RELION® 610 SERIES

Voltage Protection
REU610
Product Guide

Contents

1. Description

REU610 is a voltage protection relay for system voltage protection, measuring and supervising in utility and industrial power systems. REU610 is a member of ABB's Relion® protection and control product family and part of its 610 product series. The 610 series includes protection relays for feeder protection, motor protection and general system voltage supervision. The plug-in design of the 610 series protection relays facilitates the commissioning of the switchgear and enables fast and safe insertion and withdrawal of relay plug-in units.

The protection relay is primarily designed for the overvoltage protection of power system components, such as busbars, feeders, power transformers and capacitor batteries. It is also used for the general power system earth-fault supervision. Further, the protection relay can be used for undervoltage protection of motors and overvoltage protection of capacitor batteries, for initialization of automatic busbar changeover and disconnecting small power units from the network in case of a major network disturbance. The 610 series protection relays are suitable for employment in marine and offshore environments.

The numerical voltage protection relays of the 610 series support a wide range of standard communication protocols, among them the IEC 61850, IEC 60870-5-103, DNP3, Modbus, Profibus, LON and SPA communication protocols.

2. Functional overview

Table 1. Functionality

Description	
Protection	
Three-phase overvoltage, low-set stage	•
Three-phase overvoltage, high-set stage [1)]	•
Negative phase-sequence overvoltage [1)]	•
Three-phase undervoltage, low-set stage	•
Three-phase undervoltage, high-set stage [2)]	•
Positive phase-sequence undervoltage [2)]	•
Residual overvoltage, low-set stage	•
Residual overvoltage, high-set stage	•
Circuit-breaker failure	•
Lockout relay function	•
Condition monitoring	
Trip circuit supervision	•
Trip lockout function	•
Trip counters for circuit-breaker condition monitoring	•
Measurement	
Disturbance recorder	•
Residual voltage	•
Three-phase voltages (phase-to-phase)	•
Negative and positive phase-sequence voltage	•

• = Included

1) Mutually exlusive functions
2) Mutually exlusive functions

3. Protection functions

The protection relay offers integrated protection functions including two-stage overvoltage and undervoltage protection, two-stage residual overvoltage protection, as well as single-stage negative phase-sequence overvoltage protection and single-stage positive phase-sequence undervoltage protection.

