DNP3.

## 2. Standard configuration

REM615 is available in four alternative standard configurations. The standard signal configuration can be altered by means of the graphical signal matrix or the graphical application functionality of the Protection and Control IED Manager PCM600. Further, the application configuration functionality of the relay supports the creation of multi-layer logic functions using various logical elements including timers and flip-flops. By combining protection functions with logic function blocks, the relay configuration can be adapted to user-specific application requirements.

The relay is delivered from the factory with default connections described in the functional diagrams for binary inputs, binary outputs, function-to-function connections and alarm LEDs. Some of the supported functions in REM615 must be added with the Application Configuration tool to be available in the Signal Matrix tool and in the relay. The positive measuring direction of directional protection functions is towards the outgoing feeder.

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Figure 1. Functionality
overview for standard
configuration A



**REM615 V5.0 FP1  ANSI Func Appl A**

| | | | |
|---|---|---|---|
| 66/51LRS | 51LR-1 | 51P | 50P-1 |
| | | | 50P-3 |
| 49M | 46R | 46M-1 | 46M-2 |
| 37M-1 | | 50 BF | 50N BF |
| 51G | 50G-1 | | |
| AFD-1[1] | AFD-2[1] | AFD-3[1] | 38[2] |

[1] Available with Arc Flash Detection (AFD) option
[2] Available with RTD option

52

M

3
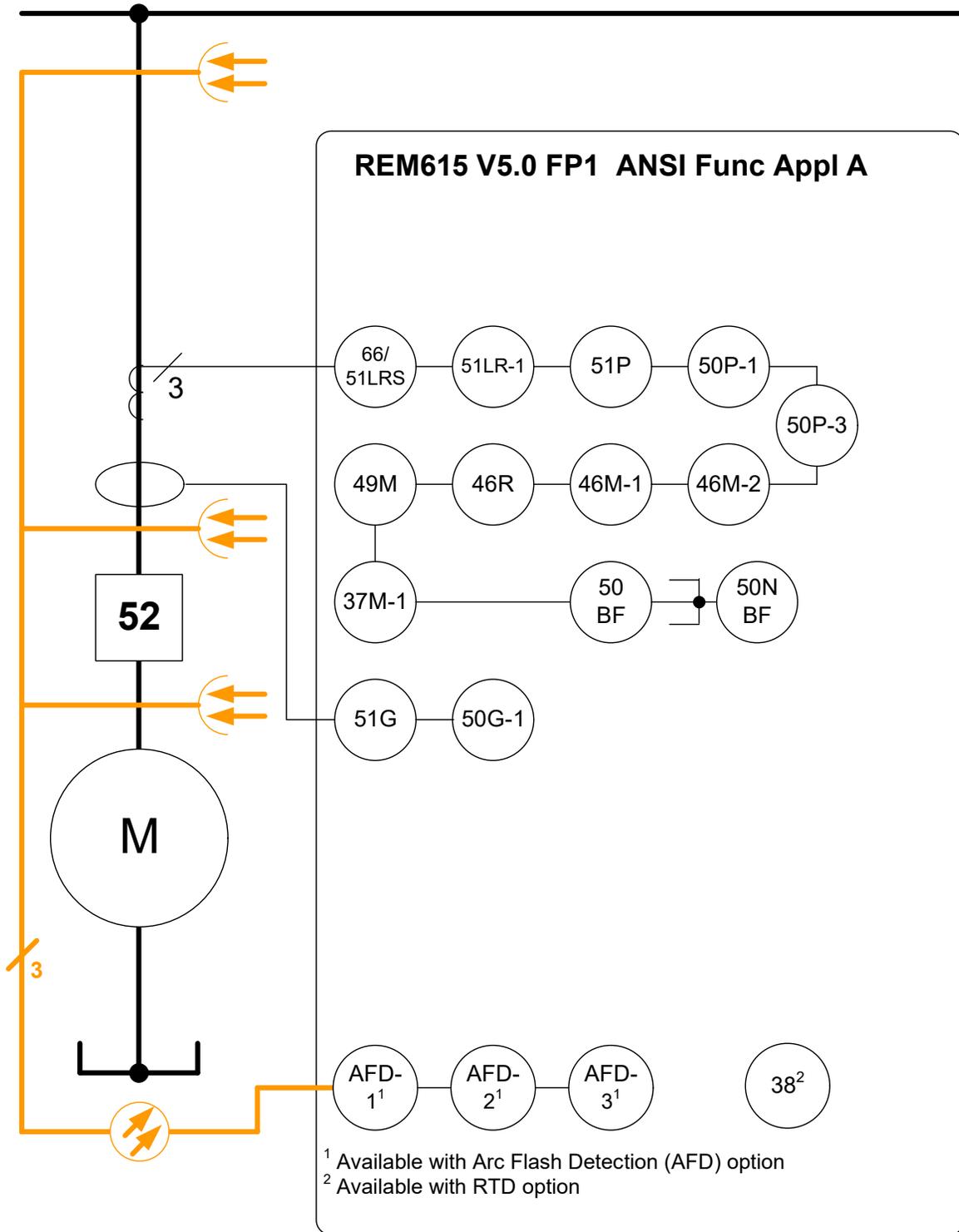
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Figure 2. Functionality
overview for standard
configuration B



Y or Δ

**REM615 V5.0 FP1 ANSI Func Appl B**

27-1  27PS  47-1  81-1  81-2

66/51LRS  51LR-1  51P  50P-1  60

49M  46R  46M-1  46M-2  27R

37M-1  50P-3  50 BF  50N BF  67/51N

51G  50G-1

52

M

AFD-1[1]  AFD-2[1]  AFD-3[1]  38[2]

[1] Available with Arc Flash Detection (AFD) option
[2] Available with RTD option
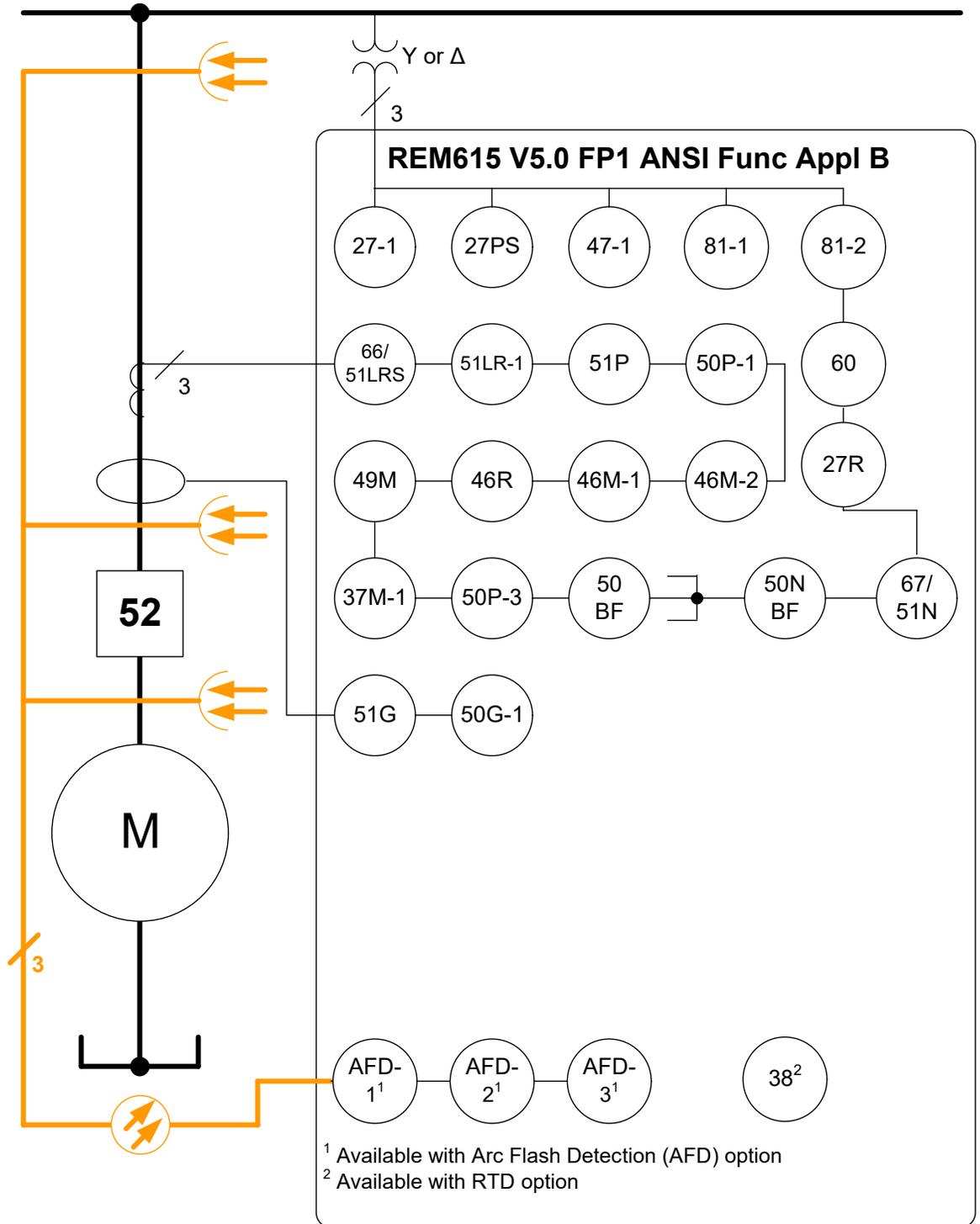
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Figure 3. Functionality
overview for standard
configuration D



Va, Vb, Vc

**REM615 V5.0 FP1 ANSI Func Appl D**

3I

27-1 · 27PS · 47-1 · 81-1 · 81-2

66/51LRS · 51LR-1 · 51P · 50P-1 · 60

49M · 46R · 46M-1 · 46M-2 · 27R

37M-1 · 50P-3 · 50 BF · 50N BF · 67/51N

51G · 50G-1

52

M

3

AFD-1[1] · AFD-2[1] · AFD-3[1]

[1] Available with Arc Flash Detection (AFD) option
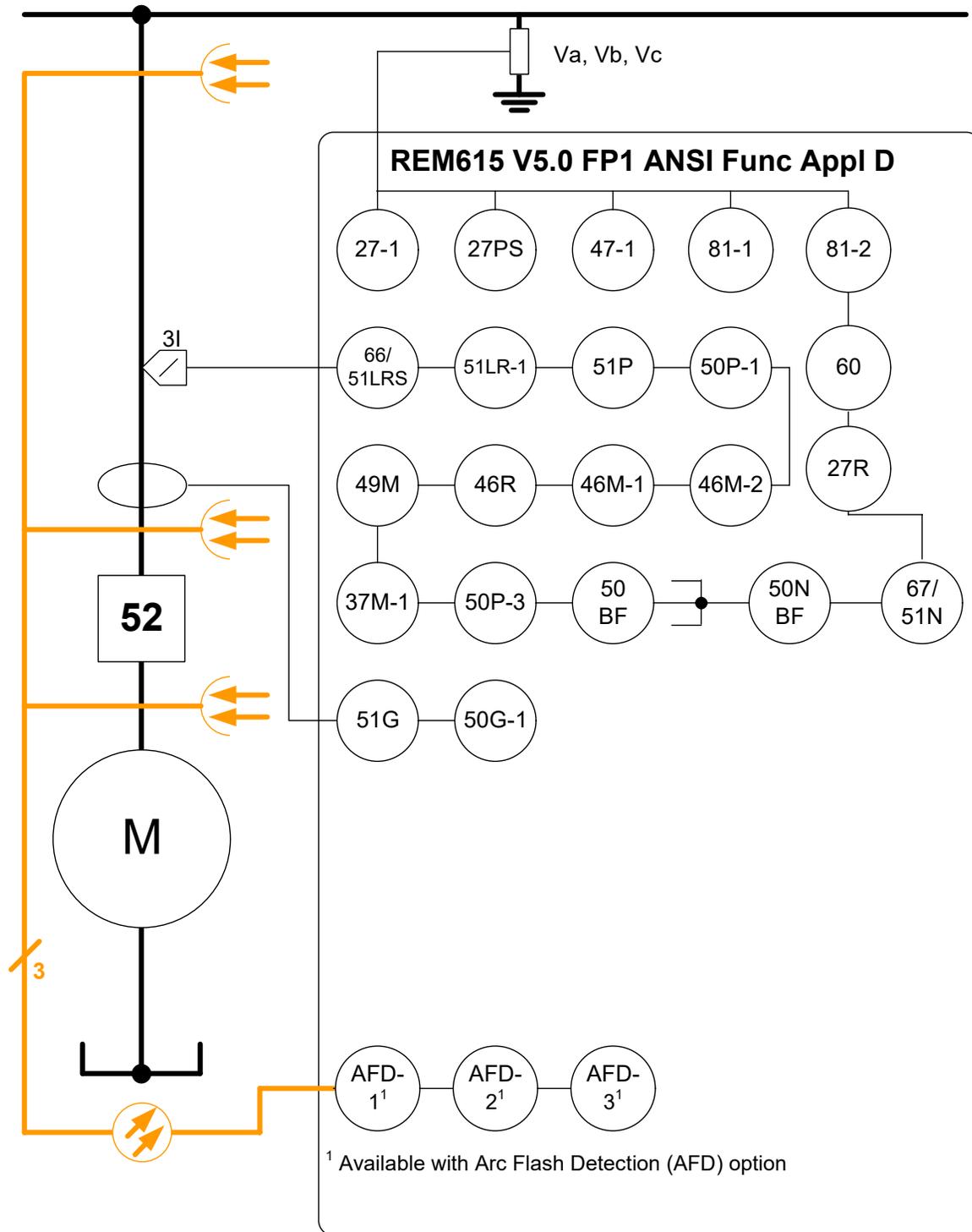
Figure 4. Functionality overview for standard configuration E
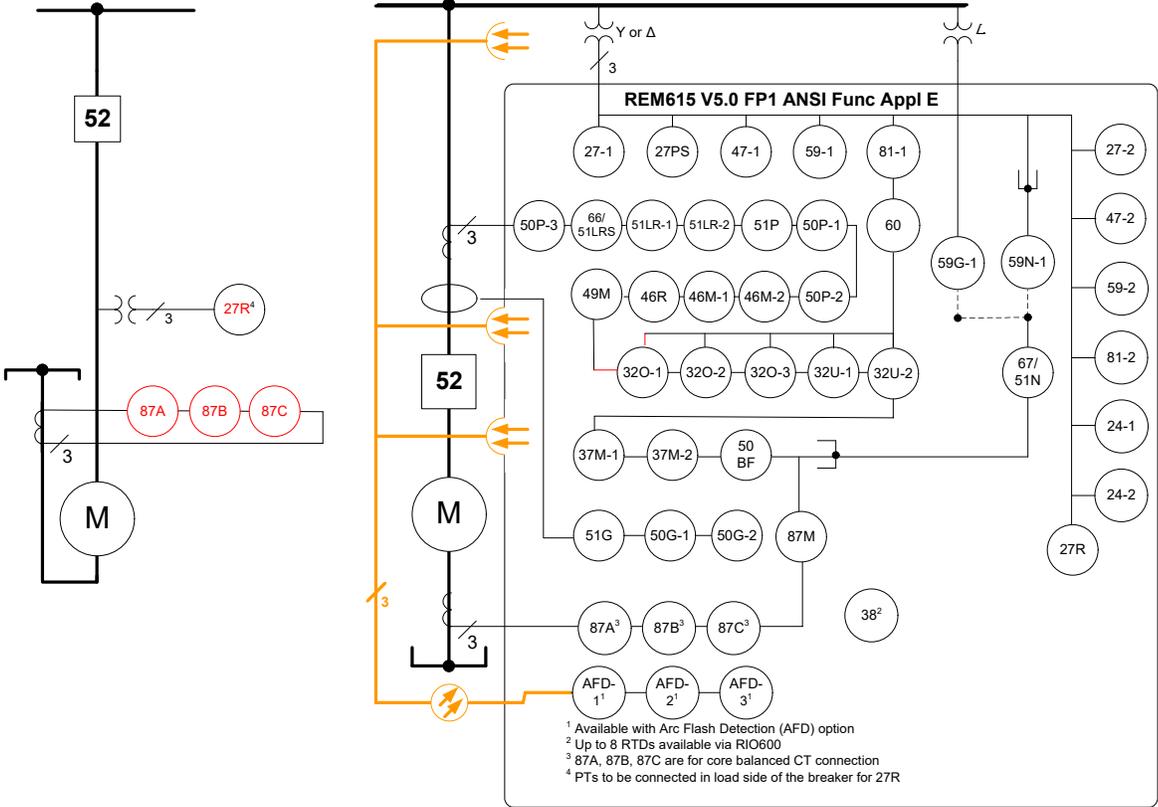
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**Table 1. Standard configurations**

| Description | Std. conf. |
|---|---|
| Basic motor protection (RTD option) | A |
| Motor protection with voltage & frequency based protection and measurements (RTD option), remanent voltage | B |
| Motor protection with voltage & frequency based protection and measurements (Sensor inputs), remanent voltage | D |
| Differential (core balance and true), overcurrent, load loss, phase and neutral voltage, frequency and RTD protection, power protection and power system metering for medium to large motors | E |

