



Relion® 615 series

Motor Protection and Control REM615 Product Guide

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1. Description

REM615 is a dedicated motor protection and control IED (intelligent electronic device) 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 IEDs are characterized by their compactness and withdrawable 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 IED has been given the application-specific settings, it can directly be put into service.

The 615 series IEDs support a range of communication protocols including IEC 61850 with GOOSE messaging, IEC 60870-5-103, Modbus® and DNP3.

2. Standard configuration

The motor protection and control IED REM615 is available with one standard configuration.

Table 1. Standard configuration

Description	Std.conf.
Motor protection with current and voltage based protection and measurements functions	C

Table 2. Supported functions

Functionality	C
Protection ¹⁾	
Thermal overload protection for motors	●
Motor start-up supervision	●
Negative-sequence overcurrent protection for motors, instance 1	●
Negative-sequence overcurrent protection for motors, instance 2	●
Directional earth-fault protection, low stage, instance 1	●
Non-directional earth-fault protection, using calculated I_0	●
Motor load jam protection	●
Three-phase non-directional overcurrent protection, low stage, instance 1	●
Three-phase non-directional overcurrent protection, instantaneous stage, instance 1	●
Loss of load supervision	●
Phase reversal protection	●
Three-phase undervoltage protection, instance 1	●
Positive-sequence undervoltage protection	●
Negative-sequence overvoltage protection	●
Circuit breaker failure protection	●
Master trip, instance 1	●
Master trip, instance 2	●
Arc protection, instance 1	○
Arc protection, instance 2	○
Arc protection, instance 3	○
Control	
Circuit-breaker control with interlocking	●
Disconnecter position indication, instance 1	●
Disconnecter position indication, instance 2	●
Disconnecter position indication, instance 3	●
Earthing switch indication	●
Emergency start-up	●
Condition monitoring	
Circuit-breaker condition monitoring	●

Table 2. Supported functions, continued

Functionality	C
Trip circuit supervision, instance 1	●
Trip circuit supervision, instance 2	●
Current circuit supervision	●
Fuse failure supervision	●
Motor runtime counter	●
Measurement	
Disturbance recorder	●
Three-phase current measurement	●
Sequence current measurement	●
Residual current measurement	●
Three-phase voltage measurement	●
Residual voltage measurement	●
Sequence voltage measurement	●
Three-phase power and energy measurement	●

● = included, o = optional at the time of order

1) Note that all directional protection functions can also be used in non-directional mode.

3. Protections functions

The IED offers all the functionality needed to manage motor starts and normal drive operations also including protection and fault clearance in abnormal situations. The main features of the motor IED include thermal overload protection, motor start-up time supervision, locked rotor protection and protection against too frequent motor starts. Furthermore, the IED offers negative phase sequence current unbalance protection, motor running stall protection, loss-of-load supervision, phase-reversal protection and a provision to perform a forced emergency start.

The IED also incorporates non-directional and directional earth-fault protection, back-

up overcurrent protection, three phase undervoltage protection, and negative phase sequence overvoltage and positive sequence undervoltage protection.

Enhanced with optional hardware and software, the IED 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 personal safety and limits material damage within the switchgear in an arc fault situation.

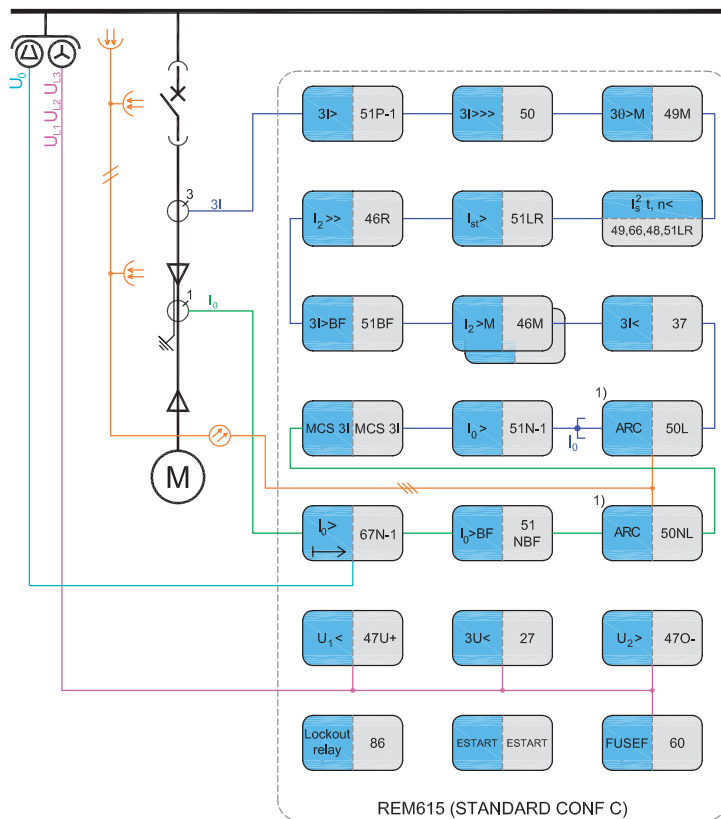


Figure 1. Protection function overview of standard configuration C

4. Application

REM615 constitutes main protection for asynchronous motors and the associated drives. Typically, the motor IED 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 IED is thoroughly adapted for earth-fault protection. Using cable current transformers sensitive and reliable earth-fault protection can be achieved. The earth-fault protection can also utilize phase current transformers in Holmgreen (summed) connection. In that case possible unwanted operations of the earth-fault protection at motor start-up can be prevented using the IED's internal interlocking features or suitable stabilizing circuits.