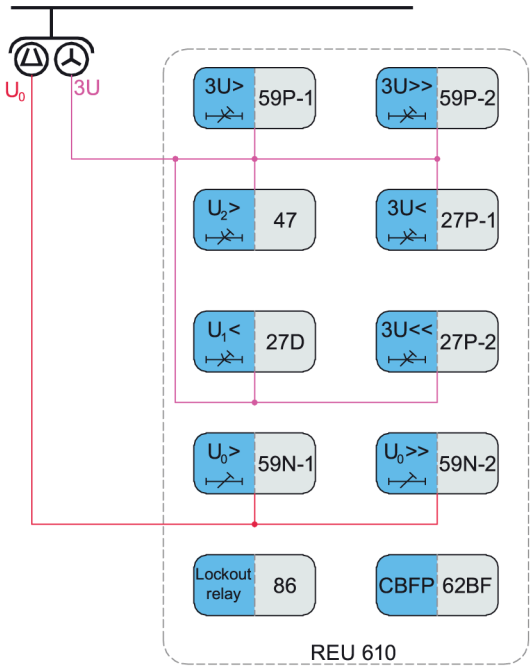


Figure 1. Protection function overview of REU610

4. Application

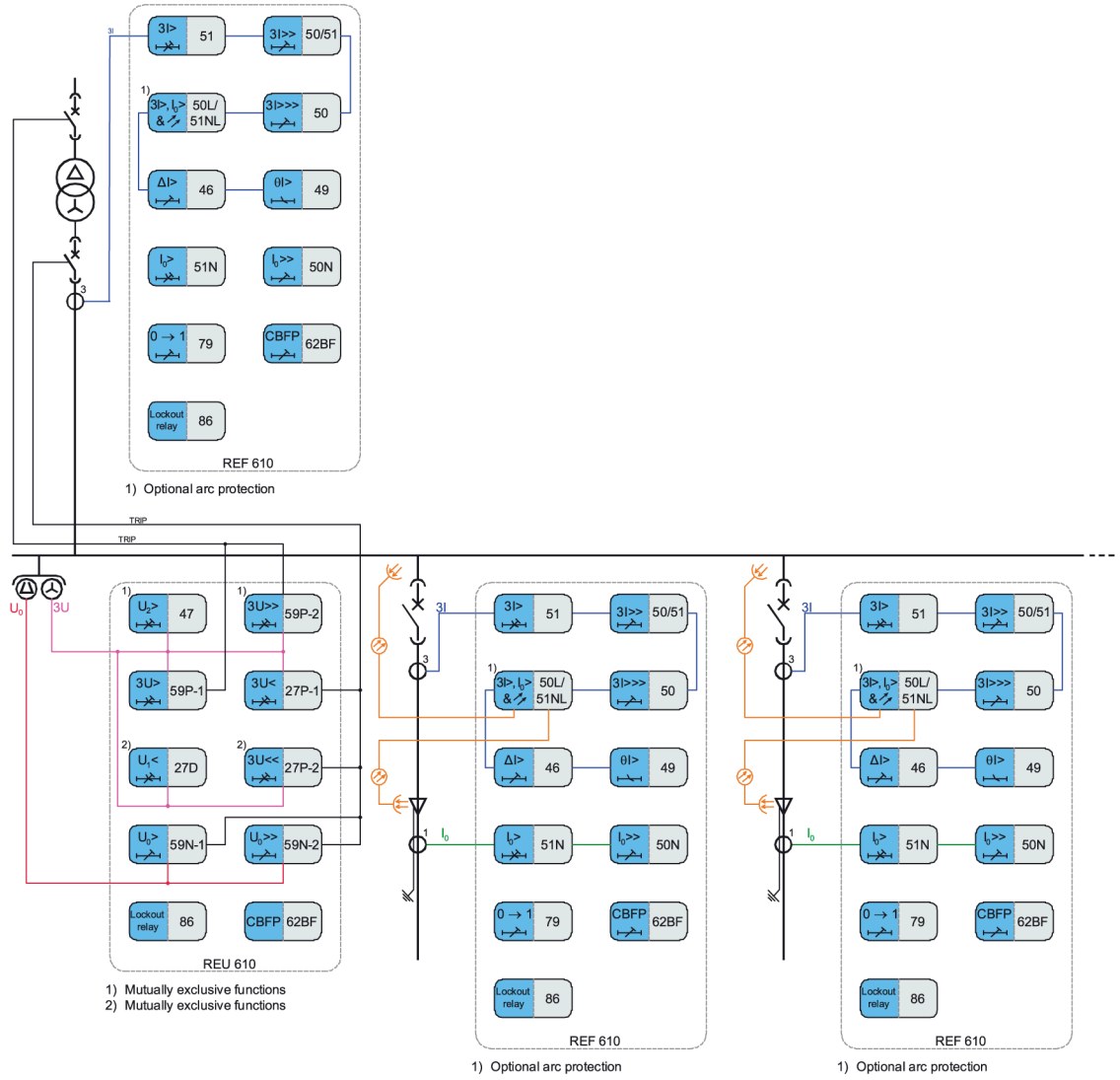


Figure 2. REU610 providing two-stage busbar overvoltage protection, two-stage busbar undervoltage protection and two-stage residual overvoltage protection. The two undervoltage stages trip the LV side CB of the infeeder. The two residual overvoltage stages offer back-up earth-fault protection for the outgoing feeders and main earth-fault protection for the infeeder and the busbar system. The three-phase overvoltage stages trip the HV side CB, thus providing overexcitation protection for the power transformer.