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**Table 2. Supported functions**

| Function | IEC 61850 | ANSI | A | B | D | E |
|---|---|---|---|---|---|---|
| **Protection** | | | | | | |
| Three-phase non-directional overcurrent protection, low stage | PHLPTOC | 51P | 1 | 1 | 1 | 1 |
| Three-phase non-directional overcurrent protection, high stage | PHHPTOC | 50P | 1[19] | 1[19] | 1[19] | 2 |
| Three-phase non-directional overcurrent protection, instantaneous stage | PHIPTOC | 50P-3 | 1 | 1 | 1 | 1 |
| Non-directional earth-fault protection, low stage | EFLPTOC | 51G | 1[4] | | | 1[4] |
| Non-directional earth-fault protection, high stage | EFHPTOC | 50G | 1[4] | 1[5] | 1[5] | 2[4] |
| Directional earth-fault protection, low stage | DEFLPDEF | 67/51N | | 1[4],[10] | 1[4],[10] | 1 |
| Residual overvoltage protection | ROVPTOV | 59G/59N | | | | 1<br>1 |
| Three-phase undervoltage protection | PHPTUV | 27 | | 1 | 1 | 2 |
| Three-phase overvoltage protection | PHPTOV | 59 | | | | 2 |
| Positive-sequence undervoltage protection | PSPTUV | 27PS | | 1 | 1 | 1 |
| Negative-sequence overvoltage protection | NSPTOV | 47 | | 1 | 1 | 2 |
| Three-phase remnant undervoltage protection | MSVPR | 27R | | 1 | 1 | 1 |
| Frequency protection | FRPFRQ | 81 | | 2 | 2 | 2 |
| Overexcitation protection | OEPVPH | 24 | | | | 2 |
| Negative-sequence overcurrent protection for machines | MNSPTOC | 46M | 2 | 2 | 2 | 2 |
| Loss of load supervision | LOFLPTUC | 37M | 1 | 1 | 1 | 2 |
| Motor load jam protection | JAMPTOC | 51LR | 1 | 1 | 1 | 2 |
| Motor start-up supervision | STTPMSU | 66/51LRS | 1 | 1 | 1 | 1 |
| Phase reversal protection | PREVPTOC | 46R | 1 | 1 | 1 | 1 |
| Thermal overload protection for motors | MPTTR | 49M | 1 | 1 | 1 | 1 |
| Motor differential protection | MPDIF | | | | | 1 |
| High-impedance differential protection for phase A | HIAPDIF1 | 87A | | | | 1[IA],[BS] |
| High-impedance differential protection for phase B | HIBPDIF | 87B | | | | 1[IB],[BS] |
| High-impedance differential protection for phase C | HICPDIF | 87C | | | | 1[IC],[BS] |
| Circuit breaker failure protection | CCBRBRF | 50BF | 1 | 1 | 1 | 1 |
| Master trip | TRPPTRC | 86/94 | 1<br>1[19]<br>(3)[22]<br>(3)[6] | 1<br>1[19]<br>(3)[22]<br>(3)[6] | 2<br>(3)[22]<br>(3)[6] | 2<br>(3)[22]<br>(3)[6] |
| Arc protection | ARCSARC | AFD | (3) | (3) | (3) | (3) |
| Multipurpose protection 2) | MAPGAPC | MAP | 3<br>15[19] | 3<br>15[19] | 18[19] | 18[19] |
| Underpower protection | DUPPDPR | 32U | | | | 2 |
| Reverse power/ directional overpower protection | DOPPDPR | 32O | | | | 3 |
| **Control** | | | | | | |
| Circuit breaker control | CBXCBR | 52 | 1 | 1 | 1 | 1 |
| Disconnector control | DCXSWI | 29DS | 219) | 219) | 219) | 219) |
| Earthing switch control | ESXSWI | 29GS | 119) | 119) | 119) | 119) |
| Disconnector position indication | DCSXSWI | 52-TOC, 29DS | 119)<br>219) | 119)<br>219) | 1<br>219) | 1<br>219) |

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**Table 2. Supported functions (continued)**

| Function | IEC 61850 | ANSI | A | B | D | E |
|---|---|---|---|---|---|---|
| **Control** | | | | | | |
| Earthing switch indication | ESSXSWI | 29GS | 2[19] | 2[19] | 1<br>1[19] | 1<br>1[19] |
| Emergency startup | ESMGAPC | 62EST | 1 | 1 | 1 | 1 |
| **Conditioning monitoring and supervision** | | | | | | |
| Circuit breaker condition monitoring | SSCBR | 52CM | 1 | 1 | 1 | 1 |
| Trip circuit supervision | TCSSCBR | TCM | 2 | 2 | 2 | 2 |
| Current circuit supervision | CCSPVC | CCM | 1 | 1 | 1 | 1 |
| Fuse failure supervision | SEQSPVC | 60 | | 1 | 1[19] | 1[19] |
| Runtime counter for machines and devices | MDSOPT | OPTM | 1 | 1 | 1 | 1 |
| **Measurement** | | | | | | |
| Load profile record | LDPRLRC | LOADPROF | 1 | 1 | 1 | 1 |
| Three-phase current measurement | CMMXU | IA, IB, IC | 1 | 1 | 1 | 2 |
| Sequence current measurement | CSMSQI | I1, I2, I0 | 1 | 1 | 1 | 1 |
| Residual current measurement | RESCMMXU | IG | 1 | 1 | 1 | 1 |
| Three-phase voltage measurement | VMMXU | VA, VB, VC | | 1 | 1 | 1 |
| Residual voltage measurement | RESVMMXU | VG | | | | 1 |
| Sequence voltage measurement | VSMSQI | V1, V2, V0 | | 1 | 1 | 1 |
| Single-phase power and energy measurement | SPEMMXU | SP, SE | | 1 | 1 | 1 |
| Three-phase power and energy measurement | PEMMXU | P, E | | 1 | 1 | 1 |
| RTD/mA measurement | XRGGIO130 | X130 (RTD) | (1) | (1) | | |
| Frequency measurement | FMMXU | f | | 1 | 1 | 1 |
| IEC 61850-9-2 LE sampled value sending 23), 26) | SMVSENDER | SMVSENDER | | (1) | (1) | (1) |
| IEC 61850-9-2 LE sampled value receiving (voltage sharing) 23), 26) | SMVRCV | SMVRECEIVER | | (1) | (1) | (1) |
| **Other** | | | | | | |
| Minimum pulse timer (2 pcs) | TPGAPC | 62TP | 1<br>3[19] | 3<br>1[19] | 3<br>1[19] | 3<br>1[19] |
| Minimum pulse timer (2 pcs, second resolution) | TPSGAPC | 62TPS | 1 | 1 | 1 | 1 |
| Minimum pulse timer (2 pcs, minute resolution) | TPMGAPC | 62TPM | 1[19] | 1[19] | 1[19] | 1[19] |
| Pulse timer (8 pcs) | PTGAPC | 62PT | 2[19] | 2[19] | 2[19] | 2[19] |
| Time delay off (8 pcs) | TOFGAPC | 62TOF | 4[19] | 4[19] | 4[19] | 4[19] |
| Time delay on (8 pcs) | TONGAPC | 62TON | 4[19] | 4[19] | 4[19] | 4[19] |
| Set-reset (8 pcs) | SRGAPC | SR | 4[19] | 4[19] | 4[19] | 4[19] |
| Move (8 pcs) | MVGAPC | MV | 2[19] | 2[19] | 2[19] | 2[19] |
| Generic control point (16 pcs) | SPCGAPC | SPC | 2[19] | 2[19] | 2[19] | 2[19] |
| Analog value scaling (4 pcs) | SCA4GAPC | SCA4 | 4[19] | 4[19] | 4[19] | 4[19] |
| Integer value move (4 pcs) | MVI4GAPC | MVI4 | 1[19] | 1[19] | 1[19] | 1[19] |
| Generic up-down counters | UDFCNT | CTR | 4[19] | 4[19] | 4[19] | 4[19] |

() = optional

1) One of the following can be ordered as an option; Admittance based E/F, Wattmetric based E/F or Harmonics based E/F. The option is an addition to the existing E/F of the original configuration. The optional E/F has also a predefined configuration in the relay. The optional E/F can be set on or off.

2) Multi-purpose protection is used for, for example, RTD/mA based protection, or Analogue Goose

3) Light only

4) Io selectable by parameter, Io measured as default

5) Io selectable by parameter, Io calculated as default

6) Io calculated is always used

7) IoB calculated is always used

8) IoB calculated and 3IB are always used

9) Uo selectable by parameter, Uo measured as default

10) Uo calculated and negative sequence voltage selectable by parameter, Uo calculated as default

11) Uo calculated is always used

12) Uo measured is always used

13) IoB measured is always used

14) IoB measured and 3IB are always used
15) Io measured is always used
16) IoB selectable by parameter, IoB measured as default
17) Power quality option includes Current total demand distortion, Voltage total harmonic distortion and Voltage variation.
18) Available in IED and SMT but not connected to anything in logic.
19) Must be added with ACT to be available in SMT and in IED.
20) Uob measured is always used for unbalance protection with unearthed single Y connected capacitor bank.
21) The Iunb measurements values will be taken from this block and put in Measurent view.
22)  Master Trip included and connected to corresponding HSO in the configuration only when BIO0007 module is used. If additionally the ARC option is selected, then ARCSARC is connected in the configuration to the corresponding Master Trip input.
23) Only available with COM0031-0037
24) Power quality option includes only Current total demand distortion
25) Unbalance voltage measurement for capacitor bank for REV615
26) Only available with IEC 61850-9-2
LV) The function block is to be used on the low voltage side in the application
HV) The function block is to be used on the high voltage side in the application
NT) The function block is to be used on the neutral side in the application
TR) The function block is to be used on the terminal side in the application
BS) The function block is to be used on the bus side in the application
EX) This function to be excluded from the Integration Test Data generation

### 3. Protection functions

The relay offers all the functionality needed to manage motor start-ups and normal operation, also including protection and fault clearance in abnormal situations. The main features of the relay include thermal overload protection, motor start-up supervision, locked rotor protection and protection against too frequent motor start-ups. The relay also incorporates nondirectional ground-fault protection, negative phase-sequence current unbalance protection and backup overcurrent protection. Furthermore, the relay offers motor running stall protection, loss-of-load supervision and phase reversal protection.

Standard configurations B and D additionally offer directional ground-fault protection, three-phase undervoltage protection, negative-sequence overvoltage and positive-sequence undervoltage protection. Further, the B and D configurations offer frequency protection including overfrequency, underfrequency and rate-of-change frequency protection modes.

The RTD/mA module offered as an option for standard configurations A and B enables the use of the optional multipurpose protection function for tripping and alarm
purposes using RTD/mA measuring data or analog values via GOOSE messages.

In certain motor drives of special importance there must be a possibility to override the motor thermal overload protection to perform an emergency start of a hot motor. To enable an emergency hot start, REM615 offers a forced start execution feature.

Enhanced with optional hardware and software, the relay also features three light detection channels for arc fault protection of the circuit breaker, busbar and cable compartment of metal-enclosed indoor switchgear.

The arc-fault protection sensor interface is available on the optional communication module. Fast tripping increases staff safety and security and limits material damage in an arc fault situation. A binary input and output module can be selected as an option - having three high speed binary outputs (HSO) it further decreases the total operate time with typically 4...6 ms compared to the normal power outputs.

### 4. Application

REM615 constitutes main protection for asynchronous motors and the associated drives. Typically, the motor relay is used with circuit breaker or contactor controlled HV motors, and contactor controlled medium sized and large LV motors in a variety of drives, such as pumps and conveyors, crushers and choppers, mixers and agitators, fans and aerators.

The motor relay is thoroughly adapted for ground-fault protection. Using cable current transformers sensitive and reliable ground-fault protection can be achieved. Phase current transformers in Holmgreen (summation) connection can also be used for ground-fault protection. In that case possible unwanted operations of the ground-fault protection at motor start-up due to CT saturation can be prevented using the relay's internal interlocking features or a suitable stabilizing resistor in the common neutral return.

The optional RTD/mA module offered for standard configurations A and B facilitates the measurement of up to eight analog signals via the six RTD inputs or the two mA inputs using transducers. The RTD and mA inputs can be used for temperature monitoring of motor bearings and stator windings, thus expanding the functionality of the thermal overload protection and preventing premature aging of the motor. Furthermore, the RTD/mA inputs can be used for measuring the ambient cooling air temperature. The analog temperature values can, if re-

quired, be sent to other devices using analog horizontal GOOSE messaging. Temperature values can also be received from other devices over the station bus, thus increasing the extent of relevant information.

The standard configuration D includes one conventional residual current (Io) input and three combi-sensor inputs for phase currents and phase voltages. The connection of the three combi-sensors is made with RJ-45 type of connectors.

Sensors offer certain benefits compared to conventional current and voltage instrument transformers, for example, current sensors do not saturate at high currents, they consume less energy and they weigh less. In voltage sensors the risk of ferro-resonance is eliminated. The sensor inputs also enable the use of the relay in compact medium voltage switchgears, such as ABB's ReliaGear® ND Digital, Advance Digital and SafeGear Digital, with limited space for conventional measuring transformers, thus requiring the use of sensor technology. Further, the adapters also enable the use of sensors with Twin-BNC connectors.

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Figure 5. Motor protection and control of circuit breaker controlled motors using standard configurations A,B, and E
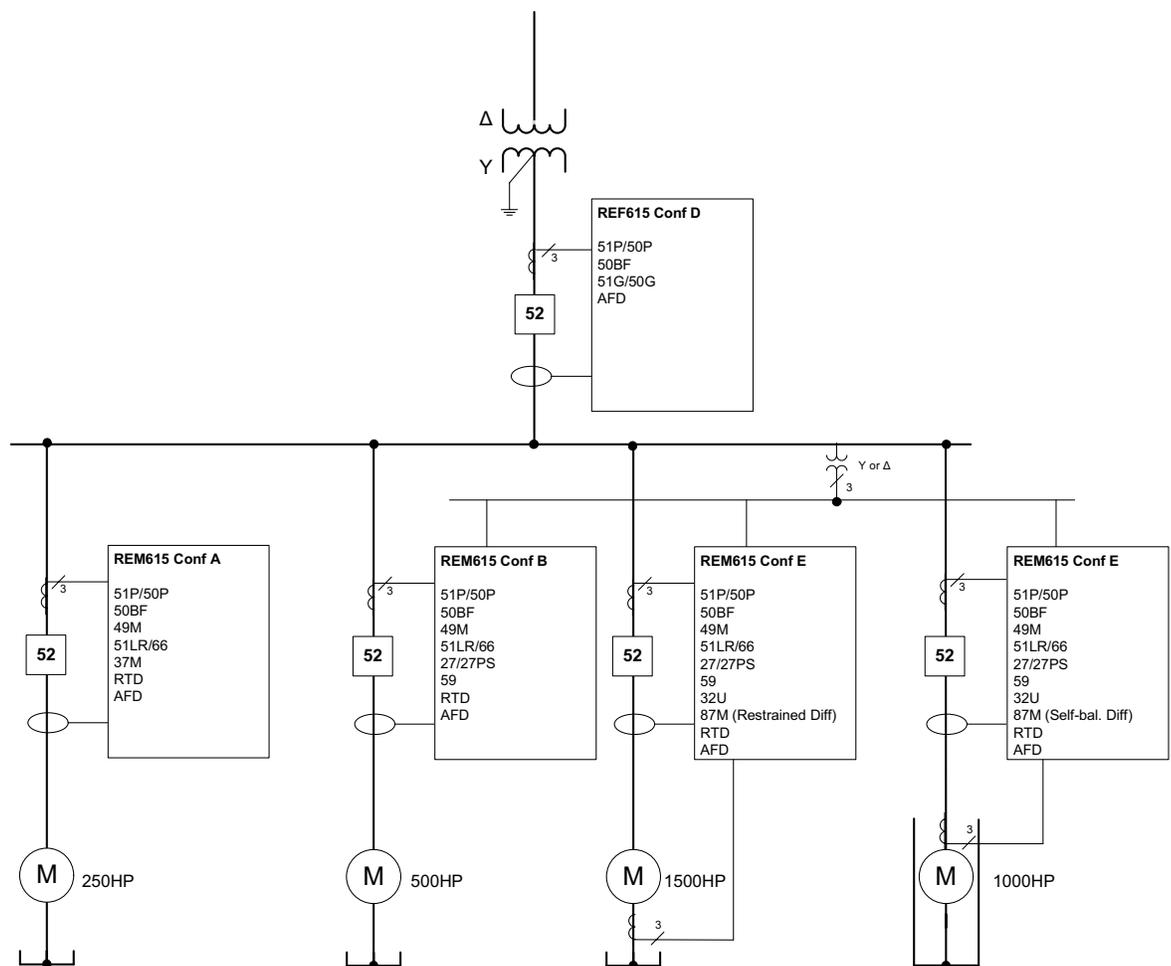


**Figure 5 illustrates an example of motor protection and control of circuit breaker controlled motors using standard configurations A, B, and E. To prevent possible power system instability due to busbar voltage collapse, the** **simultaneous starting of several motors can be inhibited with the "restart inhibit" input of REM615. The optional RTD/mA inputs are utilized for motor winding and bearing temperature supervision.**

Figure 6. Motor protection and control of contactor and circuit breaker controlled motors using standard configuration D
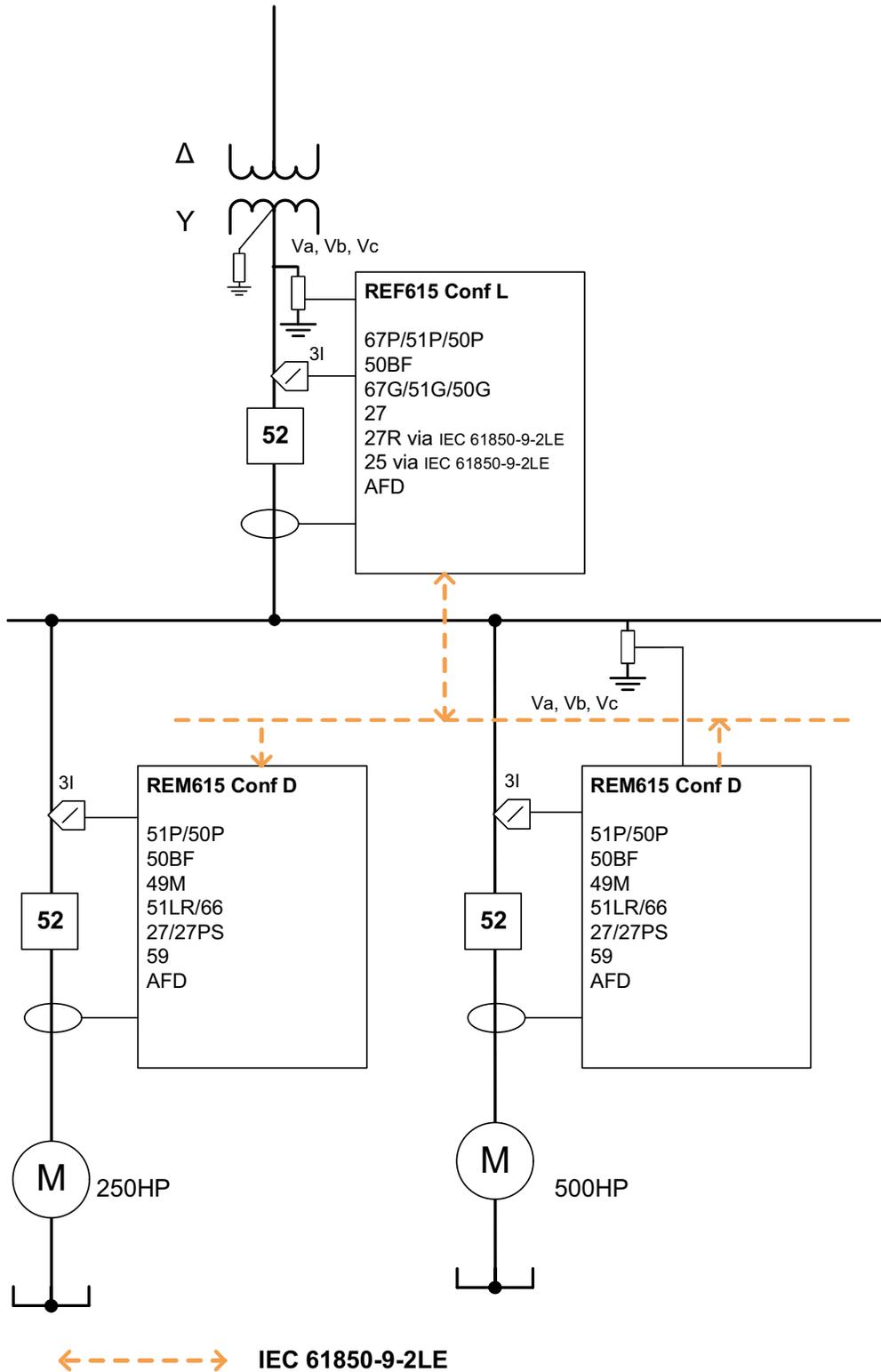
Example of motor protection and control of contactor and circuit breaker controlled motors using standard configuration D is shown in Figure 6. In this configuration current sensors (Rogowski coil) and voltage sensors (voltage divider) are used for the measurements. To prevent possible power system instability due to busbar voltage collapse, the simultaneous starting of several motors can be inhibited with the "restart inhibit" input of REM615. The optional RTD/mA inputs are utilized for motor winding and bearing temperature supervision.