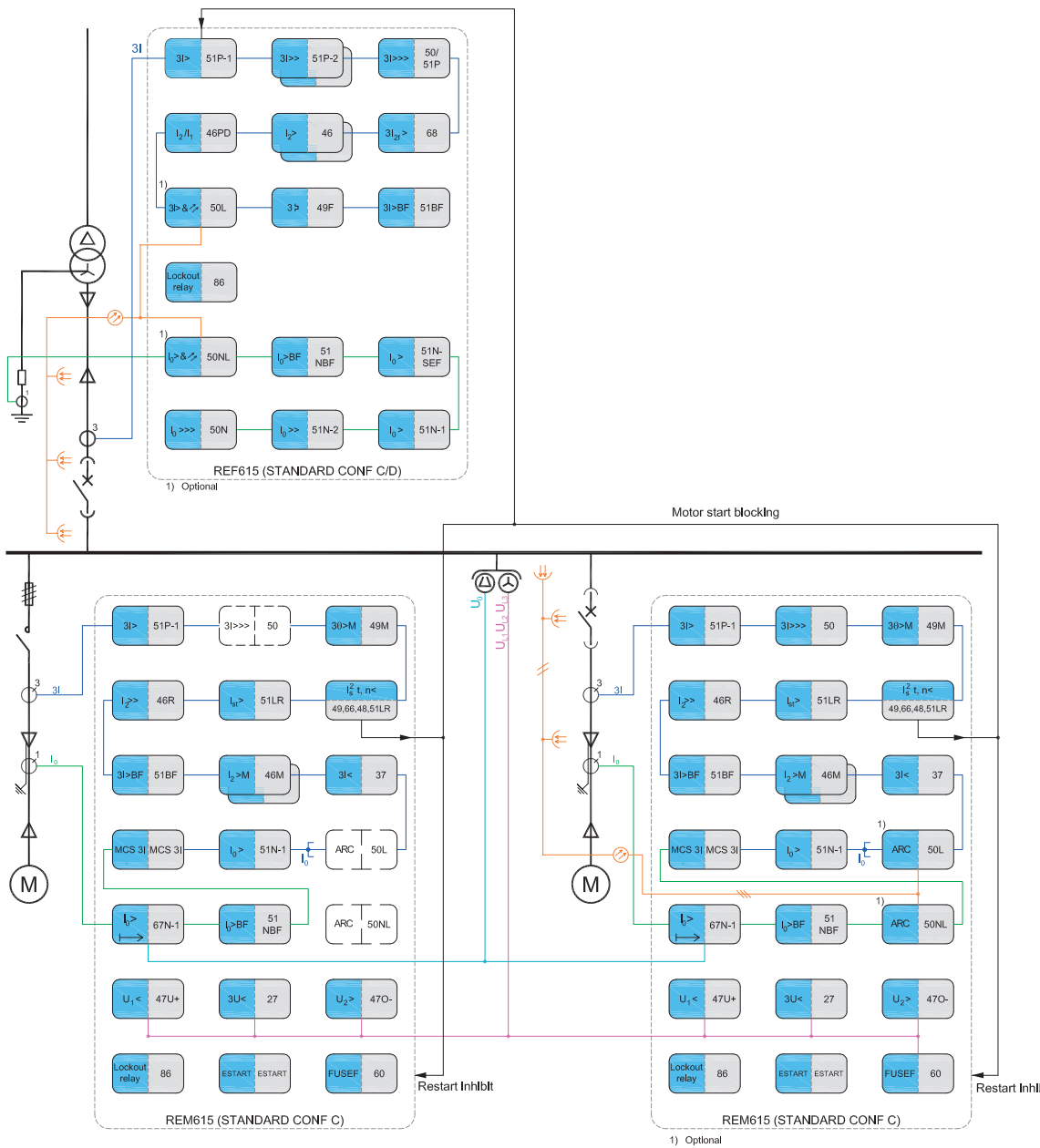


Figure 2. Motor protection and control of contactor and circuit-breaker controlled motors using REM615 with the standard configuration C. To prevent possible power system instability due to busbar voltage collapse, the simultaneous starting of several motors is inhibited. The motor start-up signal from each REM615 is connected to the “Restart-inhibit” inputs of the other REM615s. Hence while one motor is starting-up, the starting of the other motors is inhibited. The same motor start-up signal is also used to dynamically increase the setting level of the lowest O/C protection stage of the REF615 on the incoming feeder

5. Supported ABB solutions

ABB's 615 series protection and control IEDs together with the COM600 Station Automation device constitute a genuine IEC 61850 solution for reliable power distribution in utility and industrial power systems. To facilitate and streamline the system engineering ABB's IEDs are supplied with Connectivity Packages containing a compilation of software and IED-specific information including single-line diagram templates, a full IED data model including event and parameter lists. By utilizing the Connectivity Packages the IEDs can be readily configured via the PCM600 Protection and Control IED Manager and integrated with the COM600 Station Automation device or the MicroSCADA Pro network control and management system.

The 615 series IEDs offer native support for the IEC 61850 standard also including horizontal GOOSE messaging. Compared with 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. Fast software-based

communication, continuous supervision of the integrity of the protection and communication system, and inherent flexibility for reconfiguration and upgrades are among the distinctive features of the protection system approach enabled by the full implementation of the IEC 61850 substation automation standard.

At the substation level COM600 utilizes the data content of the bay level IEDs to offer enhanced substation level functionality. COM600 features a web-browser based HMI providing a customizable graphical display for visualizing single line mimic diagrams for switchgear bay solutions. To enhance personnel safety, the web HMI also enables remote access to substation devices and processes. Furthermore, COM600 can be used as a local data warehouse for technical documentation of the substation and for network data collected by the IEDs. The collected network data facilitates extensive reporting and analyzing of network fault situations using the data historian and event handling features of COM600.

COM600 also features gateway functionality providing seamless connectivity between the substation IEDs and network-level control and management systems such as MicroSCADA Pro and System 800xA

Table 3. Supported ABB solutions

Product	Version
Station Automation COM600	3.3 or later
MicroSCADA Pro	9.2 SP1 or later

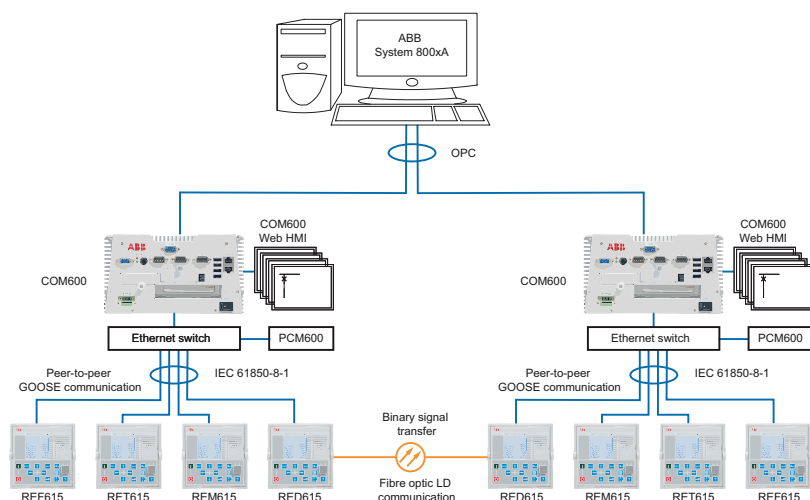


Figure 3. Industrial power system example using 615 series IEDs, Station Automation COM600 and System 800xA

6. Control

The IED offers control of one circuit breaker with dedicated push-buttons for opening and closing. Interlocking schemes required by the application are configured with the signal matrix in PCM600.

7. Measurement

The IED continuously measures the phase currents and the neutral current. Further, the IED measures the phase voltages and the residual voltage. In addition, the IED 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 IED.

The values measured can be accessed locally via the user interface on the IED front panel or remotely via the communication interface of the IED. The values can also be accessed locally or remotely using the web-browser based user interface.

8. Disturbance recorder

The IED 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 voltage 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 on the rising or the falling edge of the binary signal or both.

By default, the binary channels are set to record external or internal IED signals, for example the start or trip signals of the IED stages, or external blocking or control signals. Binary IED signals such as a protection start or trip signal, or an external IED control signal over a binary input can be set to trigger the recording. The 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 (SoE) information, the IED incorporates a non-volatile memory with a capacity of storing 50 event codes with associated time stamps. The non-volatile memory retains its data also in case the IED temporarily loses its auxiliary supply. The event log facilitates detailed pre- and post-fault analyses of feeder faults and disturbances.

The SoE information can be accessed locally via the user interface on the IED front panel or remotely via the communication interface of the IED. The information can further be accessed, either locally or remotely, using the web-browser based user interface.

10. Recorded data

The IED has the capacity to store the records of four latest fault events. The records enable the user to analyze the four most recent power system events. The available measurement modes include DFT, RMS and peak-to-peak. In addition, the maximum demand current with time stamp is separately recorded. By default, the records are stored in a non-volatile memory.

11. Circuit-breaker monitoring

The condition monitoring functions of the IED constantly monitors 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 CB history data, which can be used for scheduling preventive CB maintenance.

12. Trip-circuit supervision

The trip-circuit supervision continuously monitors the availability and operability of the trip circuit. It provides open-circuit 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 IED's built-in self-supervision system continuously monitors the state of the IED hardware and the operation of the IED software. Any fault or malfunction detected will be used for alerting the operator. A permanent IED fault will block the protection functions to prevent incorrect operation.

14. Fuse failure supervision

The IED includes fuse failure supervision functionality. The fuse failure supervision detects failures between the voltage measurement circuit and the IED. The failures are detected 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 IED 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 IED from unauthorized access and to maintain information integrity, the IED

is provided with a four-level, role-based authentication system with administrator-programmable individual passwords for the viewer, operator, engineer and administrator level. The access control applies to the front-panel user interface, the web-browser based user interface and the PCM600 tool.

17. Inputs and outputs

The IED 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 cover the rated voltages 100, 110, 115 and 120 V. Both phase-to-phase voltages and phase-to-earth voltages can be connected.

The rated values of the current and voltage inputs are settable parameters of the IED. In addition, the binary input thresholds are selectable within the range of 18...176 V DC by adjusting the IED's parameter settings.

All binary input and output contacts are freely configurable with the signal matrix in PCM600.

Please refer to the Input/output overview table and the terminal diagrams for more detailed information about the inputs and outputs.

Table 4. Input/output overview

Standard configuration	Analog inputs		Binary inputs/outputs	
	CT	VT	BI	BO
C	4	5 ¹⁾	16	10

1) One of the five inputs is reserved for future applications

18. Communication

The IED supports a range of communication protocols including IEC 61850, IEC 60870-5-103, Modbus® and DNP3.

Operational information and controls are available through these protocols.

The IEC 61850 communication implementation supports all monitoring and control functions. Additionally, parameter setting and disturbance file records can be accessed using the IEC 61850 protocol. Disturbance files are available to any Ethernet-based application in the standard COMTRADE format. Further, the IED can send and receive binary signals from other IEDs (so called horizontal communication) using the IEC61850-8-1 GOOSE profile. The IED meets the GOOSE performance requirements for tripping applications in distribution substations, as defined by the IEC 61850 standard. The IED can simultaneously report events to five different clients on the station bus.