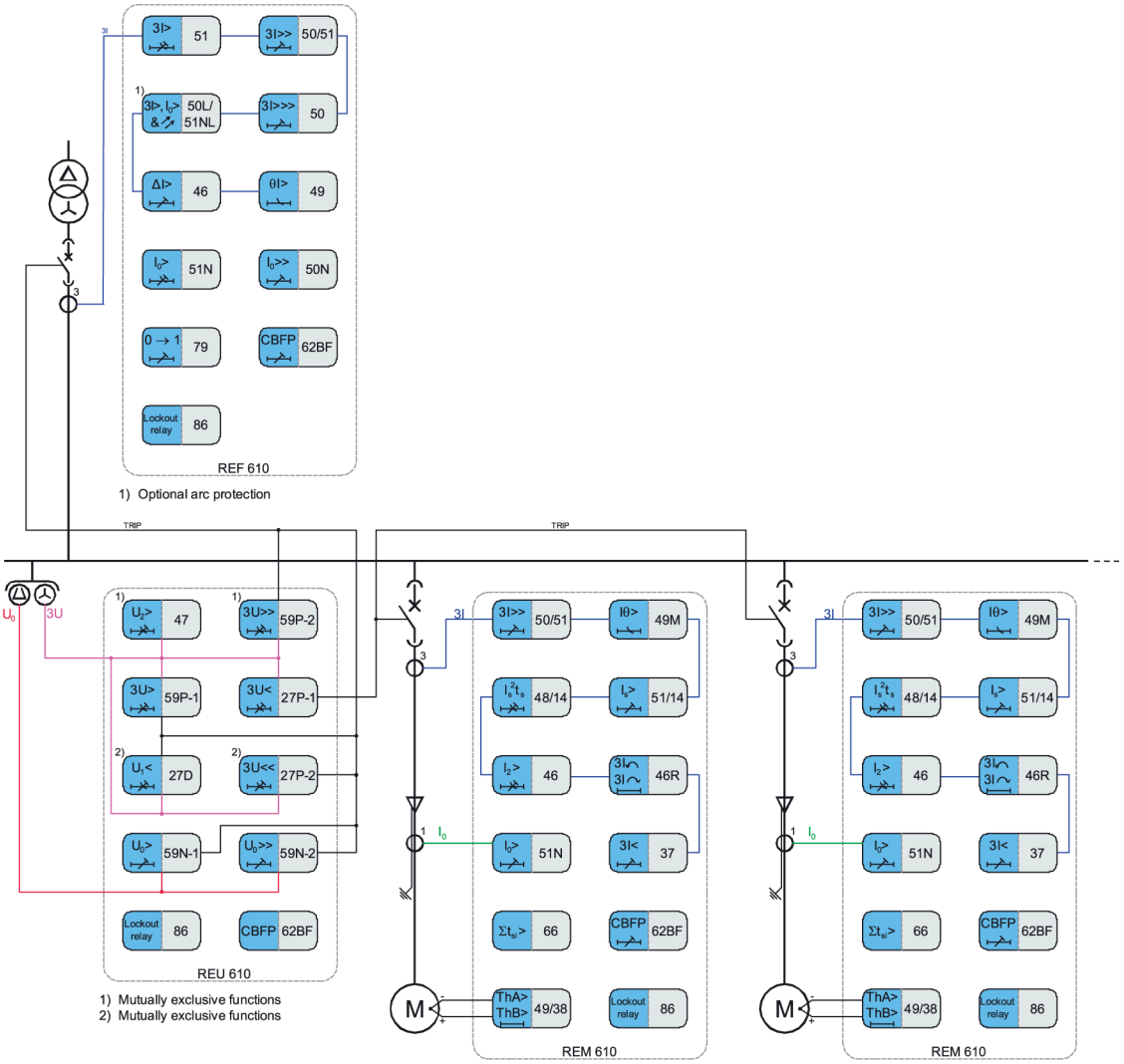


Figure 3. REU610 providing busbar overvoltage and undervoltage protection, and residual overvoltage protection. Both the three-phase overvoltage stages, the high-set three-phase undervoltage stage and residual overvoltage stages all trip the CB of the incoming feeder. The low-set stage of the three-phase undervoltage stage trips the CBs of the motor feeders, preventing the motors and drives from automatically starting on return of the power supply.

5. Measurement

The protection relay physically measures the three phase-to-phase voltages and the residual voltage of the power system. Further, from the phase-to-phase voltages the protection relay calculates the positive and negative phase-sequence voltages, the one-minute average phase-to-phase voltage, the average phase-to-phase voltage for a user-specifiable time frame, the maximum value of the one-minute average voltage, and the maximum and minimum phase-to-phase voltage value since last reset.

The values of the voltages measured or calculated can be accessed locally via the user interface on the protection relay's front panel, or remotely via the serial communication interface on the rear panel of the protection relay.

6. Disturbance recorder

The protection relay is provided with a built-in battery backed-up digital disturbance recorder for four analog signal channels and eight digital signal channels. The analog channels can be set to record the curve form of the voltages measured. The digital channels can be set to record external or internal relay signals, for example the start or trip signals of protection relay's stages, external blocking or control signals. Any digital relay signal such as a protection start or trip signal, or an external relay control signal can be set to trigger the recording. The recordings are stored in a nonvolatile memory from which the data can be uploaded for subsequent fault analysis.

7. Event recorder

To provide network control and monitoring systems with substation level event logs, the protection relay incorporates a nonvolatile memory with capacity of storing 100 event codes including the time stamps.The nonvolatile memory retains its data also in case the protection relay temporarily loses its auxiliary supply.The event log facilitates detailed pre- and post-fault analyses of the power system and network disturbances.

8. 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.

9. 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.