The standard configuration D has been pre-configured especially for ABB switchgears, for example, Advance Digital. The use of this configuration is not restricted for that purpose only.

**5. Supported ABB solutions**

The 615 series protection relays together with the Substation Management Unit COM600F constitute a genuine IEC 61850 solution for reliable power distribution in utility and industrial power systems. To facilitate the system engineering, ABB's relays are supplied with connectivity packages. The connectivity packages include a compilation of software and relay-specific information, including single-line diagram templates and a full relay data model. The data model includes event and parameter lists. With the connectivity packages, the relays can be readily configured using PCM600 and integrated with COM600F or the network control and management system MicroSCADA Pro.

The 615 series relays offer native support for IEC 61850 Edition 2 also including binary and analog horizontal GOOSE messaging. In addition, process bus with the sending of sampled values of analog currents and voltages and the receiving of sampled values of voltages is supported. Compared to traditional hard-wired, inter-device signaling, peer-to-peer communication over a switched Ethernet LAN offers an advanced and versatile platform for power system protection. Among the distinctive features of the protection system approach, enabled by the full implementation of the IEC 61850 substation automation standard, are fast communication capability, continuous supervision of the protection and communication system's integrity, and an inherent flexibility regarding reconfiguration and upgrades.This protection relay series is able to optimally utilize interoperability provided by the IEC 61850 Edition 2 features.

At substation level, COM600F uses the data content of the baylevel devices to enhance substation level functionality. COM600F features a Web browser-based HMI, which provides a customizable graphical display for visualizing single-line mimic diagrams for switchgear bay solutions. The SLD feature is especially useful when 615 series relays without the optional single-line diagram feature are used. The Web HMI of COM600F also provides an overview of the whole substation, including relay-specific single-line diagrams, which makes information easily accessible. Substation devices and processes can also be remotely accessed through the Web HMI, which improves personnel safety. In addition, COM600F can be used as a local data warehouse for the substation's technical documentation and for the network data collected by the devices. The collected network data facilitates extensive reporting and analyzing of network fault situations by using the data historian and event handling features of COM600F. The historical data can be used for accurate monitoring of process and equipment performance, using calculations based on both real-time and historical values. A better understanding of the process dynamics is achieved by combining time-based process measurements with production and maintenance events.

COM600F can also function as a gateway and provide seamless connectivity between the substation devices and network-level control and management systems, such as MicroSCADA Pro and System 800xA.

GOOSE Analyzer interface in COM600F enables the following and analyzing the horizontal IEC 61850 application during commissioning and operation at station level. It logs all GOOSE events during substation operation to enable improved system supervision.

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**Table 3. Supported ABB solutions**

| Product | Version |
| --- | --- |
| Substation Management Unit COM600F | 5.0 or later |
| MicroSCADA Pro SYS 600 | 9.4 or later (Edition 2) |
| System 800xA | 5.1 or later |

Figure 7. ABB power
system example using
Relion relays, COM600F
and MicroSCADA Pro/
System 800xA
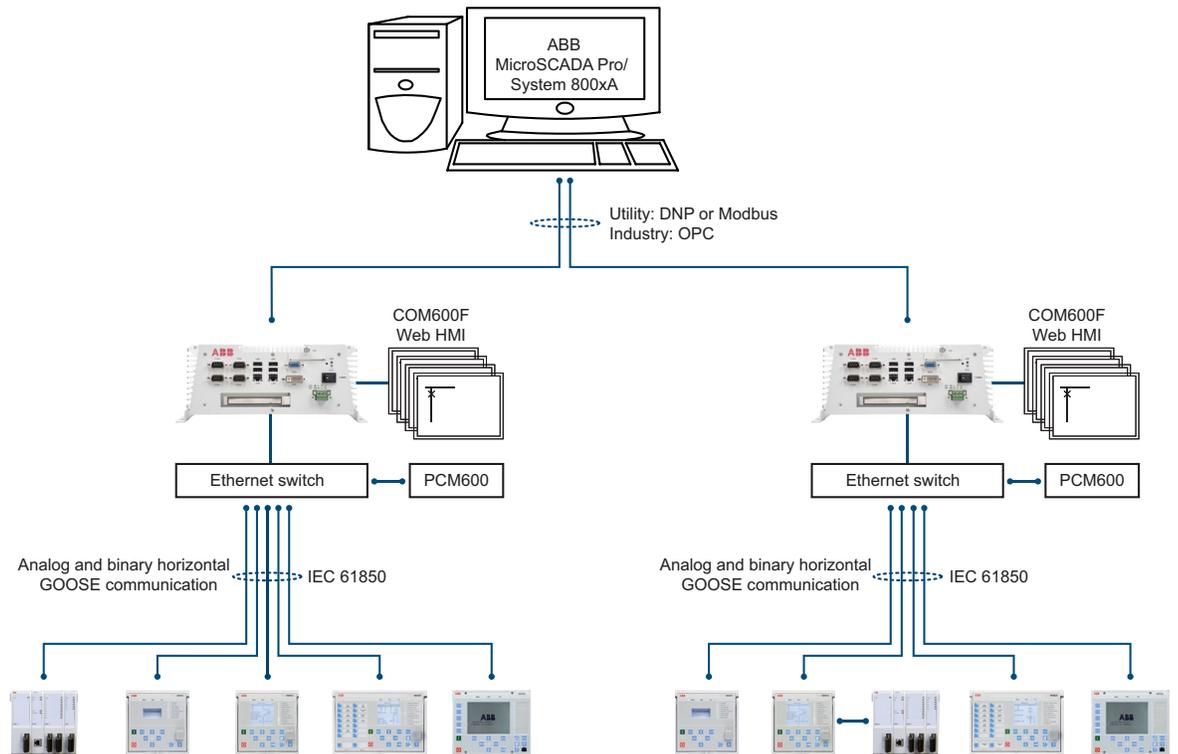


## 6. Control

REM615 integrates functionality for the control of a
circuit breaker via the front panel HMI or by means
of remote controls. In addition to the circuit breaker
control the relay features two control blocks which
are intended for motor-operated control of discon-
nectors or circuit breaker truck and for their posi-
tion indications. Further, the relay offers one con-
trol block which is intended for motor-operated
control of one earthing switch control and its posi-
tion indication.

Two physical binary inputs and two physical binary
outputs are needed in the relay for each controlla-
ble primary device taken into use. Depending on the
chosen standard configuration of the relay the
number of unused binary inputs and binary outputs
varies. Further, some standard configurations also
offer optional hardware modules that increase the
number of available binary inputs and outputs.

If the amount of available binary inputs or outputs
of the chosen standard configuration is not suffi-
cient, the standard configuration can be modified
to release some binary inputs or outputs which
have originally been configured for other purposes,
when applicable, or an external input or output
module, for example, RIO600 can be integrated to

the relay. The binary inputs and outputs of the ex-
ternal I/O module can be used for the less time crit-
ical binary signals of the application. The integra-
tion enables releasing of some initially reserved
binary inputs and outputs of the relay in the stan-
dard configuration.
The suitability of the binary outputs of the relay
which have been

selected for controlling of primary devices should
be carefully verified, for example the make and
carry as well as the breaking capacity. In case the
requirements for the control-circuit of the primary
device are not met, the use of external auxiliary re-
lays should to be considered.

The large graphical LCD of the relay's HMI includes a
single-line diagram (SLD) with position indication
for the relevant primary devices. Interlocking
schemes required by the application are configured
using the signal matrix or the application configu-
ration functionality of PCM600.

The relay is provided with a load profile recorder.
The load profile feature stores the historical load
data captured at a periodical time interval (demand
interval). The records are in COMTRADE format.

**7. Measurement**
The relay continuously measures the phase currents and the neutral current. Furthermore, the relay measures the phase voltages and the residual voltage. Depending on the standard configuration, the relay also offers frequency measurement. In addition, the relay calculates the symmetrical components of the currents and voltages, maximum current demand value over a user-selectable pre-set time frame, the active and reactive power, the power factor and the active and reactive energy values. Calculated values are also obtained from the protection and condition monitoring functions of the relay.

The measured values can be accessed via the local HMI or remotely via the communication interface of the relay. The values can also be accessed locally or remotely using the Web HMI.

The relay is provided with a load profile recorder. The load profile feature stores the historical load data captured at a periodical time interval (demand interval). The records are in COMTRADE format.

**8. Disturbance recorder**
The relay is provided with a disturbance recorder featuring up to 12 analog and 64 binary signal channels. The analog channels can be set to record either the waveform or the trend of the currents and voltages measured.

The analog channels can be set to trigger the recording function when the measured value falls below or exceeds the set values. The binary signal channels can be set to start a recording either on the rising or the falling edge of the binary signal or on both.

By default, the binary channels are set to record external or internal relay signals, for example, the start or trip signals of the relay stages, or external blocking or control signals. Binary relay signals, such as protection start and trip signals, or an external relay control signal via a binary input, can be set to trigger the recording. Recorded information is stored in a non-volatile memory and can be uploaded for subsequent fault analysis.

**9. Event log**
To collect sequence-of-events information, the relay has a non-volatile memory capable of storing 1024 events with the associated time stamps. The non-volatile memory retains its data even if the relay temporarily loses its auxiliary supply. The event log facilitates detailed pre- and post-fault analyses of feeder faults and disturbances. The considerable capacity to process and store data and events in the relay facilitates meeting the growing information demand of future network configurations.

The sequence-of-events information can be accessed either via local HMI or remotely via the communication interface of the relay. The information can also be accessed locally or remotely using the Web HMI.

**10. Recorded data**
The relay has the capacity to store the records of the 128 latest fault events. The records can be used to analyze the power system events. Each record includes, for example, current, voltage and angle values and a time stamp. The fault recording can be triggered by the start or the trip signal of a protection block, or by both. The available measurement modes include DFT, RMS and peak-to-peak. Fault records store relay measurement values at the moment when any protection function starts. In addition, the maximum demand current with time stamp is separately recorded. The records are stored in the non-volatile memory.

Figure 8. Recording and event capabilities overview
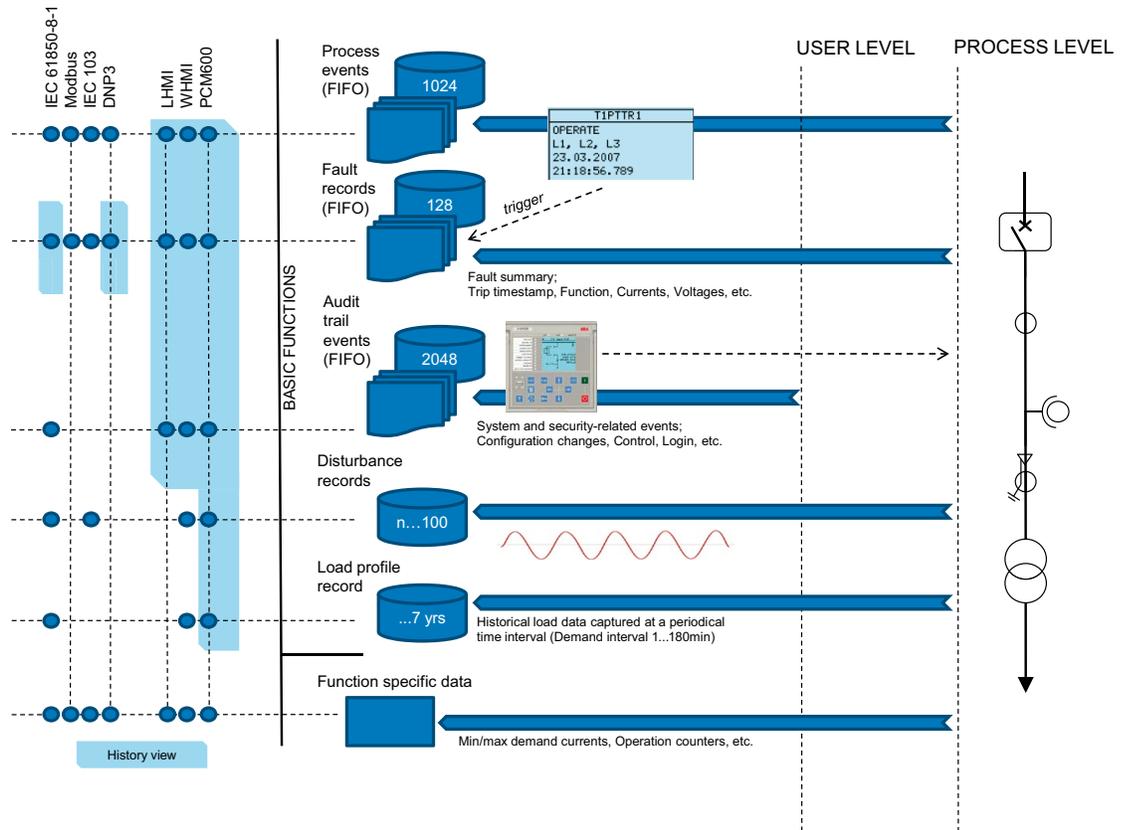


## 11. Condition monitoring

The condition monitoring functions of the relay constantly monitor the performance and the condition of the circuit breaker.

The monitoring comprises the spring charging time, SF6 gas pressure, the travel time and the inactivity time of the circuit breaker. The monitoring functions provide operational circuit breaker
history data, which can be used for scheduling preventive circuit breaker maintenance.

In addition, the relay includes a runtime counter for monitoring of how many hours the motor has been in operation thus enabling scheduling of time-based preventive maintenance of the motor.

## 12. Trip-circuit supervision

The trip-circuit supervision continuously monitors the availability and operability of the trip circuit. It provides opencircuit monitoring both when the circuit breaker is in its closed and in its open position. It also detects loss of circuit-breaker control voltage.

## 13. Self-supervision

The relay's built-in self-supervision system continuously monitors the state of the relay hardware and the operation of the relay software. Any fault or malfunction detected is used for alerting the operator.

A permanent relay fault blocks the protection functions to prevent incorrect operation.

### 14. Fuse failure supervision

The relay includes fuse failure supervision functionality. The fuse failure supervision detects failures between the voltage measurement circuit and the relay. The failures are detected either by the negative sequence-based algorithm or by the delta voltage and delta current algorithm. Upon the detection of a failure, the fuse failure supervision function activates an alarm and blocks voltage-dependent protection functions from unintended operation.

### 15. Current circuit supervision

The relay includes current circuit supervision. Current circuit supervision is used for detecting faults in the current transformer secondary circuits. On detecting of a fault the current circuit supervision function activates an alarm LED and blocks certain protection functions to avoid unintended operation. The current circuit supervision function calculates the sum of the phase currents from the protection cores and compares the sum with the measured single reference current from a core balance current transformer or from separate cores in the phase current transformers.

### 16. Access control

To protect the relay from unauthorized access and to maintain information integrity, the relay is provided with a four-level, rolebased authentication system with administrator-programmable individual passwords for the viewer, operator, engineer and administrator levels. The access control applies to the local
HMI, the Web HMI and PCM600.

### 17. Inputs and outputs

The relay is equipped with three phase-current inputs, one residual-current input, three phase-voltage inputs and one residual voltage input. The phase-current inputs and the residual current inputs are rated 1/5 A, that is, the inputs allow connection of either 1 A or 5 A secondary current transformers. The optional residual-current input 0.2/1 A is normally used in applications requiring sensitive earth-fault protection and
featuring core-balance current transformers. The three phase voltage inputs and the residual-voltage input covers the rated voltages 60-210 V. Both phase-to-phase voltages and phaseto- earth voltages can be connected.

The standard configuration D includes one conventional residual current (Io 0.2/1 A) input and three sensor inputs for the direct connection of three combi-sensors with RJ-45 connectors. As an alternative to combi-sensors, separate current and voltage sensors can be utilized using adapters. Furthermore, the adapters also enable the use of sensors with Twin-BNC connectors.

The rated values of the current and voltage inputs are settable parameters of the relay. In addition, the binary input thresholds are selectable within the range of 16…176 V DC by adjusting the relay's parameter settings.

All binary inputs and outputs contacts are freely configurable with the signal matrix or application configuration functionality of PCM600.