All communication connectors, except for the front port connector, are placed on integrated optional communication modules. The IED can be connected to Ethernet-based communication systems via the RJ-45 connector (100BASE-TX) or the fibre-optic LC connector (100BASE-FX).

Modbus implementation supports RTU, ASCII and TCP modes. Besides standard Modbus functionality, the IED 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 IED simultaneously. If required, both IEC 61850 and serial Modbus protocols can be run simultaneously.

The IEC 60870-5-103 implementation supports two parallel serial bus connections to two different masters. Besides basic standard functionality, the IED supports changing of the active setting group and uploading of disturbance files in IEC 60870-5-103 format.

DNP3 supports both serial and TCP modes for connection to one master.

When the IED 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 IED 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)

In addition, the IED supports time synchronization via the following serial communication protocols:

- Modbus
- DNP3
- IEC 60870-5-103

Table 5. Supported station communication interfaces and protocols

Interfaces/ Protocols	Ethernet		Serial	
	100BASE-TX RJ-45	100BASE-FX LC	RS-232/RS-485	Fibre-optic ST
IEC 61850	•	•	-	-
MODBUS RTU/ ASCII	-	-	•	•
MODBUS TCP/ IP	•	•	-	-
DNP3 (serial)	-	-	•	•
DNP3 TCP/IP	•	•	-	-
IEC 60870-5-103	-	-	•	•

• = Supported

19. Technical data

Table 6. Dimensions

Description	Value	
Width	frame	179.8 mm
	case	164 mm
Height	frame	177 mm (4U)
	case	160 mm
Depth	194 mm (153 + 41 mm)	
Weight	IED	3.5 kg
	spare unit	1.8 kg

Table 7. Power supply

Description	Type 1	Type 2
U _{aux} nominal	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	
U _{aux} variation	38...110% of U _n (38...264 V AC)	50...120% of U _n (12...72 V DC)
	80...120% of U _n (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	250 V DC ~ 9.0 W (nominal)/~ 13.7 W (max) 240 V AC ~ 10.6 W (nominal)/~ 15.5 W (max)	60 V DC ~ 8.5 W (nominal)/~ 13.4 W (max)
Ripple in the DC auxiliary voltage	Max 12% of the DC value (at frequency of 100 Hz)	
Maximum interruption time in the auxiliary DC voltage without resetting the IED	<ul style="list-style-type: none"> • 110 V DC: 86 ms • 110 V AC: 118 ms 	48 V DC: 64 ms
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	4 A	20 A
		• For 1 s	100 A	500 A
	Dynamic current withstand:	• Half-wave value	250 A	1250 A
		Input impedance	<100 mΩ	<20 mΩ
Voltage inputs	Rated voltage	100 V AC/ 110 V AC/ 115 V AC/ 120 V AC (Parametrization)		
	Voltage withstand:	• Continuous	2 x U_n (240 V AC)	
		• For 10 s	3 x U_n (360 V AC)	
	Burden at rated voltage	<0.05 VA		

1) Ordering option for residual current input

2) Residual current and/or phase current

Table 9. 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	18...176 V DC
Reaction time	3 ms

Table 10. 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	10 A
Make and carry 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	100 mA at 24 V AC/DC

Table 11. 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):	
• Control voltage range	20...250 V AC/DC
• Current drain through the supervision circuit	~1.5 mA
• Minimum voltage over the TCS contact	20 V AC/DC (15...20 V)

Table 12. 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, at 48/110/220 V DC	5 A/3 A/1 A
Minimum contact load	100 mA at 24 V AC/DC

Table 13. Lens sensor and optical fibre for arc protection

Description	Value
Fibre-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 fibre	100 mm

Table 14. Degree of protection of flush-mounted IED

Description	Value
Front side	IP 54
Rear side, connection terminals	IP 20

Table 15. Environmental conditions

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

1) Degradation in MTBF and HMI performance outside the temperature range of -25...+55 °C

2) For IEDs with an LC communication interface the maximum operating temperature is +70 °C

Table 16. Environmental tests

Description	Type test value	Reference
Dry heat test (humidity <50%)	<ul style="list-style-type: none">• 96 h at +55°C• 16 h at +85°C¹⁾	IEC 60068-2-2
Dry cold test	<ul style="list-style-type: none">• 96 h at -25°C• 16 h at -40°C	IEC 60068-2-1
Damp heat test, cyclic	<ul style="list-style-type: none">• 6 cycles (12 h + 12 h) at +25°C...+55°C, humidity >93%	IEC 60068-2-30
Storage test	<ul style="list-style-type: none">• 96 h at -40°C• 96 h at +85°C	IEC 60068-2-48

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

Table 17. Electromagnetic compatibility tests

Description	Type test value	Reference
1 MHz burst disturbance test: <ul style="list-style-type: none"> • Common mode • Differential mode 	2.5 kV 1.0 kV	IEC 61000-4-18 and IEC 60255-22-1, level 3
Electrostatic discharge test: <ul style="list-style-type: none"> • Contact discharge • Air discharge 	8 kV 15 kV	IEC 61000-4-2, IEC 60255-22-2 and IEEE C37.90.3.2001
Radio frequency interference tests: <ul style="list-style-type: none"> • Conducted, common mode • Radiated, amplitude-modulated • Radiated, pulse-modulated 	10 V (rms), f=150 kHz...80 MHz 10 V/m (rms), f=80...2700 MHz 10 V/m, f=900 MHz	IEC 61000-4-6 and IEC 60255-22-6, level 3 IEC 61000-4-3 and IEC 60255-22-3, level 3 ENV 50204 and IEC 60255-22-3, level 3
Fast transient disturbance tests: <ul style="list-style-type: none"> • All ports 	4kV	IEC 61000-4-4 and IEC 60255-22-4, class A
Surge immunity test: <ul style="list-style-type: none"> • Binary inputs • Communication • Other ports 	4 kV, line-to-earth 2 kV, line-to-line 1 kV, line-to-earth 4 kV, line-to-earth 2 kV, line-to-line	IEC 61000-4-5 and IEC 60255-22-5, level 4/3
Power frequency (50 Hz) magnetic field: <ul style="list-style-type: none"> • Continuous 	300 A/m	IEC 61000-4-8, level 5

Table 17. Electromagnetic compatibility tests, continued

Description	Type test value	Reference
Power frequency immunity test: <ul style="list-style-type: none"> • Common mode • Differential mode 	Binary inputs only 300 V rms 150 V rms	IEC 61000-4-16 and IEC 60255-22-7, class A
Voltage dips and short interruptions	30%/10 ms 60%/100 ms 60%/1000 ms >95%/5000 ms	IEC 61000-4-11
Electromagnetic emission tests: <ul style="list-style-type: none"> • Conducted, RF-emission (mains terminal) 		EN 55011, class A and IEC 60255-25
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	
<ul style="list-style-type: none"> • Radiated RF -emission 		
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	

Table 18. Insulation tests

Description	Type test value	Reference
Dielectric tests: • Test voltage	2 kV, 50 Hz, 1 min 500 V, 50 Hz, 1min, communication	IEC 60255-5
Impulse voltage test: • Test voltage	5 kV, unipolar impulses, waveform 1.2/50 μ s, source energy 0.5 J 1 kV, unipolar impulses, waveform 1.2/50 μ s, source energy 0.5 J, communication	IEC 60255-5
Insulation resistance measurements • Isolation resistance	>100 M Ω , 500 V DC	IEC 60255-5
Protective bonding resistance • Resistance	<0.1 Ω , 4 A, 60 s	IEC 60255-27

Table 19. Mechanical tests

Description	Reference	Requirement
Vibration tests (sinusoidal)	IEC 60068-2-6 (test Fc) IEC 60255-21-1	Class 2
Shock and bump test	IEC 60068-2-27 (test Ea Shock) IEC 60068-2-29 (test Eb Bump) IEC 60255-21-2	Class 2

Table 20. EMC compliance

Description	Reference
EMC directive	2004/108/EC
Standard	EN 50263 (2000) EN 60255-26 (2007)

Table 21. Product safety

Description	Reference
LV directive	2006/95/EC
Standard	EN 60255-27 (2005) EN 60255-6 (1994)