As an option for standard configurations A and B, the relay offers six RTD inputs and two mA inputs. By means of the optional RTD/mA module the relay can measure up to eight analog signals such as temperature, pressure and tap changer position values via the six RTD inputs or the two mA inputs using transducers. The values can, apart from measuring and monitoring purposes, be used for tripping and alarm purposes using the offered optional multipurpose protection functions.

Optionally, a binary input and output module can be selected. It has three high speed binary outputs (HSO) and it decreases the total operate time with typically 4...6 ms compared to the normal power outputs.

See the Input/output overview table and the terminal diagrams for more information about the inputs and outputs.

—
**Table 4. Input/output overview**

| Std. conf. | Order code digit | | Analog channels | | | Binary channels | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 5-6 | 7-8 | CT | VT | Combi-sensor | BI | BO | RTD | mA |
| A | AC/AD | AB | 4 | — | — | 4 | 4 PO + 2 SO | — | — |
| | | AD | 4 | — | — | 12 | 4 PO + 6 SO | — | — |
| | | FE | 4 | — | — | 12 | 4 PO + 2 SO + 3 HSO | — | — |
| | AG/AH | AB | 4 | — | — | 4 | 4 PO + 2 SO | 6 | 2 |
| B | CA/CB | AH | 4 | 3 | — | 8 | 4 PO + 6 SO | — | — |
| | | AJ | 4 | 3 | — | 14 | 4 PO + 9 SO | — | — |
| | | FD | 4 | 3 | — | 8 | 4 PO + 2 SO + 3 HSO | — | — |
| | | FF | 4 | 3 | — | 14 | 4 PO + 5 SO + 3 HSO | — | — |
| | CC/CD | AH | 4 | 3 | — | 8 | 4 PO + 2 SO | 6 | 2 |
| | | FD | 4 | 3 | — | 8 | 4 PO + 2 SO + 3 HSO | 6 | 2 |
| D | DA | AH | 1 | — | 3 | 8 | 4 PO + 6 SO | — | — |
| | | FD | 1 | — | 3 | 8 | 4 PO + 2 SO + 3 HSO | — | — |
| E | BC | AD | 7 | 5 | — | 12 | 4 PO + 6 SO | — | — |
| | | FE | 7 | 5 | — | 12 | 4 PO + 2 SO + 3 HSO | — | — |

## 18. Station communication

The relay supports a range of communication protocols including IEC 61850 Edition 2, IEC 61850-9-2 LE, Modbus® and DNP3. Operational information and controls are available through these protocols. However, some communication functionality, for example, horizontal communication between the relays, is only enabled by the IEC 61850 communication protocol.

The IEC 61850 protocol is a core part of the relay as the protection and control application is fully based on standard modelling. The relay supports Edition 2 and Edition 1 versions of the standard. With Edition 2 support, the relay has the latest functionality modelling for substation applications and the best interoperability for modern substations. It incorporates also the full support of standard device mode functionality supporting different test applications. Control applications can utilize the new safe and advanced station control authority feature.

The IEC 61850 communication implementation supports monitoring and control functions. Additionally, parameter settings, disturbance recordings and fault records can be accessed using the IEC 61850 protocol. Disturbance recordings are available to any Ethernet-based application in the standard COM-TRADE file format. The relay supports simultaneous event reporting to five different clients on the station bus. The relay can exchange data with other devices using the IEC 61850 protocol.

The relay can send binary and analog signals to other devices using the IEC 61850-8-1 GOOSE (Generic Object Oriented Substation Event) profile. Binary GOOSE messaging can, for example, be employed for protection and interlocking-based protection schemes. The relay meets the GOOSE performance requirements for tripping applications in distribution substations, as defined by the IEC 61850 standard (<10 ms data exchange between the devices). The relay also supports the sending and receiving of analog values using GOOSE messaging. Analog GOOSE messaging enables easy transfer of analog measurement values over the station bus, thus facilitating for example the sending of measurement values between the relays when controlling parallel running transformers.

The relay also supports IEC 61850 process bus by sending sampled values of analog currents and voltages and by receiving sampled values of voltages. With this functionality the galvanic interpanel wiring can be replaced with Ethernet communication. The measured values are transferred as sampled values using IEC 61850-9-2 LE protocol. The intended application for sampled values shares the voltages to other 615 series relays, having voltage based functions and 9-2 support. 615 relays with process bus based applications use IEEE 1588 for high accuracy time synchronization.

For redundant Ethernet communication, the relay offers either two optical or two galvanic Ethernet network interfaces. A third port with galvanic Ethernet network interface is also available. The third Ethernet interface provides connectivity for any other Ethernet device to an IEC 61850 station bus inside a switchgear bay, for example connection of a Remote I/O. Ethernet network redundancy can be achieved using the high-availability seamless redundancy (HSR) protocol or the parallel redundancy protocol (PRP) or a with self-healing ring using RSTP in managed switches. Ethernet redundancy can be applied to Ethernet-based IEC 61850, Modbus and DNP3 protocols.

The IEC 61850 standard specifies network redundancy which improves the system availability for the substation communication. The network redundancy is based on two complementary protocols defined in the IEC 62439-3 standard: PRP and HSR protocols. Both the protocols are able to overcome a failure of a link or switch with a zero switch-over time. In both the protocols, each network node has two identical Ethernet ports dedicated for one network connection. The protocols rely on the duplication of all transmitted information and provide a zero switch-over time if the links or switches fail, thus fulfilling all the stringent real-time requirements of substation automation.

In PRP, each network node is attached to two independent networks operated in parallel. The networks are completely separated to ensure failure independence and can have different topologies. The networks operate in parallel, thus providing zero-time recovery and continuous checking of redundancy to avoid failures.

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Figure 9. Parallel redundancy protocol (PRP) solution
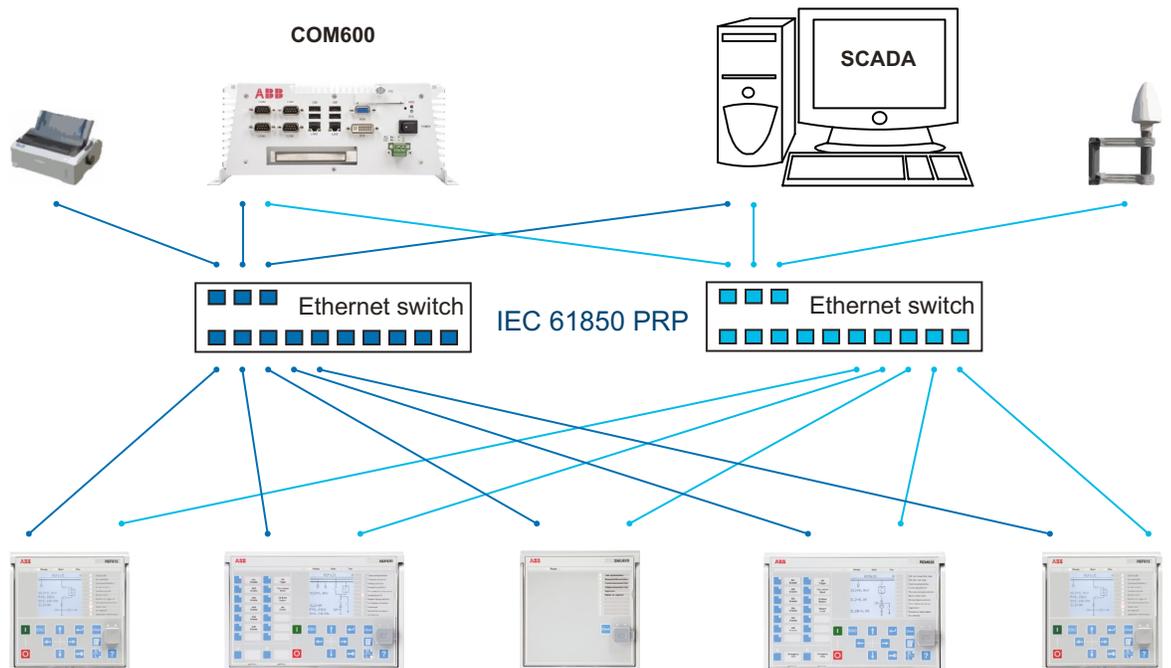
HSR applies the PRP principle of parallel operation to a single ring. For each message sent, the node sends two frames, one through each port. Both the frames circulate in opposite directions over the ring. Every node forwards the frames it receives from one port to another to reach the next node. When the originating sender node receives the frame it sent, the sender node discards the frame to avoid loops. The HSR ring with 615 series relays supports the connection of up to 30 relays. If more than 30 relays are to be connected, it is recommended to split the network into several rings to guarantee the performance for real-time applications.

The choice between the HSR and PRP redundancy protocols depends on the required functionality, cost and complexity. The self-healing Ethernet ring solution enables a cost-efficient communication ring controlled by a managed switch with standard Rapid Spanning Tree Protocol (RSTP) support. The managed switch controls the consistency of the loop, routes the data and corrects the data flow in case of a communication switch-over. The relays in the ring topology act as unmanaged switches forwarding unrelated data traffic. The Ethernet ring solution supports the connection of up to 30 615 series relays.

If more than 30 relays are to be connected, it is recommended to split the network into several rings. The self-healing Ethernet ring solution avoids single point of failure concerns and improves the reliability of the communication.

—
Figure 10. High availability seamless redundancy (HSR) solution
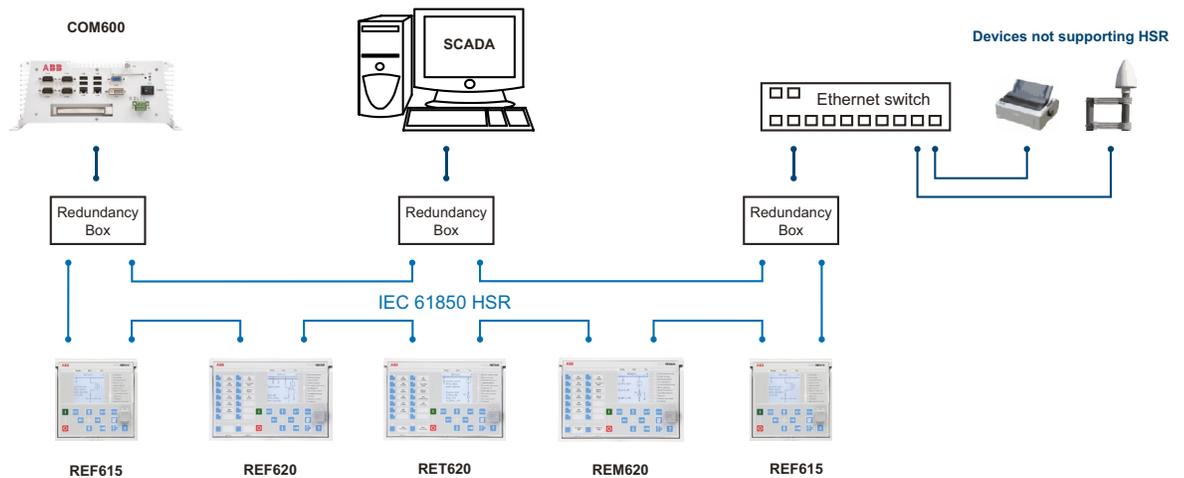
Figure 11. Self-healing
Ethernet ring solution
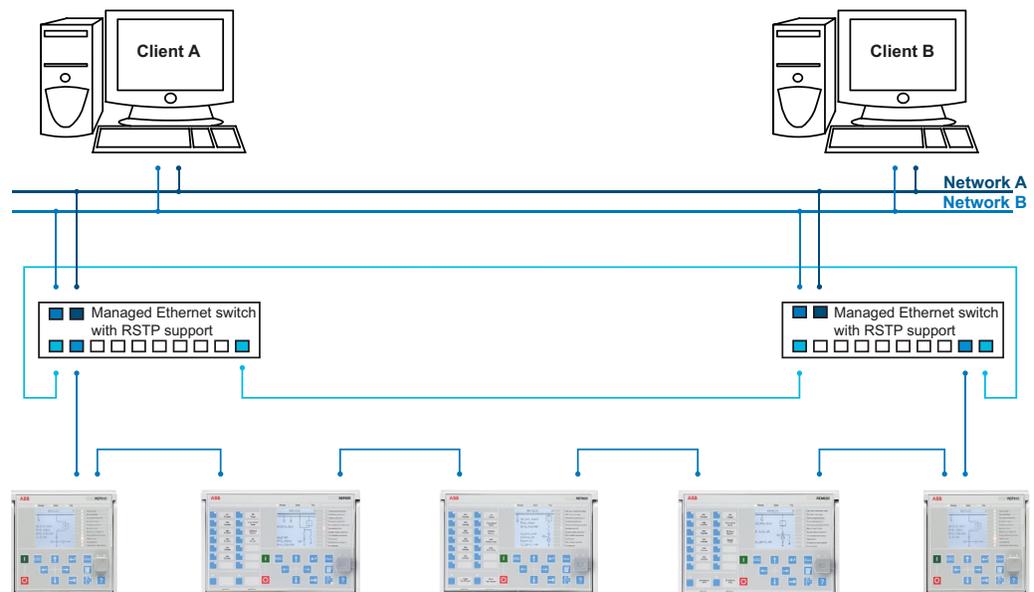


All communication connectors, except for the front port connector, are placed on integrated optional communication modules. The relay can be connected to Ethernet-based communication systems via the RJ-45 connector (100Base-TX) or the fiber optic LC connector (100Base-FX). If connection to serial bus is required, the 9-pin RS-485 screw-terminal can be used. An optional serial interface is available for RS-232 communication.

Modbus implementation supports RTU, ASCII and TCP modes. Besides standard Modbus functionality, the relay supports retrieval of time-stamped events, changing the active setting group and uploading of the latest fault records. If a Modbus TCP connection is used, five clients can be connected to the relay simultaneously. Further, Modbus serial and Modbus TCP can be used in parallel, and if required both IEC 61850 and Modbus protocols can be run simultaneously.

DNP3 supports both serial and TCP modes for connection up to five masters. Changing of the active setting and reading fault records are supported.

DNP serial and DNP TCP can be used in parallel. If required, both IEC 61850 and DNP protocols can be run simultaneously.

When the relay uses the RS-485 bus for the serial communication, both two- and four wire connections are supported. Termination and pull-up/down resistors can be configured with jumpers on the communication card so external resistors are not needed.

The relay supports the following time synchronization methods with a time-stamping resolution of 1 ms.
Ethernet-based
• SNTP (Simple Network Time Protocol)

With special time synchronization wiring
• IRIG-B (Inter-Range Instrumentation Group - Time Code Format B)

The relay supports the following high accuracy time synchronization method with a time-stamping resolution of 4 μs required especially in process bus applications.
• PTP (IEEE 1588) v2 with Power Profile

The IEEE 1588 support is included in all variants having a redundant Ethernet communication module.

IEEE 1588 v2 features
• Ordinary Clock with Best Master Clock algorithm
• One-step Transparent Clock for Ethernet ring topology
• 1588 v2 Power Profile
• Receive (slave): 1-step/2-step
• Transmit (master): 1-step
• Layer 2 mapping
• Peer to peer delay calculation
• Multicast operation

Required accuracy of grandmaster clock is +/-1 μs. The relay can work as a master clock per BMC algorithm if the external grandmaster clock is not available for short term. The IEEE 1588 support is included in all variants having a redundant Ethernet communication module. In addition, the relay supports time synchronization via Modbus, and DNP3 serial communication protocols.

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**Table 5. Supported station communication interfaces and protocols**

| Interfaces/protocol | Ethernet | | Serial | |
|---|---|---|---|---|
| | **100BASE-TX RJ-45** | **100BASE-FX LC** | **RS-232/RS-485** | **Fiber optic ST** |
| IEC 61850-8-1 | • | • | — | — |
| IEC 61850-9-2 LE | • | • | — | — |
| MODBUS RTU/ASCII | — | — | • | • |
| MODBUS TCP/IP | • | • | — | — |
| DNP3 (serial) | — | — | • | • |
| DNP3 TCP/IP | • | • | — | — |

• = Supported

## 19. Technical data

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**Table 6. Dimensions**

| Description | | Value |
|---|---|---|
| Width | frame | 177 mm |
| | case | 164 mm |
| Height | frame | 177 mm (4U) |
| | case | 160 mm |
| Depth | case | 201 mm (153 + 48mm) |
| Weight | complete protection relay | 4.1 kg |
| | plug-in unit only | 2.1 kg |

—
**Table 7. Power supply**

| Description | Type 1 | Type 2 |
|---|---|---|
| Nominal auxiliary voltage $U_n$ | 100, 110, 120, 220, 240 V AC, 50 and 60 Hz | 24, 30, 48, 60 V DC |
| | 48, 60, 110, 125, 220, 250 V DC | |
| Maximum interruption time in the auxiliary DC voltage without resetting the relay | | 50 ms at $U_n$ |
| Auxiliary voltage variation | 38...110% of Un (38...264 V AC) | 50...120% of Un (12...72 V DC) |
| | 80...120% of Un (38.4...300 V DC) | |
| Start-up threshold | | 19.2 V DC (24 V DC × 80%) |
| Burden of auxiliary voltage supply under quiescent ($P_q$)/operating condition | DC <13.0 W (nominal)/<18.0 W (max.)  AC <16.0 W (nominal)/<21.0 W (max.) | DC <13.0 W (nominal)/<18.0 W (max.) |
| Ripple in the DC auxiliary voltage | | Max 15% of the DC value (at frequency of 100 Hz) |
| Fuse type | | T4A/250 V |

—
**Table 8. Energizing inputs**

| Description | | Value | |
|---|---|---|---|
| Rated frequency | | 50/60 Hz ± 5 Hz | |
| Current inputs | Rated current, $I_n$ | 0.2/1 A[1] | 1/5 A[2] |
| | Thermal withstand capability: - Continuously - For 1 s | 4 A  100 A | 20 A  500 A |
| | Dynamic current withstand: - Half-wave value | 250 A | 1250 A |
| | Input impedance | <100 mΩ | <20 mΩ |
| Voltage input | Rated voltage | 60...210 V AC | |
| | Voltage withstand: - Continuous - For 10 s | 240 V AC  360 V AC | |
| | Burden at rated voltage | <0.05 VA | |

1 Ordering option for ground current input
2 Ground current and/or phase current

—
**Table 9. Energizing input (sensors)**

| Description | | Value |
|---|---|---|
| Current sensor input | Rated current voltage (in secondary slide) | 75 mV...9000 mV[1] |
| | Continuous voltage withstand | 125 V |
| | Input impedance at 50/60 Hz | 2...3 MΩ[2] |
| Voltage sensor input | Rated voltage | 6 kV...30 kV[3] |
| | Continuous voltage withstand | 50 V |
| | Input impedance at 50/60 Hz | 3 MΩ |

1 Equals the current range of 40...4000 A with a 80 A, 3 mV/Hz Rogowski
2 Depending on the used nominal current (hardware gain)
3 This range is covered (up to 2*rated) with sensor division ratio of 10 000:1

—
**Table 10. Binary inputs**

| Description | Value |
|---|---|
| Operating range | ±20% of the rated voltage |
| Rated voltage | 24...250 V DC |
| Current drain | 1.6...1.9 mA |
| Power consumption | 31.0...570.0 mW |
| Threshold voltage | 16...176 V DC |
| Reaction time | <3 ms |

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**Table 11. RTD/mA measurement (XRGGIO130)**

| Description | | Value | |
|---|---|---|---|
| RTD inputs | Supported RTD sensors | 100 Ω platinum<br>250 Ω platinum<br>100 Ω nickel<br>120 Ω nickel<br>250 Ω nickel<br>10 Ω copper | TCR 0.00385 (DIN 43760)<br>TCR 0.00385<br>TCR 0.00618 (DIN 43760)<br>TCR 0.00618<br>TCR 0.00618<br>TCR 0.00427 |
| | Supported resistance range | 0...2 kΩ | |
| | Maximum lead resistance (three-wire measurement) | 2 kV (inputs to protective earth) | |
| | Response time | <4 s | |
| | RTD/resistance sensing current | Maximum 0.33 mA rms | |
| | Operation accuracy | Resistance | Temperature |
| | | ± 2.0% or ±1 Ω | ±1°C<br>10 Ω copper: ±2°C |
| mA inputs | Supported current range | 0...20 mA | |
| | Current input impedance | 44 Ω ± 0.1% | |
| | Operation accuracy | ±0.5% or ±0.01 mA | |

—
**Table 12. Signal output X100: SO1**

| Description | Value |
|---|---|
| Rated voltage | 250 V AC/DC |
| Continuous contact carry | 5 A |
| Make and carry for 3.0 s | 15 A |
| Make and carry for 0.5 s | 30 A |
| Breaking capacity when the control-circuit time constant L/R<40 ms | 1 A/0.25 A/0.15 A |
| Minimum contact load | 100 mA at 24 V AC/DC |

—
**Table 13. Signal outputs and IRF output**

| Description | Value |
|---|---|
| Rated voltage | 250 V AC/DC |
| Continuous contact carry | 5 A |
| Make and carry for 3.0 s | 15 A |
| Make and carry for 0.5 s | 15 A |
| Breaking capacity when the control-circuit time constant L/R<40 ms, at 48/110/220 V DC | 1 A/0.25 A/0.15 A |
| Minimum contact load | 10 mA at 5 V AC/DC |

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**Table 14. Double-pole power output relays with TCS function**

| Description | Value |
| --- | --- |
| Rated voltage | 250 V AC/DC |
| Continuous contact carry | 8 A |
| Make and carry for 3.0 s | 15 A |
| Make and carry for 0.5 s | 30 A |
| Breaking capacity when the control-circuit time constant L/R<40 ms, at 48/110/220 V DC (two contacts connected in series) | 5 A/3 A/1 A |
| Minimum contact load | 100 mA at 24 V AC/DC |
| Trip-circuit supervision (TCS):<br>• Control voltage range<br>• Current drain through the supervision circuit<br>• Minimum voltage over the TCS contact | 20…250 V AC/DC<br>~1.5 mA<br>20 V AC/DC (15…20 V) |

—

**Table 15. Single-pole power output relays**

| Description | Value |
| --- | --- |
| Rated voltage | 250 V AC/DC |
| Continuous contact carry | 8 A |
| Make and carry for 3.0 s | 15 A |
| Make and carry for 0.5 s | 30 A |
| Breaking capacity when the 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 at 24 V AC/DC |

—

**Table 16. High-speed output HSO with BIO0007**

| Description | Value |
| --- | --- |
| Rated voltage | 250 V AC/DC |
| Continuous contact carry | 6 A |
| Make and carry for 3.0 s | 15 A |
| Make and carry for 0.5 s | 30 A |
| Breaking capacity when the control-circuit time constant L/R <40 ms, at 48/110/220 V DC | 5 A/3 A/1 A |
| Operate time | <1 ms |
| Reset | <20 ms, resistive load |

—

**Table 17. Front port Ethernet interfaces**

| Ethernet interface | Protocol | Cable | Data transfer rate |
| --- | --- | --- | --- |
| Front | TCP/IP protocol | Standard Ethernet CAT 5 cable with RJ-45 connector | 10 MBits/s |

—

**Table 18. Station communication link, fiber optic**

| Connector | Fiber type[1] | Wave length | Typical max. length[2] | Permitted path attenuation[3] |
| --- | --- | --- | --- | --- |
| LC | MM 62.5/125 or 50/125 µm glass fiber core | 1300 nm | 2 km | <8 dB |
| ST | MM 62.5/125 or 50/125 µm glass fiber core | 820…900 nm | 1 km | <11 dB |

1 (MM) multi-mode fiber, (SM) single-mode fiber
2 Maximum length depends on the cable attenuation and quality, the amount of splices and connectors in the path.
3 Maximum allowed attenuation caused by connectors and cable together

—
**Table 19. IRIG-B**

| Description | Value |
| --- | --- |
| IRIG time code format | B004, B005[1] |
| Isolation | 500V 1 min |
| Modulation | Unmodulated |
| Logic level | 5 V TTL |
| Current consumption | <4 mA |
| Power consumption | <20 mW |

1 According to the 200-04 IRIG standard

—
**Table 20. Lens sensor and optical fiber for arc protection**

| Description | Value |
| --- | --- |
| Fiber optic cable including lens | 1.5 m, 3.0 m or 5.0 m |
| Normal service temperature range of the lens | -40...+100°C |
| Maximum service temperature range of the lens, max 1 h | +140°C |
| Minimum permissible bending radius of the connection fiber | 100 mm |

—
**Table 21. Degree of protection of flush-mounted protection relay**

| Description | Value |
| --- | --- |
| Front side | IP 54 |
| Rear side, connection terminals | IP 10 |
| Left and right side | IP 20 |
| Top and bottom | IP 20 |

—
**Table 22. Environmental conditions**

| Description | Value |
| --- | --- |
| Operating temperature range | -25...+55ºC (continuous) |
| Short-time service temperature range | -40...+85ºC (<16h)[1], [2] |
| Relative humidity | <93%, non-condensing |
| Atmospheric pressure | 86...106 kPa |
| Altitude | Up to 2000 m |
| Transport and storage temperature range | -40...+85ºC |

1 Degradation in MTBF and HMI performance outside the temperature range of -25...+55 ºC
2 For relays with an LC communication interface the maximum operating temperature is +70 ºC

—
**Table 23. Electromagnetic compatibility tests**

| Description | Type test value | Reference |
| --- | --- | --- |
| 1 MHz/100 kHz burst disturbance test | | IEC 61000-4-18<br>IEC 60255-26, class III<br>IEEE C37.90.1-2002 |
| • Common mode | 2.5 kV | |
| • Differential mode | 2.5 kV | |
| 3 MHz, 10 MHz and 30 MHz burst disturbance test | | IEC 61000-4-18<br>IEC 60255-26, class III |
| • Common mode | 2.5 kV | |
| Electrostatic discharge test | | IEC 61000-4-2<br>IEC 60255-26<br>IEEE C37.90.3-2001 |
| • Contact discharge | 8 kV | |
| • Air discharge | 15 kV | |

| Description | Type test value | Reference |
|---|---|---|
| Radio frequency interference test | | |
| | 10 V (rms) f = 150 kHz...80 MHz | IEC 61000-4-6 IEC 60255-26, class III |
| | 10 V/m (rms) f = 80...2700 MHz | IEC 61000-4-3 IEC 60255-26, class III |
| | 10 V/m f = 900 MHz | ENV 50204 IEC 60255-26, class III |
| | 20 V/m (rms) f = 80...1000 MHz | IEEE C37.90.2-2004 |
| Fast transient disturbance test | | IEC 61000-4-4 IEC 60255-26 IEEE C37.90.1-2002 |
| • All ports | 4 kV | |
| Surge immunity test | | IEC 61000-4-5 IEC 60255-26 |
| • Communication | 1 kV, line-to-earth | |
| • Other ports | 4 kV, line-to-earth 2 kV, line-to-line | |
| Power frequency (50 Hz) magnetic field immunity test • Continuous • 1...3 s | 300 A/m 300 A/m | IEC 61000-4-8 |
| Pulse magnetic field immunity test | 1000 A/m 6.4/16 µs | IEC 61000-4-9 |
| Damped oscillatory magnetic field immunity test | | IEC 61000-4-10 |
| • 2 s | 100 A/m | |
| • 1 MHz | 400 transients/s | |
| Voltage dips and short interruptions | 30%/10 ms 60%/100 ms 60%/1000 ms >95%/5000 ms | IEC 61000-4-11 |
| Power frequency immunity test | Binary inputs only | IEC 61000-4-16 IEC 60255-26, class A |
| • Common mode | 300 V rms | |
| • Differential mode | 150 V rms | |
| Conducted common mode disturbances | 15 Hz...150 kHz Test level 3 (10/1/10 V rms) | IEC 61000-4-16 |
| Emission tests | | EN 55011, class A IEC 60255-26 CISPR 11 CISPR 12 |
| • Conducted | | |
| 0.15...0.50 MHz | <79 dB (µV) quasi peak <66 dB (µV) average | |
| 0.5...30 MHz | <73 dB (µV) quasi peak <60 dB (µV) average | |
| • Radiated | | |
| 30...230 MHz | <40 dB (µV/m) quasi peak, measured at 10 m distance | |
| 230...1000 MHz | <47 dB (µV/m) quasi peak, measured at 10 m distance | |
| 1...3 GHz | <76 dB (µV/m) peak <56 dB (µV/m) average, measured at 3 m distance | |
| 3...6 GHz | <80 dB (µV/m) peak <60 dB (µV/m) average, measured at 3 m distance | |

—
**Table 24. Insulation tests**

| Description | Type test value | Reference |
|---|---|---|
| Dielectric tests | 2 kV, 50 Hz, 1 min<br>500 V, 50 Hz, 1 min, communication | IEC 60255-27<br>IEEE C37.90-2005 |
| Impulse voltage test | 5 kV, 1.2/50 µs, 0.5 J<br>1 kV, 1.2/50 µs, 0.5 J, communication | IEC 60255-27<br>IEEE C37.90-2005 |
| Insulation resistance measurements | >100 MΩ, 500 V DC | IEC 60255-27 |
| Protective bonding resistance | <0.1 Ω, 4 A, 60 s | IEC 60255-27 |

—
**Table 25. Mechanical tests**

| Description | Type test value | Reference |
|---|---|---|
| Vibration tests (sinusoidal) | IEC 60068-2-6 (test Fc)<br>IEC 60255-21-1 | Class 2 |
| Shock and bump test | IEC 60068-2-27 (test Ea shock)<br>IEC 60068-2-29 (test Eb bump)<br>IEC 60255-21-2 | Class 2 |
| Seismic test | IEC 60255-21-3 | Class 2 |

—
**Table 26. Environmental tests**

| Description | Type test value | Reference |
|---|---|---|
| Dry heat test | • 96 h at +55ºC<br>• 16 h at +85ºC[1] | IEEE C37.90-2005<br>IEC 60068-2-2 |
| Dry cold test | • 96 h at -25ºC<br>• 16 h at -40ºC | IEEE C37.90-2005<br>IEC 60068-2-1 |
| Damp heat test | • 6 cycles (12 h + 12 h) at +25°C…+55°C, humidity >93% | IEEE C37.90-2005<br>IEC 60068-2-30 |
| Change of temperature test | • 5 cycles (3 h + 3 h)<br>at -25°C…+55°C | IEEE C37.90-2005<br>IEC60068-2-14 |
| Storage test | • 96 h at -40ºC<br>• 96 h at +85ºC | IEEE C37.90-2005<br>IEC 60068-2-1<br>IEC 60068-2-2 |

1 For relays with an LC communication interface the maximum operating temperature is +70°C

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**Table 27. Product safety**

| Description | Value |
|---|---|
| LV directive | 2006/95/EC |
| Standard | EN 60255-27 (2013)<br>EN 60255-1 (2009) |

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**Table 28. EMC compliance**

| Description | Value |
|---|---|
| EMC directive | 2004/108/EC |
| Standard | EN 60255-26 (2013) |

—
**Table 29. RoHS compliance**

| Description | Value |
|---|---|
| Complies with RoHS directive 2002/95/EC | |

## Protection functions

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**Table 30. Three-phase non-directional overcurrent protection (PHxPTOC)**

| Characteristic | | Value | | |
|---|---|---|---|---|
| Operation accuracy | | Depending on the frequency of the measured current: fn ±2 Hz | | |
| | PHLPTOC | ±1.5% of the set value or ±0.002 x $I_n$ | | |
| | PHHPTOC[1] and PHIPTOC | ±1.5% of set value or ±0.002 x $I_n$ (at currents in the range of 0.1…10 x $I_n$) ±5.0% of the set value (at currents in the range of 10…40 x $I_n$) | | |
| Start time [2], [3] | | Minimum | Typical | Maximum |
| | PHIPTOC: $I_{Fault}$ = 2 x set Start value $I_{Fault}$ = 10 x set Start value | 16 ms 11 ms | 19 ms 12 ms | 23 ms 14 ms |
| | PHHPTOC and PHLPTOC: $I_{Fault}$ = 2 x set Start value | 23 ms | 26 ms | 29 ms |
| Reset time | | Typically 40 ms | | |
| Reset ratio | | Typically 0.96 | | |
| Retardation time | | < 30 ms | | |
| Operate time accuracy in definite time mode | | ±1.0% of the set value or ±20 ms | | |
| Operate time accuracy in inverse time mode | | ±5.0% of the theoretical value or ±20 ms [4] | | |
| Suppression of harmonics | | RMS: No suppression DFT: -50dB at f = n x $f_n$, where n = 2, 3, 4, 5,… Peak-to-Peak: No suppression P-to-P+backup: No suppression | | |

1 Not included in REM615
2 Set Operate delay time = 0,02 s, Operate curve type = IEC definite time, Measurement mode = default (depends on stage), current before fault = 0.0 × In, fn = 50 Hz, fault current in one phase with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
3 Includes the delay of the signal output contact
4 Includes the delay of the heavy-duty output contact

—
**Table 31. Three-phase non-directional overcurrent protection (PHxPTOC) main settings**

| Parameter | Function | Value (range) | Step |
|---|---|---|---|
| Start value | PHLPTOC | 0.05…5.00 × $I_n$ | 0.01 |
| | PHHPTOC[1] | 0.10…40.00 × $I_n$ | 0.01 |
| | PHIPTOC | 1.00…40.00 × $I_n$ | 0.01 |
| Time multiplier | PHIPTOC | 0.05…15.00 | 0.01 |
| Operate delay time | PHLPTOC and PHHPTOC | 40…200000 ms | 10 |
| | PHIPTOC | 20…200000 ms | 10 |
| Operating curve type[2] | PHLPTOC | Definite or inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19 | |
| | PHHPTOC[1] | Definite or inverse time Curve type: 1, 3, 5, 9, 10, 12, 15, 17 | |
| | PHIPTOC | Definite time | |

1 Not included in this product
2 For further reference, see the Operation characteristics table

—
**Table 32. Non-directional earth-fault protection (EFxPTOC)**

| Characteristic | | Value | | |
|---|---|---|---|---|
| Operation accuracy | | Depending on the frequency of the measured current: $f_n$ ±2 Hz | | |
| | EFLPTOC | ±1.5% of the set value or ±0.002 x $I_n$ | | |
| | EFHPTOC and EFIPTOC[1] | ±1.5% of set value or ±0.002 x $I_n$ (at currents in the range of 0.1…10 x $I_n$) ±5.0% of the set value (at currents in the range of 10…40 x $I_n$) | | |
| Start time [2], [3] | | Minimum | Typical | Maximum |
| | EFIPTOC[1]: $I_{Fault}$ = 2 × set Start value $I_{Fault}$ = 10 × set Start value | 16 ms 11 ms | 19 ms 12 ms | 23 ms 14 ms |
| | EFHPTOC and EFLPTOC: $I_{Fault}$ = 2 × set Start value | 23 ms | 26 ms | 29 ms |
| Reset time | | Typically 40 ms | | |
| Reset ratio | | Typically 0.96 | | |
| Retardation time | | < 30 ms | | |
| Operate time accuracy in definite time mode | | ±1.0% of the set value or ±20 ms | | |
| Operate time accuracy in inverse time mode | | ±5.0% of the theoretical value or ±20 ms [4] | | |
| Suppression of harmonics | | DFT: -50dB at f = n x $f_n$, where n = 2, 3, 4, 5,… | | |

1 Not included in REM615
2 Measurement mode = default (depends on stage), current before fault = 0.0 × $I_n$, $f_n$ = 50 Hz, earth-fault current with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
3 Includes the delay of the signal output contact
4 Maximum Start value = 2.5 × $I_n$, Start value multiples in range of 1.5…20

—
**Table 33. Non-directional earth-fault protection (EFxPTOC) main settings**

| Parameter | Function | Value (range) | Step |
|---|---|---|---|
| Start value | EFLPTOC | 0.010…5.000 × $I_n$ | 0.005 |
| | EFHPTOC | 0.10…40.00 × $I_n$ | 0.01 |
| | EFIPTOC[1] | 1.00…40.00 × $I_n$ | 0.01 |
| Time multiplier | EFLPTOC and EFHPTOC | 0.05…15.00 | 0.01 |
| Operate delay time | EFLPTOC and EFHPTOC | 40…200000 ms | 10 |
| | EFIPTOC[1] | 20…200000 ms | 10 |
| Operating curve type[2] | EFLPTOC | Definite or inverse time Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19 | |
| | EFHPTOC | Definite or inverse time Curve type: 1, 3, 5, 9, 10, 12, 15, 17 | |
| | EFIPTOC[1] | Definite time | |