Table 22. RoHS compliance

Description
Complies with RoHS directive 2002/95/EC

Table 23. 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

Protection functions

Table 24. Three-phase non-directional overcurrent protection (PHxPTOC)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the current measured: $f_n \pm 2\text{Hz}$		
	PHLPTOC	$\pm 1.5\%$ of the set value or $\pm 0.002 \times I_n$		
	PHHPTOC ¹⁾ and PHIPTOC	$\pm 1.5\%$ of set value or $\pm 0.002 \times I_n$ (at currents in the range of $0.1 \dots 10 \times I_n$) $\pm 5.0\%$ of the set value (at currents in the range of $10 \dots 40 \times I_n$)		
Start time ²⁾³⁾		Minimum	Typical	Maximum
	PHIPTOC: $I_{\text{Fault}} = 2 \times \text{set Start value}$ $I_{\text{Fault}} = 10 \times \text{set Start value}$	16 ms	19 ms	23 ms
		11 ms	12 ms	14 ms
	PHHPTOC ¹⁾ and PHLPTOC: $I_{\text{Fault}} = 2 \times \text{set Start value}$	22 ms	24 ms	25 ms
Reset time	< 40 ms			
Reset ratio	Typical 0.96			
Retardation time	< 30 ms			
Operate time accuracy in definite time mode	$\pm 1.0\%$ of the set value or ± 20 ms			
Operate time accuracy in inverse time mode	$\pm 5.0\%$ of the theoretical value or ± 20 ms ⁴⁾			
Suppression of harmonics	RMS: No suppression DFT: -50dB at $f = n \times f_n$, where $n = 2, 3, 4, 5, \dots$ Peak-to-Peak: No suppression P-to-P+backup: No suppression			

1) Not included in REM615 standard configuration C

2) Set *Operate delay time* = 0,02 s, *Operate curve type* = IEC definite time, *Measurement mode* = default (depends on stage), current before fault = $0.0 \times I_n$, $f_n = 50$ 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 25. Three-phase non-directional overcurrent protection (PHxPTOC) main settings

Parameter	Function	Value (Range)	Step
Start Value	PHLPTOC	0.05...5.00 x I _n	0.01
	PHHPTOC ¹⁾	0.10...40.00 x I _n	0.01
	PHIPTOC	1.00...40.00 x I _n	0.01
Time multiplier	PHLPTOC	0.05...15.00	0.05
	PHHPTOC ¹⁾	0.05...15.00	0.05
Operate delay time	PHLPTOC	40...200000 ms	10
	PHHPTOC ¹⁾	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 REM615 standard configuration C

2) For further reference please refer to the Operating characteristics table at the end of the Technical data chapter

Table 26. Directional EF protection (DEFxPDEF)

Characteristic		Value		
Operation accuracy	DEFLPDEF	Depending on the frequency of the current measured: $f_n \pm 2\text{Hz}$		
	DEFHPDEF ¹⁾	Current: $\pm 1.5\%$ of the set value or $\pm 0.002 \times I_n$ Voltage $\pm 1.5\%$ of the set value or $\pm 0.002 \times U_n$ Phase angle: $\pm 2^\circ$		
Start time ²⁾³⁾	DEFHPDEF ¹⁾ and DEFLPTDEF: $I_{\text{Fault}} = 2 \times \text{set Start value}$	Minimum	Typical	Maximum
		61 ms	64 ms	66 ms
Reset time	< 40 ms			
Reset ratio	Typical 0.96			
Retardation time	< 30 ms			
Operate time accuracy in definite time mode	$\pm 1.0\%$ of the set value or ± 20 ms			
Operate time accuracy in inverse time mode	$\pm 5.0\%$ of the theoretical value or ± 20 ms ⁴⁾			
Suppression of harmonics	RMS: No suppression DFT: -50dB at $f = n \times f_n$, where $n = 2, 3, 4, 5,$... Peak-to-Peak: No suppression			

1) Not included in REM615 standard configuration C

2) Set *Operate delay time* = 0.06 s, *Operate curve type* = IEC definite time, *Measurement mode* = default (depends on stage), current before fault = $0.0 \times I_n$, $f_n = 50$ 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* = $2.5 \times I_n$, *Start value* multiples in range of 1.5 to 20

Table 27. Directional EF protection (DEFxPDEF) main settings

Parameter	Function	Value (Range)	Step
Start Value	DEFLPDEF	0.01...5.00 x I _n	0.005
	DEFHPDEF ¹⁾	0.10...40.00 x I _n	0.01
Directional mode	DEFLPDEF and DEFHPDEF	1=Non-directional 2=Forward 3=Reverse	
Time multiplier	DEFLPDEF	0.05...15.00	0.05
	DEFHPDEF ¹⁾	0.05...15.00	0.05
Operate delay time	DEFLPDEF	60...200000 ms	10
	DEFHPDEF ¹⁾	60...200000 ms	10
Operating curve type ²⁾	DEFLPDEF	Definite or inverse time 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 Curve type: 1, 3, 5, 15, 17	
Operation mode	DEFLPDEF and DEFHPDEF ¹⁾	1=Phase angle 2=I ₀ Sin 3=I ₀ Cos 4=Phase angle 80 5=Phase angle 88	

1) Not included in REM615 standard configuration C

2) For further reference please refer to the Operating characteristics table at the end of the Technical data chapter

Table 28. Non-directional EF protection (EFxPTOC)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the current measured: $f_n \pm 2\text{Hz}$		
	EFLPTOC	$\pm 1.5\%$ of the set value or $\pm 0.002 \times I_n$		
	EFHPTOC ¹⁾ and EFIPTOC ¹⁾	$\pm 1.5\%$ of set value or $\pm 0.002 \times I_n$ (at currents in the range of $0.1 \dots 10 \times I_n$) $\pm 5.0\%$ of the set value (at currents in the range of $10 \dots 40 \times I_n$)		
Start time ²⁾³⁾	EFIPTOC ¹⁾ : $I_{\text{Fault}} = 2 \times \text{set Start value}$ $I_{\text{Fault}} = 10 \times \text{set Start value}$	Minimum	Typical	Maximum
		16 ms 11 ms	19 ms 12 ms	23 ms 14 ms
	EFHPTOC ¹⁾ and EFLPTOC: $I_{\text{Fault}} = 2 \times \text{set Start value}$	22 ms	24 ms	25 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Retardation time		< 30 ms		
Operate time accuracy in definite time mode		$\pm 1.0\%$ of the set value or ± 20 ms		
Operate time accuracy in inverse time mode		$\pm 5.0\%$ of the theoretical value or ± 20 ms ⁴⁾		
Suppression of harmonics		RMS: No suppression DFT: -50dB at $f = n \times f_n$, where $n = 2, 3, 4, 5, \dots$ Peak-to-Peak: No suppression		

1) Not included in REM615 standard configuration C

2) *Measurement mode* = default (depends on stage), current before fault = $0.0 \times I_n$, $f_n = 50$ 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* = $2.5 \times I_n$, *Start value* multiples in range of 1.5 to 20

Table 29. Non-directional EF protection (EFxPTOC) main settings

Parameter	Function	Value (Range)	Step
Start value	EFLPTOC	0.010...5.000 x I _n	0.005
	EFHPTOC ¹⁾	0.10...40.00 x I _n	0.01
	EFIPTOC ¹⁾	1.00...40.00 x I _n	0.01
Time multiplier	EFLPTOC	0.05...15.00	0.05
	EFHPTOC ¹⁾	0.05...15.00	0.05
Operate delay time	EFLPTOC	40...200000 ms	10
	EFHPTOC ¹⁾	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 ¹⁾	Definite or inverse time Curve type: 1, 3, 5, 9, 10, 12, 15, 17	
	EFIPTOC ¹⁾	Definite time	

1) Not included in REM615 standard configuration C

2) For further reference please refer to the Operating characteristics table at the end of the Technical data chapter

Table 30. Three phase undervoltage protection (PHPTUV)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the voltage measured: $f_n \pm 2\text{Hz}$		
		$\pm 1.5\%$ of the set value or $\pm 0.002 \times U_n$		
Start time ¹⁾²⁾	$U_{\text{Fault}} = 0.9 \times \text{set}$ <i>Start value</i>	Minimum	Typical	Maximum
		62 ms	64 ms	66 ms
Reset time		< 40 ms		
Reset ratio		Depends of the set <i>Relative hysteresis</i>		
Retardation time		< 35 ms		
Operate time accuracy in definite time mode		$\pm 1.0\%$ of the set value or ± 20 ms		
Operate time accuracy in inverse time mode		$\pm 5.0\%$ of the theoretical value or ± 20 ms ³⁾		
Suppression of harmonics		DFT: -50 dB at $f = n \times f_n$, where $n = 2, 3, 4, 5,$...		