**1 Not included in this product**
**2 For further reference, see the Operation characteristics table**

—
**Table 34. Directional earth-fault protection (DEFxPDEF)**

| Characteristic | | Value | | |
|---|---|---|---|---|
| Operation accuracy | DEFLPDEF | Depending on the frequency of the measured current: $f_n$ ±2 Hz<br>Current:<br>±1.5% of set value or ±0.002 x $I_n$<br>Voltage:<br>±1.5% of set value or ±0.002 x $I_n$<br>Phase angle:<br>±2° | | |
| | DEFHPDEF[1] | Current:<br>±1.5% of the set value or ±0.002 × $I_n$<br>(at currents in the range of 0.1…10 × $I_n$)<br>±5.0% of the set value<br>(at currents in the range of 10…40 × $I_n$)<br>Voltage:<br>±1.5% of the set value or ±0.002 × $U_n$<br>Phase angle:<br>±2° | | |
| Start time [1] [2] | | Minimum | Typical | Maximum |
| | DEFHPDEF [1]<br>$I_{Fault}$ = 2 x set Start value | 42 ms | 46 ms | 49 ms |
| | DEFLPDEF<br>$I_{Fault}$ = 2 x set Start value | 58 ms | 62 ms | 66 ms |
| Reset time | | Typically 40 ms | | |
| Reset ratio | | Typically 0.96 | | |
| Retardation time | | < 30 ms | | |
| Operate time accuracy in definite time mode | | ±1.0% of the set value or ±20 ms | | |
| Operate time accuracy in inverse time mode | | ±5.0% of the theoretical value or ±20 ms [3] | | |
| Suppression of harmonics | | RMS: No suppression<br>DFT: -50dB at $f = n \times f_n$, where n = 2, 3, 4, 5,…<br>Peak-to-Peak: No suppression | | |

1 Not included in REM615
2 Set Operate delay time = 0.06 s,Operate curve type = IEC definite time, Measurement mode = default (depends on stage), current before fault = 0.0 × In, fn = 50 Hz, earth-fault current with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
3 Includes the delay of the signal output contact
4) Maximum Start value = 2.5 × In, Start value multiples in range of 1.5…20

—
**Table 35. Directional earth-fault protection (DEFxPDEF) main settings**

| Parameter | Function | Value (range) | Step |
|---|---|---|---|
| Start value | DEFLPDEF | 0.010…5.000 × $I_n$ | 0.005 |
| | DEFLPDEF[1] | 0.10…40.00 × $I_n$ | 0.01 |
| Directional mode | DEFLPDEF and DEFHPDEF | 1 = Non-directional<br>2 = Forward<br>3 = Reverse | — |
| Time multiplier | DEFLPDEF | 0.05…15.00 | 0.01 |
| | DEFHPDEF[1] | 0.05…15.00 | 0.01 |
| Operate delay time | DEFLPDEF | 50…200000 ms | 10 |
| | DEFHPDEF[1] | 40…200000 ms | 10 |
| Operating curve type[2] | DEFLPDEF | Definite or inverse time<br>Curve type: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19 | |
| | DEFHPDEF[1] | Definite or inverse time<br>Curve type: 1, 3, 5, 15, 17 | |
| Operation mode | DEFxPDEF | 1 = Phase angle<br>2 = IoSin<br>3 = IoCos<br>4 = Phase angle 80<br>5 = Phase angle 88 | |

1 Not included in REM615
2 For further reference, see the Operating characteristics table

—
**Table 36. Three-phase undervoltage protection (PHPTUV)**

| Characteristic | Value | | |
|---|---|---|---|
| Operation accuracy | Depending on the frequency of the measured current: $f_n$ ±2 Hz | | |
| | ±1.5% of the set value or ±0.002 x $U_n$ | | |
| Start time [1] [2] | | Minimum | Typical | Maximum |
| | $U_{Fault}$ = 0.9 x set Start value  62 ms | 66 ms | 70 ms |
| Reset time | Typically 40 ms | | |
| Reset ratio | Depends on the set Relative hysteresis | | |
| Retardation time | < 35 ms | | |
| Operate time accuracy in definite time mode | ±1.0% of the set value or ±20 ms | | |
| Operate time accuracy in inverse time mode | ±5.0% of the theoretical value or ±20 ms[3] | | |
| Suppression of harmonics | DFT: -50dB at f = n x $f_n$, where n = 2, 3, 4, 5,… | | |

1) Start value = 1.0 × $U_n$, Voltage before fault = 1.1 × $U_n$, $f_n$ = 50 Hz, undervoltage in one phase-to-phase with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact
3) Minimum Start value = 0.50, Start value multiples in range of 0.90…0.20

—
**Table 37. Three-phase undervoltage protection (PHPTUV) main settings**

| Parameter | Function | Value (range) | Step |
|---|---|---|---|
| Start value | PHPTUV | 0.05…1.20 × $U_n$ | 0.01 |
| Time multiplier | PHPTUV | 0.05…15.00 | 0.01 |
| Operate delay time | PHPTUV | 60…300000 ms | 10 |
| Operating curve type[1] | PHPTUV | Definite or inverse time<br>Curve type: 5, 15, 21, 22, 23 | |

1) For further reference, see the Operation characteristics table

—
**Table 38. Positive-sequence undervoltage protection (PSPTUV)**

| Characteristic | Value | | |
|---|---|---|---|
| Operation accuracy | Depending on the frequency of the measured current: $f_n$ ±2 Hz | | |
| | ±1.5% of the set value or ±0.002 x $I_n$ | | |
| Start time [1], [2] | | Minimum | Typical | Maximum |
| | $U_{Fault}$ = 0.99 x set Start value  52 ms | 55 ms | 58 ms |
| | $U_{Fault}$ = 0.9 x set Start value  44 ms | 47 ms | 50 ms |
| Reset time | Typically 40 ms | | |
| Reset ratio | Depends on the set Relative hysteresis | | |
| Retardation time | < 35 ms | | |
| Operate time accuracy in definite time mode | ±1.0% of the set value or ±20 ms | | |
| Suppression of harmonics | DFT: -50dB at f = n x $f_n$, where n = 2, 3, 4, 5,… | | |

1 Start value = 1.0 × $U_n$, positive-sequence voltage before fault = 1.1 × $U_n$, $f_n$ = 50 Hz, positive sequence undervoltage with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2 Includes the delay of the signal output contact

—
**Table 39. Positive-sequence undervoltage protection (PSPTUV) main settings**

| Parameter | Function | Value (range) | Step |
|---|---|---|---|
| Start value | PSPTUV | 0.010…1.200 × $U_n$ | 0.001 |
| Operate delay time | PSPTUV | 40…120000 ms | 10 |
| Voltage block value | PSPTUV | 0.01…1.00 × $U_n$ | 0.01 |

—

**Table 40. Negative-sequence overvoltage protection (NSPTOV)**

| Characteristic | | Value | | |
|---|---|---|---|---|
| Operation accuracy | | Depending on the frequency of the measured current: $f_n$ | | |
| | | ±1.5% of the set value or ±0.002 × $U_n$ | | |
| Start time [1], [2] | | Minimum | Typical | Maximum |
| | $U_{Fault}$ = 1.1 x set Start value | 33 ms | 35 ms | 37 ms |
| | $U_{Fault}$ = 2.0 x set Start value | 24 ms | 26 ms | 28 ms |
| Reset time | | Typically 40 ms | | |
| Reset ratio | | Typically 0.96 | | |
| Retardation time | | < 35 ms | | |
| Operate time accuracy in definite time mode | | ±1.0% of the set value or ±20 ms | | |
| Suppression of harmonics | | DFT: -50dB at $f = n \times f_n$, where n = 2, 3, 4, 5,… | | |

1 Negative-sequence voltage before fault = 0.0 × $U_n$, $f_n$ = 50 Hz, negative-sequence overvoltage with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
2 Includes the delay of the signal output contact

—

**Table 41. Negative-sequence overvoltage protection (NSPTOV) main settings**

| Parameter | Function | Value (range) | Step |
|---|---|---|---|
| Start value | NSPTOV | 0.010…1.000 × $U_n$ | 0.001 |
| Operate delay time | NSPTOV | 40…120000 ms | 1 |

—

**Table 42. Frequency protection (FRPFRQ)**

| Characteristic | | Value |
|---|---|---|
| Operation accuracy | f>/f< | ±5 mHz |
| | df/dt | ±50 mHz/s (in range \|df/dt\| <5 Hz/s) |
| | | ±2.0% of the set value (in range 5 Hz/s < \|df/dt\| < 15 Hz/s) |
| Start time [1] [2] | f>/f< | <80 ms |
| | df/dt | <120 ms |
| Reset time | | <150 ms |
| Operate time accuracy | | ±1.0% of the set value or ±30 ms |

—

**Table 43. Frequency protection (FRPFRQ) main settings**

| Parameter | Function | Value (range) | Step |
|---|---|---|---|
| Operation mode | FRPFRQ | 1 = Freq< <br> 2 = Freq> <br> 3 = df/dt <br> 4 = Freq< + df/dt <br> 5 = Freq> + df/dt <br> 6 = Freq< OR df/dt <br> 7 = Freq> OR df/dt | - |
| Start value Freq> | FRPFRQ | 0.9000…1.2000 × $f_n$ | 0.0001 |
| Start value Freq< | FRPFRQ | 0.8000…1.1000 × $f_n$ | 0.0001 |
| Start value df/dt | FRPFRQ | -0.2000…0.2000 × $f_n$/s | 0.005 |
| Operate Tm Freq | FRPFRQ | 80…200000 ms | 10 |
| Operate Tm df/dt | FRPFRQ | 120…200000 ms | 10 |

—
**Table 44. Negative-sequence overcurrent protection for machines (MNSPTOC)**

| Characteristic | Value | | |
|---|---|---|---|
| Operation accuracy | Depending on the frequency of the measured current: $f_n$ | | |
| | $\pm$1.5% of the set value or $\pm$0.002 x $I_n$ | | |
| Start time [1], [2] | Minimum | Typical | Maximum |
| $I_{Fault}$ = 2.0 x set Start value | 23 ms | 26 ms | 28 ms |
| Reset time | Typically 40 ms | | |
| Reset ratio | Typically 0.96 | | |
| Retardation time | < 35 ms | | |
| Operate time accuracy in definite time mode | $\pm$1.0% of the set value or $\pm$20 ms | | |
| Operate time accuracy in inverse time mode | $\pm$5.0% of the theoretical value or $\pm$20 ms [3] | | |
| Suppression of harmonics | DFT: -50dB at $f = n \times f_n$, where n = 2, 3, 4, 5,... | | |

1 Negative-sequence current before = 0.0, fn = 50 Hz, results based on statistical distribution of 1000 measurements
2 Includes the delay of the signal output contact
3 Start value multiples in range of 1.10...5.00

—
**Table 45. Negative-sequence overcurrent protection for machines (MNSPTOC) main settings**

| Parameter | Function | Value (range) | Step |
|---|---|---|---|
| Start value | MNSPTOC | 0.01...0.50 × $I_n$ | 0.01 |
| Operating curve type | MNSPTOC | | Definite or inverse time<br>Curve type: 5, 15, 17, 18 |
| Operate delay time | MNSPTOC | 100...120000 ms | 10 |
| Operation | | 1 = on<br>5 = off | — |
| Cooling time | MNSPTOC | 5...7200 s | 1 |

—
**Table 46. Loss of load supervision (LOFLPTUC)**

| Characteristc | Value |
|---|---|
| Operation accuracy | Depending on the frequency of the measured current: $f_n$ $\pm$2 Hz |
| | $\pm$1.5% of the set value or $\pm$0.002 × $I_n$ |
| Start time | Typically 300 ms |
| Reset time | Typically 40 ms |
| Reset ratio | Typically 1.04 |
| Retardation time | <35 ms |
| Operate time accuracy in definite time mode | $\pm$1.0% of the set value or $\pm$20 ms |

—
**Table 47. Loss of load supervision (LOFLPTUC) main settings**

| Parameter | Function | Value (range) | Step |
|---|---|---|---|
| Start value low | LOFLPTUC | 0.01...0.50 × $I_n$ | 0.01 |
| Start value high | LOFLPTUC | 0.01...1.00 × $I_n$ | 0.01 |
| Operate delay time | LOFLPTUC | 400...600000 ms | 10 |
| Operation | LOFLPTUC | 1 = on<br>5 = off | — |

—

**Table 48. Motor load jam protection (JAMPTOC)**

| Characteristc | Value |
|---|---|
| Operation accuracy | Depending on the frequency of the measured current: $f_n$ ±2 Hz |
| | ±1.5% of the set value or ±0.002 × $I_n$ |
| Reset time | Typically 40 ms |
| Reset ratio | Typically 0.96 |
| Retardation time | <35 ms |
| Operate time accuracy in definite time mode | ±1.0% of the set value or ±20 ms |

—

**Table 49. Motor load jam protection (JAMPTOC) main settings**

| Parameter | Function | Value (range) | Step |
|---|---|---|---|
| Operation | JAMPTOC | 1 = on<br>5 = off | — |
| Start value | JAMPTOC | 0.10...10.00 × $I_n$ | 0.01 |
| Operate delay time | JAMPTOC | 100...120000 ms | 10 |

—

**Table 50. Motor start-up supervision (STTPMSU)**

| Characteristic | | Value | | |
|---|---|---|---|---|
| Operation accuracy | | Depending on the frequency of the measured current: $f_n$ ±2 Hz | | |
| | | ±1.5% of the set value or ±0.002 x $I_n$ | | |
| | | Minimum | Typical | Maximum |
| Start time [1], [2] | $I_{Fault}$ = 1.1 × set Start detection A | 27 ms | 30 ms | 34 ms |
| Operate time accuracy | | ±1.0% of the set value or ±20 ms | | |
| Reset ratio | | Typically 0.90 | | |

1 Current before = 0.0 × $I_n$, $f_n$ = 50 Hz, overcurrent in one phase, results based on statistical distribution of 1000 measurements
2 Includes the delay of the signal output contact

—

**Table 51. Motor start-up supervision (STTPMSU) main settings**

| Parameter | Function | Value (range) | Step |
|---|---|---|---|
| Motor start-up A | STTPMSU | 1.0...10.0 × $I_n$ | 0.1 |
| Motor start-up time | STTPMSU | 1...80 s | 1 |
| Lock rotor time | STTPMSU | 2...120 s | 1 |
| Operation | STTPMSU | 1 = on<br>5 = off | — |
| Operation mode | STTPMSU | 1 = IIt<br>2 = IIt, CB<br>3 = IIt + stall<br>4 = IIt + stall, CB | — |
| Restart inhibit time | STTPMSU | 0...250 min | 1 |

—
**Table 52. Phase reversal protection (PREVPTOC)**

| Characteristic | Value | | |
|---|---|---|---|
| Operation accuracy | Depending on the frequency of the measured current: $f_n$ ±2 Hz | | |
| | ±1.5% of the set value or ±0.002 x $I_n$ | | |
| Start time [1], [2] | Minimum | Typical | Maximum |
| $I_{Fault}$ = 2.0 × set Start Value | 23 ms | 25 ms | 28 ms |
| Reset time | Typically 40 ms | | |
| Reset ratio | Typically 0.96 | | |
| Retardation time | <35 ms | | |
| Operate time accuracy in definite time mode | ±1.0% of the set value or ±20 ms | | |
| Suppression of harmonics | DFT: -50 dB at $f = n \times f_n$, where n = 2, 3, 4, 5,… | | |

1) Negative-sequence current before = 0.0, $f_n$ = 50 Hz, results based on statistical distribution of 1000 measurements
2) Includes the delay of the signal output contact

—
**Table 53. Phase reversal protection (PREVPTOC) main settings**

| Parameter | Function | Value (range) | Step |
|---|---|---|---|
| Start value | PREVPTOC | 0.05…1.00 x $I_n$ | 0.01 |
| Operate delay time | PREVPTOC | 100…60000 ms | 10 |
| Operation | | 1 = on | |
| | PREVPTOC | 5 = off | — |

—
**Table 54. Thermal overload protection for motors (MPTTR)**

| Characteristc | Value |
|---|---|
| Operation accuracy | Depending on the frequency of the measured current: $f_n$ ±2 Hz |
| | Current measurement: ±1.5% of the set value or ±0.002 × $I_n$ (at currents in the range of 0.01…4.00 × $I_n$) |
| Operate time accuracy in definite time mode[1] | ±2.0% of the theoretical value or ±0.50 s |

1 Overload current > 1.2 × Operate level temperature

—
**Table 55. Thermal overload protection for motors (MPTTR) main settings**

| Parameter | Function | Value (range) | Step |
|---|---|---|---|
| Overload factor | MPTTR | 1.00…1.20 | 0.01 |
| Alarm thermal value | MPTTR | 50.0…100.0% | 0.1 |
| Restart thermal Val | MPTTR | 20.0…80.0% | 0.1 |
| Weighting factor p | MPTTR | 20.0…100.0% | 0.1 |
| Time constant normal | MPTTR | 80…4000 s | 1 |
| Time constant start | MPTTR | 80…4000 s | 1 |
| Env temperature mode | | 1 = FLC Only | |
| | | 2 = Use input | |
| | MPTTR | 3 = Set Amb Temp | — |
| Env temperature Set | MPTTR | -20.0…70.0°C | 0.1 |
| Operation | | 1 = on | |
| | MPTTR | 5 = off | — |

—
**Table 56. Circuit breaker failure protection (CCBRBRF)**

| Characteristc | Value |
|---|---|
| Operation accuracy | Depending on the frequency of the measured current: $f_n$ ±2 Hz |
| | ±1.5% of the set value or ±0.002 × $I_n$ |
| Operate time accuracy | ±1.0% of the set value or ±20 ms |
| Reset time | Typically 40 ms |
| Retardation time | <20 ms |