- 1) *Start value* = $1.0 \times U_n$, Voltage before fault = $1.1 \times U_n$, $f_n = 50$ 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 to 0.20

Table 31. Three-phase undervoltage protection (PHPTUV) main settings

Parameter	Function	Value (Range)	Step
Start value	PHPTUV	$0.05 \dots 1.20 \times U_n$	0.01
Time multiplier	PHPTUV	0.05...15.00	0.05
Operate delay time	PHPTUV	60...300000 ms	10
Operating curve type ¹⁾	PHPTUV	Definite or inverse time Curve type: 5, 15, 21, 22, 23	

- 1) For further reference please refer to the Operating characteristics table at the end of the Technical data chapter

Table 32. Positive sequence undervoltage protection (PSPTUV)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the voltage measured: $f_n \pm 2\text{Hz}$		
		$\pm 1.5\%$ of the set value or $\pm 0.002 \times U_n$		
Start time ¹⁾²⁾	$U_{\text{Fault}} = 0.99 \times \text{set}$ <i>Start value</i> $U_{\text{Fault}} = 0.9 \times \text{set}$ <i>Start value</i>	Minimum	Typical	Maximum
		51 ms 43 ms	53 ms 45 ms	54 ms 46 ms
Reset time		< 40 ms		
Reset ratio		Depends of the set <i>Relative hysteresis</i>		
Retardation time		< 35 ms		
Operate time accuracy in definite time mode		$\pm 1.0\%$ of the set value or ± 20 ms		
Suppression of harmonics		DFT: -50 dB at $f = n \times f_n$, where $n = 2, 3, 4, 5, \dots$		

- 1) *Start value* = $1.0 \times U_n$, Positive sequence voltage before fault = $1.1 \times U_n$, $f_n = 50$ 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 33. Positive sequence undervoltage protection (PSPTUV) main settings

Parameter	Function	Value (Range)	Step
Start value	PSPTUV	$0.010 \dots 1.200 \times U_n$	0.001
Operate delay time	PSPTUV	40...120000 ms	10
Voltage block value	PSPTUV	$0.01 \dots 1.0 \times U_n$	0.01

Table 34. Negative sequence overvoltage protection (NSPTOV)

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

1) Negative-sequence voltage before fault = $0.0 \times U_n$, $f_n = 50$ 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 35. Negative sequence overvoltage protection (NSPTOV) main settings

Parameter	Function	Value (Range)	Step
Start value	NSPTOV	$0.010 \dots 1.000 \times U_n$	0.001
Operate delay time	NSPTOV	40...120000 ms	1

Table 36. Negative phase-sequence overcurrent protection for motors (MNSPTOC)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the current measured: $f_n \pm 2\text{Hz}$		
		$\pm 1.5\%$ of the set value or $\pm 0.002 \times I_n$		
Start time ¹⁾²⁾	$I_{\text{Fault}} = 2.0 \times \text{set Start value}$	Minimum	Typical	Maximum
		22 ms	24 ms	25 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Retardation time		< 35 ms		
Operate time accuracy in definite time mode		$\pm 1.0\%$ of the set value or ± 20 ms		
Operate time accuracy in inverse time mode		$\pm 5.0\%$ of the theoretical value or ± 20 ms ³⁾		
Suppression of harmonics		DFT: -50 dB at $f = n \times f_n$, where $n = 2, 3, 4, 5, \dots$		

- 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
 3) *Start value* multiples in range of 1.10 to 5.00

Table 37. Negative phase-sequence overcurrent protection for motors (MNSPTOC) main settings

Parameter	Function	Value (Range)	Step
Start value	MNSPTOC	0.01...0.50 pu	0.01
Operating curve type	MNSPTOC	ANSI Def. Time IEC Def. Time Inv. Curve A Inv. Curve B	-
Operate delay time	MNSPTOC	0.10...120.00 s	0.01
Cooling time	MNSPTOC	5...7200 s	1
Operation	MNSPTOC	Off On	-

Table 38. Loss of load supervision (LOFLPTUC)

Characteristic	Value
Operation accuracy	Depending on the frequency of the current measured: $f_n \pm 2\text{Hz}$
	$\pm 1.5\%$ of the set value or $\pm 0.002 \times I_n$
Start time	Typical 300 ms
Reset time	< 40 ms
Reset ratio	Typical 0.96
Retardation time	< 35 ms
Operate time accuracy in definite time mode	$\pm 1.0\%$ of the set value or ± 20 ms

Table 39. Loss of load supervision (LOFLPTUC) main settings

Parameter	Function	Value (Range)	Step
Start value high	LOFLPTUC	0.01...1.00 pu	0.01
Start value low	LOFLPTUC	0.01...0.50 pu	0.01
Operate delay time	LOFLPTUC	0.40...600.00 s	0.01
Operation	LOFLPTUC	Off On	-

Table 40. Motor load jam protection (JAMPTOC)

Characteristic	Value
Operation accuracy	Depending on the frequency of the current measured: $f_n \pm 2\text{Hz}$
	$\pm 1.5\%$ of the set value or $\pm 0.002 \times I_n$
Reset time	< 40 ms
Reset ratio	Typical 0.96
Retardation time	< 35 ms
Operate time accuracy in definite time mode	$\pm 1.0\%$ of the set value or ± 20 ms

Table 41. Motor load jam protection (JAMPTOC) main settings

Parameter	Function	Value (Range)	Step
Operation	JAMPTOC	Off On	-
Start value	JAMPTOC	0.10...10.00 pu	0.01
Operate delay time	JAMPTOC	0.10...120.00 s	0.01

Table 42. Motor start-up supervision (STTPMSU)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the current measured: $f_n \pm 2\text{Hz}$ $\pm 1.5\%$ of the set value or $\pm 0.002 \times I_n$		
Start time ¹⁾²⁾	$I_{\text{Fault}} = 1.1 \times \text{set Start detection A}$	Minimum	Typical	Maximum
		27 ms	30 ms	34 ms
Operate time accuracy		$\pm 1.0\%$ of the set value or ± 20 ms		
Reset ratio		Typical 0.90		

1) Current before = $0.0 \times I_n$, $f_n = 50$ Hz, overcurrent in one phase, results based on statistical distribution of 1000 measurements

2) Includes the delay of the signal output contact

Table 43. Motor start-up supervision (STTPMSU) main settings

Parameter	Function	Value (Range)	Step
Motor start-up A	STTPMSU	1.0...10.0 pu	0.1
Motor start-up time	STTPMSU	0.3...80.0 s	0.1
Lock rotor time	STTPMSU	2.0...120.0 s	1.0
Operation	STTPMSU	Off On	-
Operation mode	STTPMSU	IIt IIt, CB IIt & stall IIt & stall, CB	-
Restart inhibit time	STTPMSU	0...250 min	1

Table 44. Phase reversal protection (PREVTOC)

Characteristic		Value		
Operation accuracy		Depending on the frequency of the current measured: $f_n \pm 2\text{Hz}$		
		$\pm 1.5\%$ of the set value or $\pm 0.002 \times I_n$		
Start time ¹⁾²⁾	$I_{\text{Fault}} = 2.0 \times \text{set Start value}$	Minimum	Typical	Maximum
		22 ms	24 ms	25 ms
Reset time		< 40 ms		
Reset ratio		Typical 0.96		
Retardation time		< 35 ms		
Operate time accuracy in definite time mode		$\pm 1.0\%$ of the set value or ± 20 ms		
Suppression of harmonics		DFT: -50 dB at $f = n \times f_n$, where $n = 2, 3, 4, 5, \dots$		

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 45. Phase reversal protection (PREVPTOC) main settings

Parameter	Function	Value (Range)	Step
Start value	PREVPTOC	0.05...1.00 pu	0.01
Operate delay time	PREVPTOC	0.100...30.000 s	0.001
Operation	PREVPTOC	Off On	-

Table 46. Three-phase thermal overload protection for motors (MPTTR)

Characteristic	Value
Operation accuracy	Depending on the frequency of the current measured: $f_n \pm 2\text{Hz}$
	Current measurement: $\pm 1.5\%$ of the set value or $\pm 0.002 \times I_n$ (at currents in the range of $0.01 \dots 4.00 \times I_n$)
Operate time accuracy ¹⁾	$\pm 2.0\%$ of the theoretical value or ± 0.50 s

1) Overload current > 1.2 x Operate level temperature

Table 47. Thermal overload protection for motors (MPTTR) main settings

Parameter	Function	Value (Range)	Step
Env temperature mode	MPTTR	FLC Only Use RTD Set Amb Temp	-
Env temperature set	MPTTR	-20.0...70.0 °C	0.1
Alarm thermal value	MPTTR	50.0...100.0 %	0.1
Restart thermal value	MPTTR	20.0...80.0 %	0.1
Overload factor	MPTTR	1.00...1.20	0.01
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
Operation	MPTTR	Off On	-

Table 48. Circuit breaker failure protection (CCBRBRF)

Characteristic	Value
Operation accuracy	Depending on the frequency of the current measured: $f_n \pm 2\text{Hz}$
	$\pm 1.5\%$ of the set value or $\pm 0.002 \times I_n$
Operate time accuracy	$\pm 1.0\%$ of the set value or $\pm 20 \text{ ms}$

Table 49. Circuit breaker failure protection (CCBRBRF) main settings

Parameter	Function	Value (Range)	Step
Current value (Operating phase current)	CCBRBRF	0.05...1.00 x I _n	0.05
Current value Res (Operating residual current)	CCBRBRF	0.05...1.00 x I _n	0.05
CB failure mode (Operating mode of function)	CCBRBRF	1=Current 2=Breaker status 3=Both	
CB fail trip mode	CCBRBRF	1=Off 2=Without check 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 50. Arc protection (ARCSARC)

Characteristic	Value			
Operation accuracy	±3% of the set value or ±0.01 x I _n			
Operate time		Minimum	Typical	Maximum
	<i>Operation mode = "Light+current"¹⁾²⁾</i>	9 ms	12 ms	15 ms
	<i>Operation mode = "Light only"²⁾</i>	9 ms	10 ms	12 ms
Reset time	< 40 ms			
Reset ratio	Typical 0.96			

1) *Phase start value* = 1.0 x I_n, current before fault = 2.0 x set *Phase start value*, f_n = 50 Hz, fault with nominal frequency, results based on statistical distribution of 200 measurements

2) Includes the delay of the heavy-duty output contact

Table 51. Arc protection (ARCSARC) main settings

Parameter	Function	Value (Range)	Step
Phase start value (Operating phase current)	ARCSARC	0.50...40.00 x I _n	0.01
Ground start value (Operating residual current)	ARCSARC	0.05...8.00 x I _n	0.01
Operation mode	ARCSARC	1=Light+current 2=Light only 3=BI controlled	

Control functions

Table 52. Emergency startup (ESMGAPC) main settings

Parameter	Function	Value (Range)	Step
Operation	ESMGAPC	Off On	-
Motor stand still A	ESMGAPC	0.05...0.20 pu	0.01

Measurement functions

Table 53. Three-phase current measurement (CMMXU)

Characteristic	Value
Operation accuracy	Depending on the frequency of the current measured: f _n ±2Hz ±0.5% or ±0.002 x I _n (at currents in the range of 0.01...4.00 x I _n)
Suppression of harmonics	DFT: -50dB at f = n x f _n , where n = 2, 3, 4, 5, ... RMS: No suppression

Table 54. Residual current measurement (RESCMMXU)

Characteristic	Value
Operation accuracy	Depending on the frequency of the current measured: $f/f_n = \pm 2\text{Hz}$
	$\pm 0.5\%$ or $\pm 0.002 \times I_n$ at currents in the range of $0.01 \dots 4.00 \times I_n$
Suppression of harmonics	DFT: -50dB at $f = n \times f_n$, where $n = 2, 3, 4, 5,$... RMS: No suppression

Table 55. Three-phase voltage measurement (VMMXU)

Characteristic	Value
Operation accuracy	Depending on the frequency of the voltage measured: $f_n \pm 2\text{Hz}$ At voltages in range $0.01 \dots 1.15 \times U_n$
	$\pm 0.5\%$ or $\pm 0.002 \times U_n$
Suppression of harmonics	DFT: -50 dB at $f = n \times f_n$, where $n = 2, 3, 4, 5,$... RMS: No suppression

Table 56. Residual voltage measurement (RESVMMXU)

Characteristic	Value
Operation accuracy	Depending on the frequency of the current measured: $f/f_n = \pm 2\text{Hz}$
	$\pm 0.5\%$ or $\pm 0.002 \times U_n$
Suppression of harmonics	DFT: -50dB at $f = n \times f_n$, where $n = 2, 3, 4, 5,$... RMS: No suppression

Table 57. Voltage sequence components (VSMSQI)

Characteristic	Value
Operation accuracy	Depending on the frequency of the voltage measured: $f_n \pm 2\text{Hz}$ At voltages in range $0.01 \dots 1.15 \times U_n$
	$\pm 1.0\%$ or $\pm 0.002 \times U_n$
Suppression of harmonics	DFT: -50 dB at $f = n \times f_n$, where $n = 2, 3, 4, 5,$...

Table 58. Three-phase power and energy (PEMMXU)

Characteristic	Value
Operation accuracy	At all three currents in range $0.10 \dots 1.20 \times I_n$ At all three voltages in range $0.50 \dots 1.15 \times U_n$ At the frequency $f_n \pm 1\text{Hz}$ Active power and energy in range $ \text{PF} > 0.71$ Reactive power and energy in range $ \text{PF} < 0.71$
	$\pm 1.5\%$ for power (S, P and Q) ± 0.015 for power factor $\pm 1.5\%$ for energy
Suppression of harmonics	DFT: -50 dB at $f = n \times f_n$, where $n = 2, 3, 4, 5, \dots$

Supervision functions

Table 59. Current circuit supervision (CCRDIF)

Characteristic	Value
Operate time ¹⁾	< 30 ms

1) Including the delay of the output contact.

Table 60. Current circuit supervision (CCRDIF) main settings

Parameter	Values (Range)	Unit	Description
Start value	0.05...0.20	$\times I_n$	Minimum operate current differential level
Maximum operate current	1.00...5.00	$\times I_n$	Block of the function at high phase current

Table 61. Fuse failure supervision (SEQRFUF)

Characteristic	Value	
Operate time ¹⁾ • NPS function	$U_{\text{Fault}} = 1.1 \times \text{set Neg Seq voltage Lev}$	< 33 ms
	$U_{\text{Fault}} = 5.0 \times \text{set Neg Seq voltage Lev}$	< 18 ms
• Delta function	$\Delta U = 1.1 \times \text{set Voltage change rate}$	< 30 ms
	$\Delta U = 2.0 \times \text{set Voltage change rate}$	< 24 ms

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

Table 62. Motor run time counter (MDSOPT)

Description	Value
Motor run-time measurement accuracy ¹⁾	$\pm 0.5\%$

1) Of the reading, for a stand-alone IED, without time synchronization.

20. Display options

The IED is available with two optional displays, a large one and a small one. Both LCD displays offer full front-panel user-interface functionality with menu navigation and menu views.

The large display offers increased front-panel usability with less menu scrolling and

improved information overview. The large display is suited for IED installations where the front panel user interface is frequently used, whereas the small display is suited for remotely controlled substations where the IED is only occasionally accessed locally via the front panel user interface.

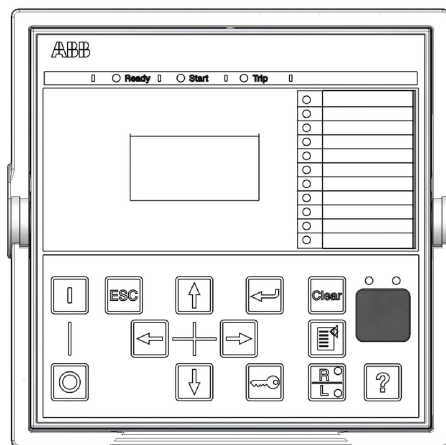


Figure 4. Small display

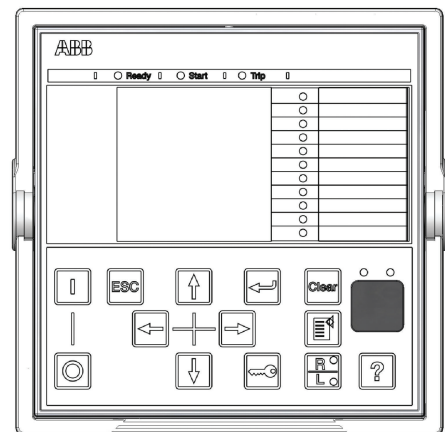


Figure 5. Large display

Table 63. Small display

Character size ¹⁾	Rows in the view	Characters per row
Small, mono-spaced (6x12 pixels)	5	20
Large, variable width (13x14 pixels)	4	8 or more

1) Depending on the selected language

Table 64. Large display

Character size ¹⁾	Rows in the view	Characters per row
Small, mono-spaced (6x12 pixels)	10	20
Large, variable width (13x14 pixels)	8	8 or more

1) Depending on the selected language

21. Mounting methods

By means of appropriate mounting accessories the standard IED case for the 615 series IED can be flush mounted, semi-flush mounted or wall mounted. The flush mounted and wall mounted IED cases can also be mounted in a tilted position (25°) using special accessories.