—
**Table 57. Circuit breaker failure protection (CCBRBRF) main settings**

| Parameter | Function | Value (range) | Step |
|---|---|---|---|
| Current value | CCBRBRF | 0.05...2.00 × $I_n$ | 0.05 |
| Current value Res | CCBRBRF | 0.05...2.00 × $I_n$ | 0.05 |
| CB failure mode | CCBRBRF | 1 = Current<br>2 = Breaker status<br>3 = Both | — |
| CB fail trip mode | CCBRBRF | 1 = Off<br>2 = Without check<br>3 = Current check | — |
| Retrip time | CCBRBRF | 0...60000 ms | 10 |
| CB failure delay | CCBRBRF | 0...60000 ms | 10 |
| CB fault delay | CCBRBRF | 0...60000 ms | 10 |

—
**Table 58. Arc protection (ARCSARC)**

| Characteristic | | Value | | |
|---|---|---|---|---|
| Operation accuracy | | ±3% of the set value or ±0.01 × $I_n$ | | |
| | | Minimum | Typical | Maximum |
| Start time | Operation mode = "Light+current"(1), (2) | 9 ms(3)<br>4 ms(4) | 12 ms(3)<br>6 ms(4) | 15 ms(3)<br>9 ms(4) |
| | Operation mode = "Light only"(2) | 9 ms(3)<br>4 ms(4) | 10 ms(3)<br>6 ms(4) | 12 ms(3)<br>7 ms(4) |
| Reset time | | Typically 40 ms | | |
| Reset ratio | | Typically 0.96 | | |

1 Not included in REM615
2 Set Operate delay time = 0.06 s, Operate curve type = IEC definite time, Measurement mode = default (depends on stage), current before fault = 0.0 × In, fn = 50 Hz, earth-fault current with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements
3 Includes the delay of the signal output contact
4) Maximum Start value = 2.5 × In, Start value multiples in range of 1.5...20

—
**Table 59. Arc protection (ARCSARC) main settings**

| Parameter | Function | Value (range) | Step |
|---|---|---|---|
| Phase start value | ARCSARC | 0.50...40.00 × In | 0.01 |
| Ground start value | ARCSARC | 0.05...8.00 × In | 0.01 |
| Operation mode | ARCSARC | 1 = Light+current<br>2 = Light only<br>3 = BI controlled | — |

—
**Table 60. Multipurpose protection (MAPGAPC)**

| Characteristc | Value |
|---|---|
| Operation accuracy | ±1.0% of the set value or ±20 ms |

—
**Table 61. Multipurpose protection (MAPGAPC) main settings**

| Parameter | Function | Value (range) | Step |
|---|---|---|---|
| Start value | MAPGAPC | -10000.0...10000.0 | 0.1 |
| Operate delay time | MAPGAPC | 0...200000 ms | 100 |
| Operation mode | MAPGAPC | 1 = Over<br>2 = Under | — |

## Control functions

—
**Table 62. Emergency start-up (ESMGAPC)**

| Characteristic | Value |
|---|---|
| Operation accuracy | At the frequency $f = f_n$ |
| | ±1.5% of the set value or ±0.002 × $U_n$ |

—
**Table 63. Emergency start-up (ESMGAPC) main settings**

| Parameter | Function | Value (range) | Step |
|---|---|---|---|
| Motor stand still A | ESMGAPC | 0.05...0.20 × $I_n$ | 0.01 |
| Operation | ESMGAPC | 1 = on<br>5 = off | — |

## Condition and supervision functions

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**Table 64. Circuit-breaker condition monitoring (SSCBR)**

| Characteristic | Value |
|---|---|
| Current measuring accuracy | ±1.5% or ±0.002 × $I_n$<br>(at currents in the range of 0.1…10 × $I_n$)<br>±5.0%<br>(at currents in the range of 10…40 × $I_n$) |
| Operate time accuracy | ±1.0% of the set value or ±20 ms |
| Travelling time measurement | +10 ms / -0 ms |

—
**Table 65. Current circuit supervision (CCSPVC)**

| Characteristic | Value |
|---|---|
| Operate time[1] | <30 ms |

1) Including the delay of the output contact

—
**Table 66. Current circuit supervision (CCSPVC) main settings**

| Parameter | Function | Value (range) | Step |
|---|---|---|---|
| Start value | CCSPVC | 0.05…0.20 × $I_n$ | 0.01 |
| Max operate current | CCSPVC | 1.00…5.00 × $I_n$ | 0.01 |

—
**Table 67. Fuse failure supervision (SEQSPVC)**

| Parameter | | Value | |
|---|---|---|---|
| Operate time[1] | NPS function | $U_{Fault}$ = 1.1 × set Neg Seq voltage Lev<br>$U_{Fault}$ = 5.0 × set Neg Seq voltage Lev | <33 ms<br><18 ms |
| | Delta function | ΔU = 1.1 × set Voltage change rate<br>ΔU = 2.0 × set Voltage change rate | <30 ms<br><24 ms |

1 Includes the delay of the signal output contact, fn = 50 Hz, fault voltage with nominal frequency injected from random phase angle, results based on statistical distribution of 1000 measurements

—
**Table 68. Runtime counter for machines and devices (MDSOPT)**

| Description | Value |
|---|---|
| Motor runtime measurement accuracy[1] | ±0.5% |

1 Of the reading, for a stand-alone relay, without time synchronization

## Measurement functions

—
**Table 69. Three-phase current measurement (CMMXU)**

| Characteristic | Value |
|---|---|
| Operation accuracy | Depending on the frequency of the measured current: $f_n$ ±2 Hz |
| | ±0.5% or ±0.002 × $I_n$<br>(at currents in the range of 0.01...4.00 × $I_n$) |
| Suppression of harmonics | DFT: -50 dB at $f = n × f_n$, where n = 2, 3, 4, 5,…<br>RMS: No suppression |

—
**Table 70. Sequence current measurement (CSMSQI)**

| Characteristic | Value |
|---|---|
| Operation accuracy | Depending on the frequency of the measured current: $f/f_n$ ±2 Hz |
| | ±0.5% or ±0.002 × $I_n$<br>at currents in the range of 0.01...4.00 × $I_n$ |
| Suppression of harmonics | DFT: -50 dB at $f = n × f_n$, where n = 2, 3, 4, 5,…<br>RMS: No suppression |

—
**Table 71. Residual current measurement (RESCMMXU)**

| Characteristic | Value |
|---|---|
| Operation accuracy | Depending on the frequency of the current measured: $f/f_n$ ±2 Hz |
| | ±0.5% or ±0.002 × $I_n$<br>at currents in the range of 0.01...4.00 × $I_n$ |
| Suppression of harmonics | DFT: -50 dB at $f = n × f_n$, where n = 2, 3, 4, 5,…<br>RMS: No suppression |

—
**Table 72. Three-phase voltage measurement (VMMXU)**

| Characteristic | Value |
|---|---|
| Operation accuracy | Depending on the frequency of the measured current: $f_n$ ±2 Hz<br>At voltages in range 0.01…1.15 × $U_n$ |
| | ±0.5% or ±0.002 × $U_n$ |
| Suppression of harmonics | DFT: -50 dB at $f = n × f_n$, where n = 2, 3, 4, 5,…<br>RMS: No suppression |

—
**Table 73. Residual voltage measurement (RESVMMXU)**

| Characteristic | Value |
|---|---|
| Operation accuracy | Depending on the frequency of the measured current: $f/f_n$ ±2 Hz |
| | ±0.5% or ±0.002 × $U_n$ |
| Suppression of harmonics | DFT: -50 dB at $f = n × f_n$, where n = 2, 3, 4, 5,…<br>RMS: No suppression |

—
**Table 74. Sequence voltage measurement (VSMSQI)**

| Characteristic | Value |
|---|---|
| Operation accuracy | Depending on the frequency of the voltage measured: fn ±2 Hz<br>At voltages in range 0.01…1.15 × $U_n$ |
| | ±1.0% or ±0.002 × $U_n$ |
| Suppression of harmonics | DFT: -50 dB at $f = n \times f_n$, where n = 2, 3, 4, 5,… |

—
**Table 75. Three-phase power and energy measurement (PEMMXU)**

| Characteristic | Value |
|---|---|
| Operation accuracy | At all three currents in range 0.10…1.20 × $I_n$<br>At all three voltages in range 0.50…1.15 × $U_n$<br>At the frequency $f_n$ ±1 Hz |
| | ±1.5% for apparent power S<br>±1.5% for active power P and active energy[1]<br>±1.5% for reactive power Q and reactive energy[2]<br>±0.015 for power factor |
| Suppression of harmonics | DFT: -50 dB at $f = n \times fn$, where n = 2, 3, 4, 5,… |

1 |PF| >0.5 which equals |cosφ| >0.5
2 |PF| <0.86 which equals |sinφ| >0.5

—
**Table 76. RTD/mA measurement (XRGGIO130)**

| Description | | Value | |
|---|---|---|---|
| RTD inputs | Supported RTD sensors | 100 Ω platinum<br>250 Ω platinum<br>100 Ω nickel<br>120 Ω nickel<br>250 Ω nickel<br>10 Ω copper | TCR 0.00385 (DIN 43760)<br>TCR 0.00385<br>TCR 0.00618 (DIN 43760)<br>TCR 0.00618<br>TCR 0.00618<br>TCR 0.00427 |
| | Supported resistance range | 0…2 kΩ | |
| | Maximum lead resistance (three-wire measurement) | 2 kV (inputs to protective earth) | |
| | Response time | <4 s | |
| | RTD/resistance sensing current | Maximum 0.33 mA rms | |
| | Operation accuracy | Resistance | Temperature |
| | | ± 2.0% or ±1 Ω | ±1°C<br>10 Ω copper: ±2°C |
| mA inputs | Supported current range | 0…20 mA | |
| | Current input impedance | 44 Ω ± 0.1% | |
| | Operation accuracy | ±0.5% or ±0.01 mA | |

—
**Table 77. Frequency measurement (FMMXU)**

| Characteristic | Value |
|---|---|
| Operation accuracy | ±5 mHz<br>(in measurement range 35…75 Hz) |

**Other functions**

—
**Table 78. Pulse timer (PTGAPC)**

| Characteristic | Value |
|---|---|
| Operate time accuracy | ±1.0% of the set value or ±20 ms |

—
**Table 79. Time delay off (8 pcs) (TOFPAGC)**

| Characteristic | Value |
|---|---|
| Operate time accuracy | ±1.0% of the set value or ±20 ms |

—
**Table 80. Time delay on (8 pcs) (TONGAPC)**

| Characteristic | Value |
|---|---|
| Operate time accuracy | ±1.0% of the set value or ±20 ms |

### 20. Local HMI

The relay is available with two optional displays, a large one and a small one. The large display is suited for relay installations where the front panel user interface is frequently used and a single line diagram is required. The small display is suited for remotely controlled substations where the relay is only occasionally accessed locally via the front panel user interface.

The LCD display offers front-panel user interface functionality with menu navigation and menu views. The display also offers increased front-panel usability with less menu scrolling and improved information overview. In addition, the large display includes a user-configurable single line diagram (SLD) with position indication for the associated primary equipment. Depending on the chosen standard configuration, the relay displays the related measuring values, apart from the de-

fault single line diagram. The SLD view can also be accessed using the Web browser-based user interface. The default SLD can be modified according to user requirements by using the Graphical Display Editor in PCM600. The user can create up to 10 SLD pages.

The local HMI includes a push button (L/R) for local/remote operation of the relay. When the relay is in the local mode, it can be operated only by using the local front panel user interface. When the relay is in the remote mode, it can execute commands sent from a remote location. The relay supports the remote selection of local/remote mode via a binary input. This feature facilitates, for example, the use of an external switch at the substation to ensure that all relays are in the local mode during maintenance work and that the circuit breakers cannot be operated remotely from the network control center.

—
Figure 12. Display
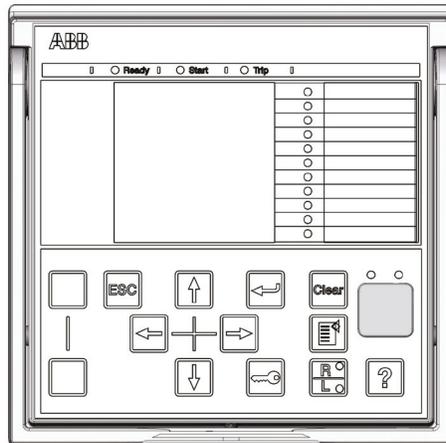


—
**Table 81. Display**

| Character size[1] | Rows in the view | Characters per row |
|---|---|---|
| Small, mono-spaced (6 × 12 pixels) | 10 | 20 |
| Large, variable width (13 × 14 pixels) | 7 | 8 or more |

1) Depending on the selected language

### 21. Mounting methods

By means of appropriate mounting accessories, the standard relay case can be flush mounted, semi-flush mounted or wall mounted. The flush mounted and wall mounted relay cases can also be mounted in a tilted position (25°) using special accessories.

Further, the relays can be mounted in any standard 19" instrument cabinet by means of 19" mounting panels available with cut-outs for one or two relays.

Mounting methods
- Flush mounting
- Semi-flush mounting
- Semi-flush mounting in a 25° tilt
- Rack mounting
- Wall mounting
- Mounting to a 19" equipment frame

Panel cut-out for flush mounting
- Height: 161.5 ±1 mm
- Width: 165.5 ±1 mm

**Figure 19. Flush mounting**
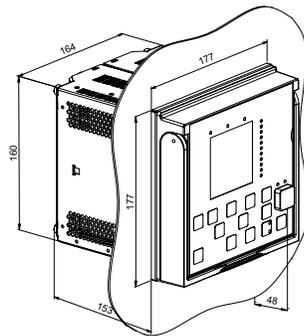


**Figure 20. Semi-flush mounting**
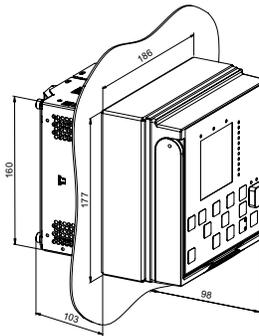


**Figure 21. Semi-flush mounting in a 25º tilt**
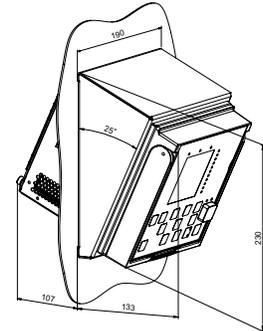


### 22. Relay case and plug-in unit

The relay cases are assigned to a certain type of plug-in unit. For safety reasons, the relay cases for current measuring relays are provided with automatically operating contacts for shortcircuiting the CT secondary circuits when a relay unit is withdrawn from its case. The relay case is further provided with a mechanical coding system preventing the current measuring relay units from being inserted into relay cases intended for voltage measuring relay units.

### 23. Selection and ordering data

Use ABB Library to access the selection and ordering information and to generate the order number.

Product Selection Tool (PST), a Next-Generation Order Number Tool, supports order code creation for ABB Distribution Automation IEC products with emphasis on, but not exclusively for, the Relion product family. PST is an easy to use, online tool always containing the latest product information. The complete order code can be created with detailed specification and the result can be printed and mailed. Registration is required.

A link to the tool can be found here.

## 24. Accessories and ordering data

—
**Table 82. Cables**

| Item | Order number |
|---|---|
| Optical sensor for arc protection, cable length 1.5 m | 1MRS120534-1.5 |
| Optical sensor for arc protection, cable length 3.0 m | 1MRS120534-3 |
| Optical sensor for arc protection, cable length 5.0 m | 1MRS120534-5 |
| Optical sensor for arc protection, cable length 7.0 m | 1MRS120534-7 |
| Optical sensor for arc protection, cable length 10.0 m | 1MRS120534-10 |
| Optical sensor for arc protection, cable length 15.0 m | 1MRS120534-15 |
| Optical sensor for arc protection, cable length 20.0 m | 1MRS120534-20 |
| Optical sensor for arc protection, cable length 25.0 m | 1MRS120534-25 |
| Optical sensor for arc protection, cable length 30.0 m | 1MRS120534-30 |

—
**Table 83. Mounting accessories**

| Item | Order number |
|---|---|
| Semi-flush mounting kit | 1MRS050696 |
| Wall mounting kit | 1MRS050697 |
| Inclined semi-flush mounting kit | 1MRS050831 |
| 19" rack mounting kit with cut-out for one relay | 1MRS050694 |
| 19" rack mounting kit with cut-out for two relays | 1MRS050695 |
| Functional earthing flange for RTD modules | 2RCA036978A0001 |

### 25. Tools

The protection relay is delivered as a preconfigured unit. The default parameter setting values can be changed from the frontpanel user interface (local HMI), the Web browser-based user interface (Web HMI) or Protection and Control IED Manager PCM600 in combination with the relay-specific connectivity package.

PCM600 offers extensive relay configuration functions. For example, depending on the protection relay, the relay signals, application, graphical display and single-line diagram, and IEC 61850 communication, including horizontal GOOSE communication, can be modified with PCM600.

When the Web HMI is used, the protection relay can be accessed either locally or remotely using a Web browser (Internet Explorer). For security reasons, the Web HMI is disabled by default but it can be en-abled via the local HMI. The Web HMI functionality can be limited to read-only access.

The relay connectivity package is a collection of software and specific relay information, which enables system products and tools to connect and interact with the protection relay. The connectivity packages reduce the risk of errors in system integration, minimizing device configuration and setup times.

Further, the connectivity packages for protection relays of this product series include a flexible update tool for adding one additional local HMI language to the protection relay. The update tool is activated using PCM600, and it enables multiple updates of the additional HMI language, thus offering flexible means for possible future language updates.