Further, the IEDs can be mounted in any standard 19" instrument cabinet by means of 19" mounting panels available with cut-outs for one or two IEDs. Alternatively, the IED can be mounted in 19" instrument cabinets by means of 4U Combiflex equipment frames.

For the routine testing purposes, the IED cases can be equipped with test switches,

type RTXP 18, which can be mounted side by side with the IED cases.

Mounting methods:

- Flush mounting
- Semi-flush mounting
- Semi-flush mounting in a 25° tilt
- Rack mounting
- Wall mounting
- Mounting to a 19" equipment frame
- Mounting with a RTXP 18 test switch to a 19" rack

Panel cut-out for flush mounting:

- Height: 161.5±1 mm
- Width: 165.5±1 mm

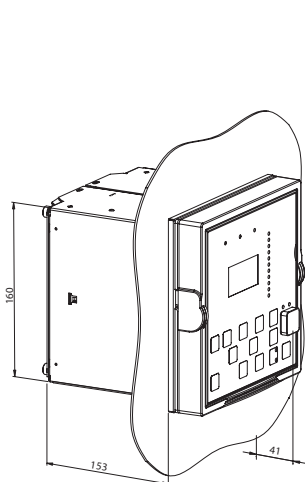


Figure 6. Flush mounting

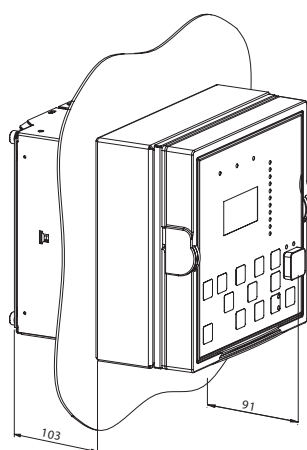


Figure 7. Semi-flush mounting

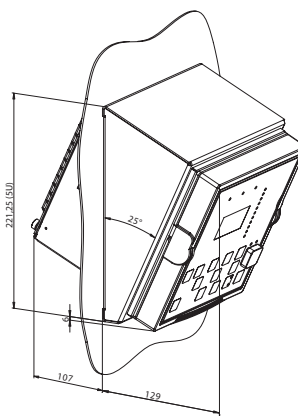


Figure 8. Semi-flush with a 25° tilt

22. IED case and IED plug-in unit

For safety reasons, the IED cases for current measuring IEDs are provided with automatically operating contacts for short-circuiting the CT secondary circuits when a IED unit is withdrawn from its case. The IED case is further provided with a mechanical

coding system preventing current measuring IED units from being inserted into a IED case for a voltage measuring IED unit and vice versa, i.e. the IED cases are assigned to a certain type of IED plug-in unit.

23. Selection and ordering data

The IED type and serial number label identifies the protection IED. The label is placed above the HMI on the upper part of the plug-in-unit. An order number label is

placed on the side of the plug-in unit as well as inside the case. The order number consists of a string of codes generated from the IED's hardware and software modules.

Use the ordering key information to generate the order number when ordering complete IEDs.

#	DESCRIPTION	
1	IED	
	615 series IED (including case)	H
	615 series IED (including case) with test switch, wired and installed in a 19" equipment panel	K
	615 series IED (including case) with test switch, wired and installed in a mounting bracket for CombiFlex rack mounting (RGHT 19" 4U variant C)	L
2	Standard	
	IEC	B
3	Main application	
	Motor protection and control	M

HBMCAEAGNBB1ABN1XC

The standard configuration determines the I/O hardware and available options. Choose the digits from one of the blue standard configuration rows below to define the correct digits for # 4-8. The example below shows standard configuration "C" with chosen options.

#	DESCRIPTION	
4-8	Standard configuration description in short: C = Motor protection with current and voltage based protection and measurement functions	
	Std. conf. # 4	Available analog inputs options # 5-6
	Available binary inputs/output options # 7-8	
	C	AE = 4 I (I ₀ 1/5 A) + 5 U or AF = 4 I (I ₀ 0.2/1 A) + 5 U
		AG = 16 BI + 10 BO

HBMCAEAGNBB1ABN1XC

The communication module hardware determines the available communication protocols. Choose the digits from one of the blue communication rows below to define the correct digits for digits 9-11. Note that the communication options are not dependant on the chosen standard configuration.

H B M C A E A G **N B B** 1 A B N 1 X C

#	DESCRIPTION		
9	Communication descriptions in short:		
-	Serial communication options digit #9		
11	Ethernet communication options digit #10		
	Communication protocol options #11		
	Serial options # 9	Ethernet options # 10	Protocol options # 11
	A = RS-485 (incl. IRIG-B)	A = Ethernet 100BaseFX (LC) or B = Ethernet 100BaseTX (RJ-45)	B = Modbus or C = IEC 61850 and Modbus or D = IEC 60870-5-103 or E = DNP3
	A = RS-485 (incl. IRIG-B)	N = None	B = Modbus or D = IEC 60870-5-103 or E = DNP3
	B = Glass fibre (ST) ^{1) 2)}	B = Ethernet 100BaseTX (RJ-45)	B = Modbus or C = IEC 61850 and Modbus or D = IEC 60870-5-103 or E = DNP3
	B = Glass fibre (ST) ^{1) 2)}	N = None	B = Modbus or D = IEC 60870-5-103 or E = DNP3
	N = None	A = Ethernet 100BaseFX (LC) or B = Ethernet 100BaseTX (RJ-45)	A = IEC 61850 or B = Modbus or C = IEC 61850 and Modbus or E = DNP3
	N = None	N = None	A = IEC 61850

¹⁾ Serial communication using glass fibre (ST) cannot be combined with arc protection.

²⁾ The communication card includes an RS-485 connector and an input for IRIG-B.

In addition to a serial communication option for station bus communication to gateways and SCADA systems, an Ethernet communication option can be chosen. This enables the use of an Ethernet based service bus for PCM600 and the WebHMI. However, this requires that an Ethernet communication option is chosen in addition to the serial communication (digit #10 = RJ-45 or LC).

HBMCAEAGNBB1ABN1XC

#	DESCRIPTION	
12	Language	
	English	I
	English and German	3
	English and Spanish	5
	English and Russian	6
	English and Portugese (Brazilian)	8
13	Front panel	
	Small LCD	A
	Large LCD	B
14	Option 1	
	Arc protection ¹⁾	B
	None	N
15	Option 2	
	None	N
16	Power supply	
	48...250 V DC, 100...240 V AC	1
	24...60 V DC	2
17	Vacant digit	
	Vacant	X
18	Version	
	Version 2.0	C

¹⁾ The arc protection hardware is located on the communication module (digit 9-10). Thus a communication module is always required to enable arc protection. Note that arc protection cannot be combined with serial communication using glass fibre (ST).

Example code: **HBMCAEAGNBB1ABN1XC**

Your ordering code:

Digit (#)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Code	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Figure 9. Ordering key for complete IEDs

24. Accessories and ordering data

Table 65. Cables

Item	Order number
Cable for optical sensors for arc protection 1.5 m	1MRS120534-1.5
Cable for optical sensors for arc protection 3.0 m	1MRS120534-3.0
Cable for optical sensors for arc protection 5.0 m	1MRS120534-5.0

Table 66. 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 IED	1MRS050694
19" rack mounting kit with cut-out for two IEDs	1MRS050695
Mounting bracket for one IED with test switch RTXP in 4U Combiflex (RHGT 19" variant C)	2RCA022642P0001
Mounting bracket for one IED in 4U Combiflex (RHGT 19" variant C)	2RCA022643P0001
19" rack mounting kit for one IED and one RTXP18 test switch (the test switch is not included in the delivery)	2RCA021952A0003
19" rack mounting kit for one IED and one RTXP24 test switch (the test switch is not included in the delivery)	2RCA022561A0003

25. Tools

The IED is delivered as a pre-configured unit. The default parameter setting values can be changed from the front-panel user interface, the web-browser based user interface (WebHMI) or the PCM600 tool in combination with the IED specific connectivity package.