—
**Table 84. Tools**

| Description | Version |
|---|---|
| PCM600 | 2.8 or later |
| Web browser | IE 11.0 |
| REM615 Connectivity Package | 5.1 or later |

—
**Table 85. Tools**

| Function | Web HMI | PCM600 |
|---|---|---|
| Relay parameter setting | • | • |
| Saving of relay parameter settings in the relay | • | • |
| Signal monitoring | • | • |
| Disturbance recorder handling | • | • |
| Alarm LED viewing | • | • |
| Access control management | • | • |
| Relay signal configuration (Signal Matrix) | — | • |
| Modbus® communication configuration (communication management) | — | • |
| DNP3 communication configuration (communication management) | — | • |
| IEC 60870-5-103 communication configuration (communication management) | — | • |
| Saving of relay parameter settings in the tool | — | • |
| Disturbance record analysis | — | • |
| XRIO parameter export/import | • | • |
| Graphical display configuration | — | • |
| Application configuration | — | • |
| IEC 61850 communication configuration, GOOSE (communication configuration) | — | • |
| Phasor diagram viewing | • | — |
| Event viewing | • | • |
| Saving of event data on the user's PC | • | • |
| Online monitoring | — | • |

• = supported

## 26. Cyber security

The relay supports role based user authentication and authorization. It can store 2048 audit trail events to a nonvolatile memory. The non-volatile memory is based on a memory type which does not need battery backup or regular component exchange to maintain the memory storage. FTP and Web HMI use TLS encryption with a minimum of 128 bit key length protecting the data in transit. In this case the used communication protocols are FTPS and HTTPS. All rear communication ports and optional protocol services can be deactivated according to the required system setup.

## 27. Terminal diagrams

Figure 16. Terminal diagram of standard configuration A

49
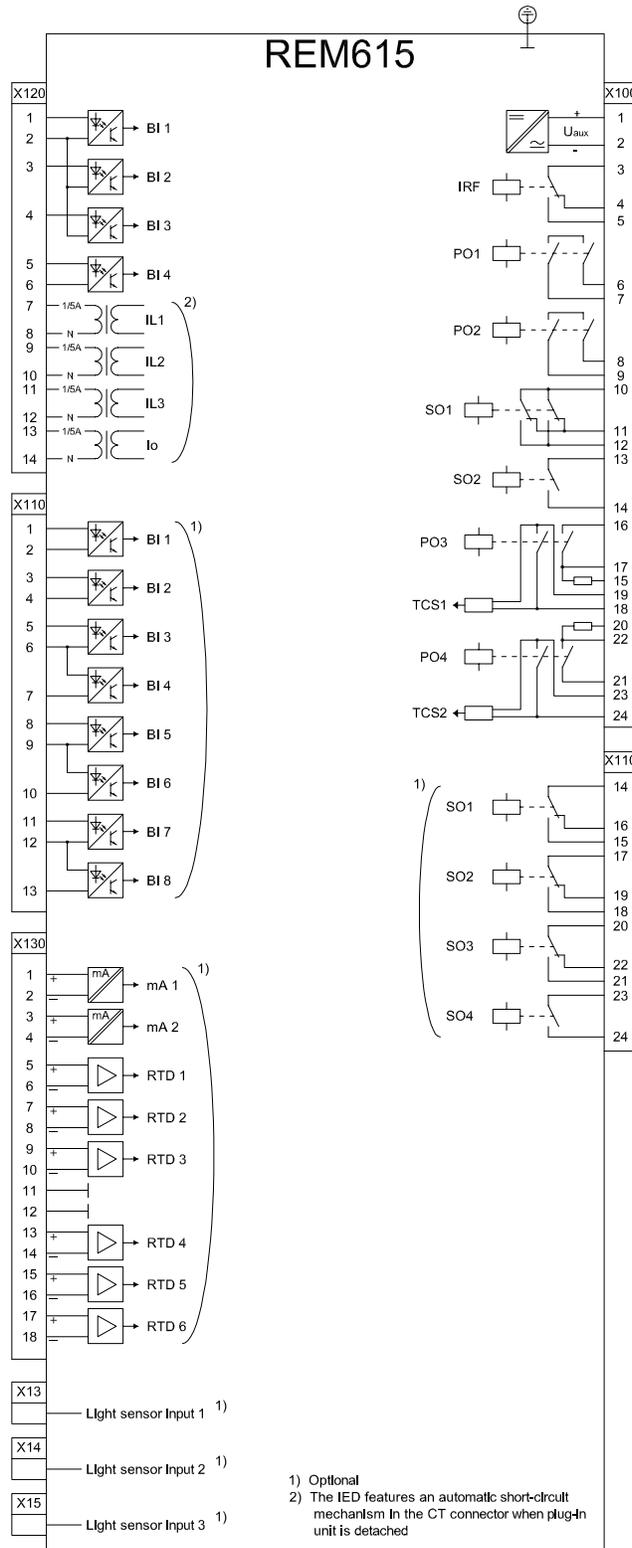


Figure 17. Terminal
diagram of standard
configuration B
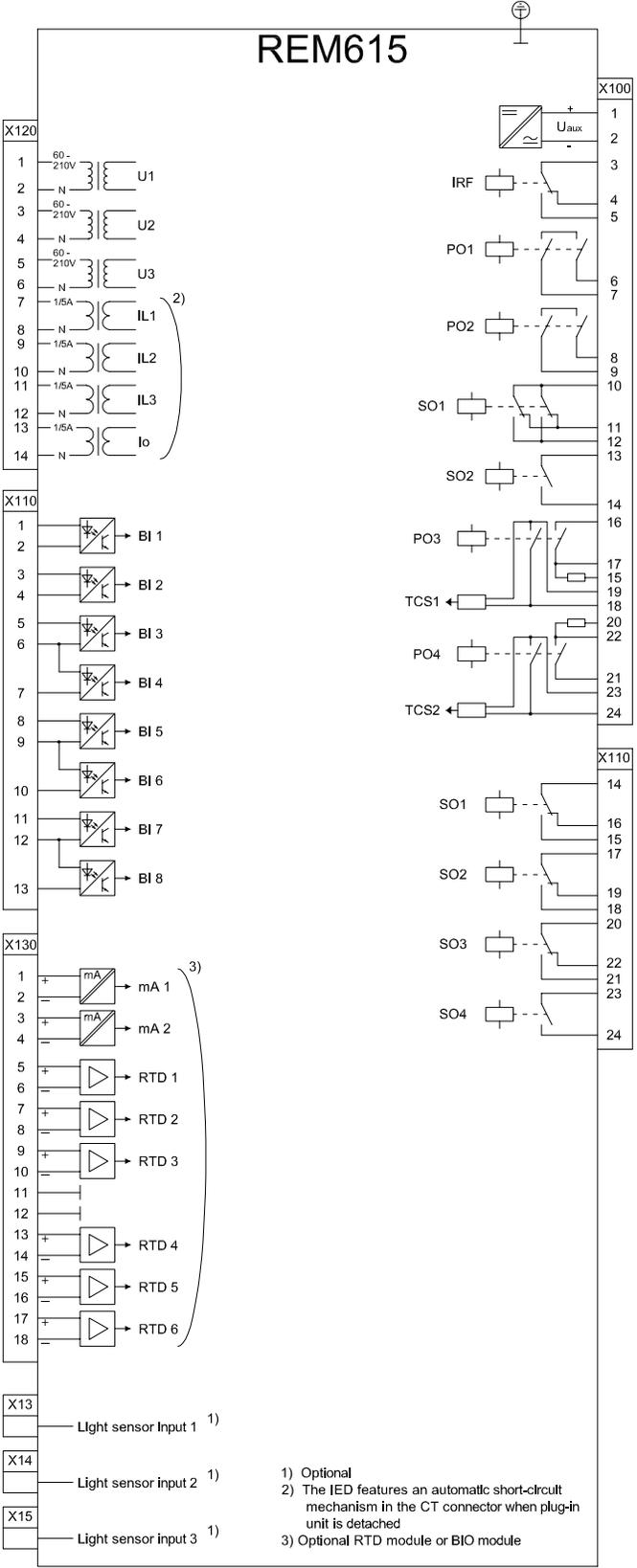
—
Figure 18. Terminal
diagram of standard
configuration D



# REM615
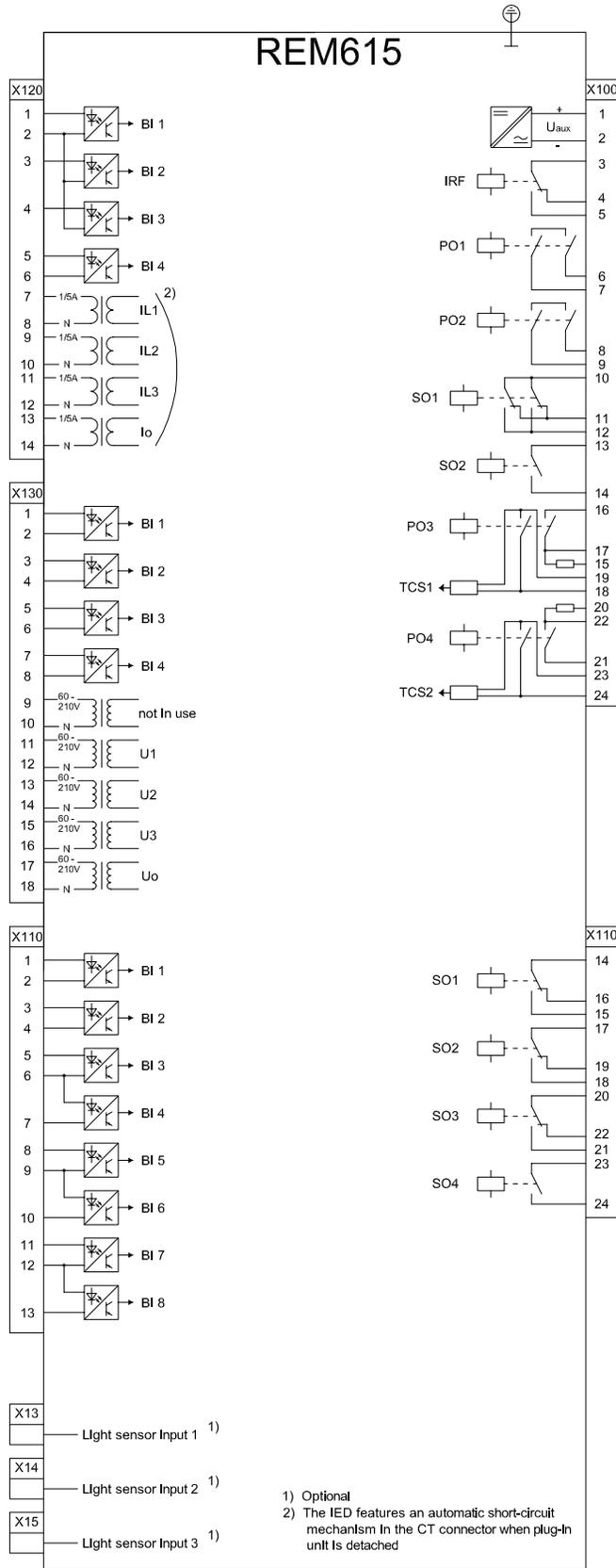
—
Figure 19. Terminal
diagram of standard
configuration E
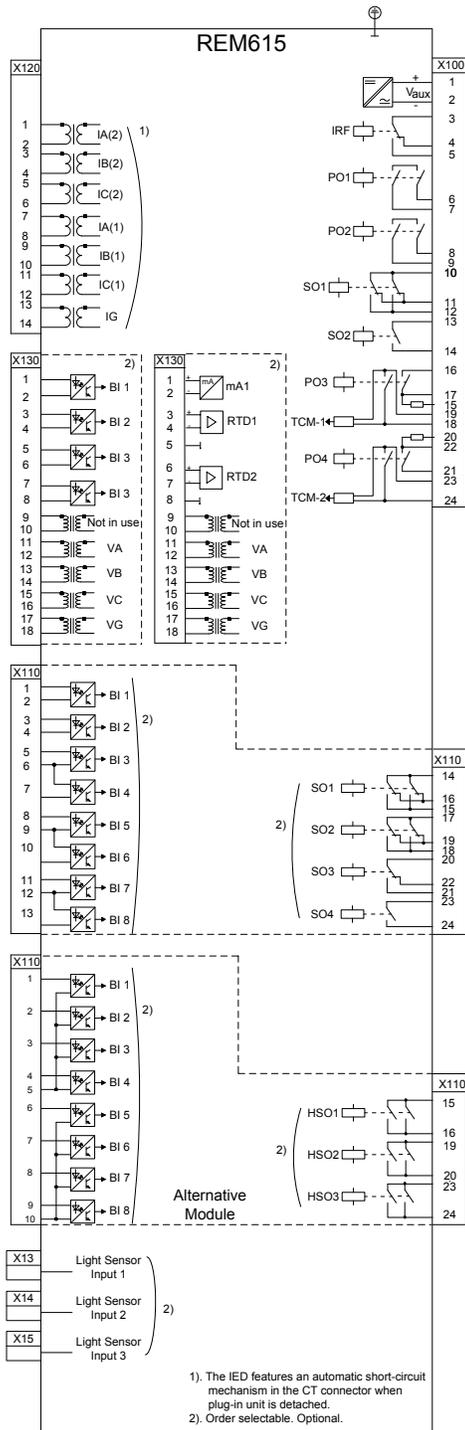


## 28. Certificates

DNV GL has issued an IEC 61850 Edition 2 Certificate Level A1 for Relion® 615 series. Certificate number: 7410570I-OPE/INC 15-1136. DNV GL has issued an IEC 61850 Edition 1 Certificate Level A1 for Relion® 615 series. Certificate number: 74105701-OPE/INC 15-1145. Additional certificates can be found on the product page.

## 29. References

The ABB Substation Automation portal provides information on the entire range of distribution automation products and services. The latest relevant information on the REM615 protection and control relay is found on the product page. Scroll down the page to find and download the related documentation.

## 30. Functions, codes and symbols

—
**Table 86. Functions included in the relay**

| Function | IEC 61850 | ANSI |
|---|---|---|
| **Protection** | | |
| Three-phase non-directional overcurrent protection, low stage | PHLPTOC | 51P |
| Three-phase non-directional overcurrent protection, high stage | PHHPTOC | 50P |
| Three-phase non-directional overcurrent protection, instantaneous stage | PHIPTOC | 50P-3 |
| Non-directional earth-fault protection, low stage | EFLPTOC | 51G |
| Non-directional earth-fault protection, high stage | EFHPTOC | 50G |
| Directional earth-fault protection, low stage | DEFLPDEF | 67/51N |
| Residual overvoltage protection | ROVPTOV | 59G/59N |
| Three-phase undervoltage protection | PHPTUV | 27 |
| Three-phase overvoltage protection | PHPTOV | 59 |
| Positive-sequence undervoltage protection | PSPTUV | 27PS |
| Negative-sequence overvoltage protection | NSPTOV | 47 |
| Three-phase remnant undervoltage protection | MSVPR | 27R |
| Frequency protection | FRPFRQ | 81 |
| Overexcitation protection | OEPVPH | 24 |
| Negative-sequence overcurrent protection for machines | MNSPTOC | 46M |
| Loss of load supervision | LOFLPTUC | 37M |
| Motor load jam protection | JAMPTOC | 51LR |
| Motor start-up supervision | STTPMSU | 66/51LRS |
| Phase reversal protection | PREVPTOC | 46R |
| Thermal overload protection for motors | MPTTR | 49M |
| Motor differential protection | MPDIF | |
| High-impedance differential protection for phase A | HIAPDIF1 | 87A |
| High-impedance differential protection for phase B | HIBPDIF | 87B |
| High-impedance differential protection for phase C | HICPDIF | 87C |
| Circuit breaker failure protection | CCBRBRF | 50BF |
| Master trip | TRPPTRC | 86/94 |
| Arc protection | ARCSARC | AFD |
| Multipurpose protection | MAPGAPC | MAP |
| Underpower protection | DUPPDPR | 32U |
| Reverse power/ directional overpower protection | DOPPDPR | 32O |
| **Control** | | |
| Circuit breaker control | CBXCBR | 52 |
| Disconnector control | DCXSWI | 29DS |
| Earthing switch control | ESXSWI | 29GS |
| Disconnector position indication | DCSXSWI | 52-TOC, 29DS |
| Earthing switch indication | ESSXSWI | 29GS |
| Emergency startup | ESMGAPC | 62EST |
| **Conditioning monitoring and supervision** | | |
| Circuit breaker condition monitoring | SSCBR | 52CM |
| Trip circuit supervision | TCSSCBR | TCM |
| Current circuit supervision | CCSPVC | CCM |
| Fuse failure supervision | SEQSPVC | 60 |
| Runtime counter for machines and devices | MDSOPT | OPTM |

—

**Table 86. Functions included in the relay (continued)**

| Function | IEC 61850 | ANSI |
| --- | --- | --- |
| **Measurement** | | |
| Disturbance recorder | RDRE | DFR |
| Load profile record | LDPRLRC | LOADPROF |
| Fault record | FLTRFRC | FAULTREC |
| Three-phase current measurement | CMMXU | IA, IB, IC |
| Sequence current measurement | CSMSQI | I1, I2, I0 |
| Residual current measurement | RESCMMXU | IG |
| Three-phase voltage measurement | VMMXU | VA, VB, VC |
| Residual voltage measurement | RESVMMXU | VG |
| Sequence voltage measurement | VSMSQI | V1, V2, V0 |
| Single-phase power and energy measurement | SPEMMXU | SP, SE |
| Three-phase power and energy measurement | PEMMXU | P, E |
| RTD/mA measurement | XRGGIO130 | X130 (RTD) |
| Frequency measurement | FMMXU | f |
| IEC 61850-9-2 LE<br>sampled value sending | SMVSENDER | SMVSENDER |
| IEC 61850-9-2 LE<br>sampled value receiving (voltage sharing) | SMVRCV | SMVRECEIVER |
| **Other** | | |
| Minimum pulse timer (2 pcs) | TPGAPC | 62TP |
| Minimum pulse timer (2 pcs, second resolution) | TPSGAPC | 62TPS |
| Minimum pulse timer (2 pcs, minute resolution) | TPMGAPC | 62TPM |
| Pulse timer (8 pcs) | PTGAPC | 62PT |
| Time delay off (8 pcs) | TOFGAPC | 62TOF |
| Time delay on (8 pcs) | TONGAPC | 62TON |
| Set-reset (8 pcs) | SRGAPC | SR |
| Move (8 pcs) | MVGAPC | MV |
| Generic control point (16 pcs) | SPCGAPC | SPC |
| Analog value scaling (4 pcs) | SCA4GAPC | SCA4 |
| Integer value move (4 pcs) | MVI4GAPC | MVI4 |
| Generic up-down counters | UDFCNT | CTR |

## 31. Document revision history

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**Table 87. Document revision history**

| Document revision/date | Product version | History |
|---|---|---|
| A/Dec. 2017 | 5.0 FP1 | First release |

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—
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