PCM600 offers extensive IED configuration functions such as IED signal configuration using the signal matrix, and IEC 61850 communication configuration including

horizontal peer-to-peer communication, GOOSE.

When the web-browser based user interface is used, the IED can be accessed either locally or remotely using a web browser (IE 7.0 or later). For security reasons, the web-browser based user interface is disabled by default. The interface can be enabled with the PCM600 tool or from the front panel user interface. The functionality of the interface can be limited to read-only access by means of PCM600.

The IED connectivity package is a collection of software and specific IED information, which enable system products and tools to

connect and interact with the IED. The connectivity packages reduce the risk of

errors in system integration, minimizing device configuration and set-up times.

Table 67. Tools

Configuration and setting tools	Version
PCM600	2.0 SP2 or later
Web-browser based user interface	IE 7.0 or later
REM615 Connectivity Package	2.5 or later

Table 68. Supported functions

Function	WebHMI	PCM600
IED signal configuration (signal matrix)	-	●
IEC 61850 communication configuration, GOOSE (communication configuration)	-	●
Modbus [®] communication configuration (communication management)	-	●
DNP3 communication configuration (communication management)	-	●
IEC 60870-5-103 communication configuration (communication management)	-	●
IED parameter setting	●	●
Saving of IED parameter settings in the IED	●	●
Saving of IED parameter settings in the tool	-	●
Signal monitoring	●	●
Disturbance recorder handling	●	●
Disturbance record analysis	-	●
Event viewing	●	-
Saving of event data on the user's PC	●	-
Alarm LED viewing	●	●
Phasor diagram viewing	●	-
Access control management	●	●

● = Supported

26. Terminal diagrams

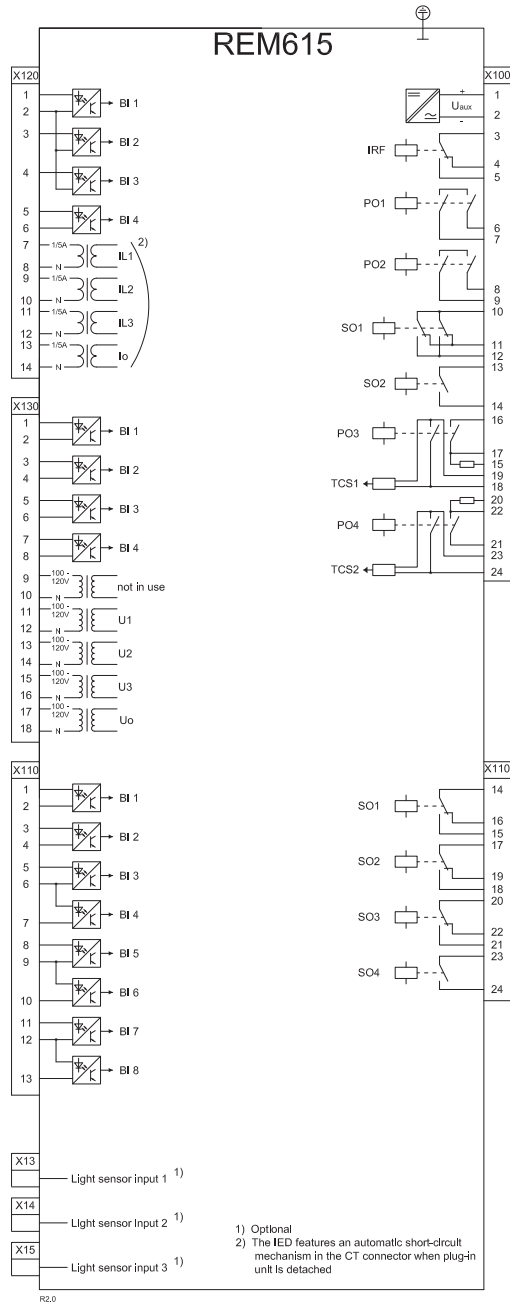


Figure 10. Terminal diagram of standard configuration C

27. References

The www.abb.com/substationautomation portal offers you information about the distribution automation product and service range.

You will find the latest relevant information on the REM615 protection IED on the product page.

The download area on the right hand side of the web page contains the latest product documentation, such as technical reference manual, installation manual, operators manual, etc. The selection tool on the web page helps you find the documents by the document category and language.

The Features and Application tabs contain product related information in a compact format.

28. Functions, codes and symbols

Table 69. REM615 Functions, codes and symbols

Functionality	IEC 61850	IEC 60617	IEC-ANSI
Protection			
Three-phase non-directional overcurrent protection, low stage, instance 1	PHLPTOC1	3I> (1)	51P-1 (1)
Three-phase non-directional overcurrent protection, instantaneous stage, instance 1	PHIPTOC1	3I>>> (1)	50P/51P (1)
Directional earth-fault protection, low stage, instance 1	DEFLPDEF1	I ₀ > → (1)	67N-1 (1)
Non-directional earth fault protection, using calculated I ₀	EFHPTOC1	I ₀ >>	51N-2
Three-phase undervoltage protection, instance 1	PHPTUV1	3U< (1)	27 (1)
Positive-sequence undervoltage protection	PSPTUV1	U ₁ <	47U+
Negative-sequence overvoltage protection	NSPTOV1	U ₂ >	47O-
Negative-sequence overcurrent protection for motors, instance 1	MNSPTOC1	I ₂ >M (1)	46M (1)
Negative-sequence overcurrent protection for motors, instance 2	MNSPTOC2	I ₂ >M (2)	46M (2)
Loss of load supervision	LOFLPTUC1	3I<	37
Motor load jam protection	JAMPTOC1	I _{st} >	51LR
Motor start-up supervision	STTPMSU1	I _{s2t n} <	49,66,48,51LR
Phase reversal protection	PREVPPTOC	I ₂ >>	46R
Thermal overload protection for motors	MPTR1	3I _{th} >M	49M
Circuit breaker failure protection	CCBRBRF1	3I>/I ₀ >BF	51BF/51NBF
Master trip, instance 1	TRPPTRC1	Master Trip (1)	94/86 (1)
Master trip, instance 2	TRPPTRC2	Master Trip (2)	94/86 (2)
Arc protection, instance 1	ARCSARC1	ARC (1)	50L/50NL (1)
Arc protection, instance 2	ARCSARC2	ARC (2)	50L/50NL (2)

Table 69. REM615 Functions, codes and symbols, continued

Functionality	IEC 61850	IEC 60617	IEC-ANSI
Arc protection, instance 3	ARCSARC3	ARC (3)	50L/50NL (3)
Control			
Circuit-breaker control	CBXCBR1	I ↔ O CB	I ↔ O CB
Disconnecter position indication, instance 1	DCSXSUW1	I ↔ O DC (1)	I ↔ O DC (1)
Disconnecter position indication, instance 2	DCSXSUW2	I ↔ O DC (2)	I ↔ O DC (2)
Disconnecter position indication, instance 3	DCSXSUW3	I ↔ O DC (3)	I ↔ O DC (3)
Earthing switch indication	ESSXSUW1	I ↔ O ES	I ↔ O ES
Emergency start-up	ESMGAPC1	ESTART	ESTART
Condition Monitoring			
Circuit-breaker condition monitoring	SSCBR1	CBCM	CBCM
Trip circuit supervision, instance 1	TCSSCBR1	TCS (1)	TCM (1)
Trip circuit supervision, instance 2	TCSSCBR2	TCS (2)	TCM (2)
Current circuit supervision	CCRDIF1	MCS 3I	MCS 3I
Fuse failure supervision	SEQRFUF1	FUSEF	60
Motor runtime counter	MDSOPT1	OPTS	OPTM
Measurement			
Disturbance recorder	RDRE1	-	-
Three-phase current measurement, instance 1	CMMXU1	3I	3I
Sequence current measurement	CSMSQI1	I ₁ , I ₂ , I ₀	I ₁ , I ₂ , I ₀
Residual current measurement, instance 1	RESCMMXU1	I ₀	I _n
Three-phase voltage measurement	VMMXU1	3U	3U
Residual voltage measurement	RESVMMXU1	U ₀	V _n
Sequence voltage measurement	VSMSQI1	U ₁ , U ₂ , U ₀	U ₁ , U ₂ , U ₀
Three-phase power and energy measurement	PEMMXU1	P, E	P, E

29. Document revision history

Document revision/ date	Product version	History
A/03.07.2009	2.0	First release

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