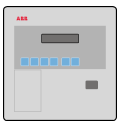
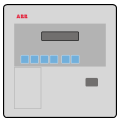
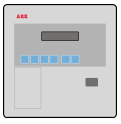
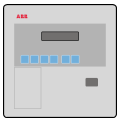
10. Inputs/Outputs

- Four voltage inputs
- Two digital inputs
- Three additional digital inputs on an optional I/0 module
- Three normally open heavy duty output contacts
- Two change-over signal output contacts
- One dedicated IRF contact
- Input/output contacts freely configurable

11. Communication

The protection relays are connected to the fiber-optic communication bus directly or via bus connection modules and gateways. The bus connection module converts the protection relay's electrical signals to optical signals for the communication bus and, vice versa, the communication bus' optical signals to electrical signals for the protection relay.

Table 2. Optional communication modules and protocols

Protocol	Plastic fiber	Plastic/Glass fiber	RS-485	RS-485DNP	Bus connection modules and gateways
SPA	●	●	●	-	
DNP3	-	-	-	●	
IEC 60780-5-103	●	●	●	-	
Modbus (RTU and ASCII)	●	●	●	-	Protection relay
IEC 61850	●	●	-	-	  Protection relay + SPA-ZC 402
LON	-	-	●	-	  Protection relay + SPA-ZC 102
	●	●	-	-	   Protection relay + SPA-ZC 21 + SPA-ZC 102
Profibus	-	-	●	-	  Protection relay + SPA-ZC 302

12. Technical data

Table 3. Dimensions

Description	Value	
Width	Frame Case	177 mm 164 mm
Height	Frame Case	177 mm (4U) 160 mm
Depth	Case	149.3 mm
Weight	Protection relay Spare unit	3.5 kg 1.8 kg

Table 4. Power supply

Description	Value	
Type	REU610CVVHxxx	REU610CVVLxxx
U_{aux}rated	U_r= 100/110/120/220/240 V AC U_r= 110/125/220/250 V DC	U_r= 24/48/60 V DC
U_{aux}variation (temporary)	85...110% of U_r (AC)	80...120% of U_r (DC)
	80...120% of U_r (DC)	
Burden of auxiliary voltage supply under quiescent (P_q)/operating condition	<9 W/13 W	
Ripple in the DC auxiliary voltage	Max. 12% of the DC value (at frequency ogf 100 Hz)	
Interruption time in the auxiliary DC voltage without resetting the protection relay	<50 ms at U_{aux} rated	
Time to trip from switching on the auxiliary voltage[1)]	<350 ms	
Internal over temperature limit	+100 ºC	
Fuse type	T2A/250 V	

1) Time to trip of stages U>>

Table 5. Energizing inputs

Description	Value
Rated frequency	50/60 Hz ±5 Hz
Rated voltage, U_n	100/110/115/120 V
Thermal withstand capability:	
• Continuously	2 x U_n (240 V)
• For 10 s	3 x U_n (360 V)
Burden at rated voltage	<0.5 VA

Table 6. Measuring range

Description	Value
Measured phase-to-phase voltages U_{12}, U_{23} and U_{31} as multiples of the rated voltages of the energizing inputs	0... 2 x U_n
Measured residual voltage (U_0) as a multiple of the rated voltage of the energizing input	0... 2 x U_n

Table 7. Digital inputs

Description	Value	
Rated voltage	DI1, DI2	DI3...DI5 (optional)
• REU610CVVHxxx Activating threshold • REU610CVVLxxx Activating threshold	110/125/220/250 V DC Max. 88 V DC (110 V DC -20%) 24/48/60/110/125/220/250 V DC Max. 19.2 V DC (24 V DC -20%)	
• REU610CVVxxLx Activating threshold • REU610CVVxxHx Activating threshold		24/48/60/110/125/220/250 V DC Max. 19.2 V DC (24 V DC -20%) 110/125/220/250 V DC Max. 88 V DC (110 V DC -20%)
Operating range	±20% of the rated voltage	
Current drain	2...18 mA	
Power consumption/input	<0.9 W	

Table 8. Signal output SO1 and optional outputs SO4 and SO5

Description	Value
Rated voltage	250 V AC/DC
Continuous 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, at 48/110/220 V DC	1 A/0.25 A/0.15 A (5 A/3 A/1 A for series connection of SO4 and SO5
Minimum contact load	100 mA at 24 V AC/DC

Table 9. Signal output SO2, optional output SO3 and IRF output

Description	Value
Rated voltage	250 V AC/DC
Continuous carry	5 A
Make and carry for 3.0 s	10 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	1 A/0.25 A/0.15 A
Minimum contact load	100 mA at 24 V AC/DC

Table 10. Power outputs PO1, PO2 and PO3

Description	Value
Rated voltage	250 V AC/DC
Continuous 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, at 48/110/220 V DC (PO1 with both 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...265 V AC/DC
• Current drain through the supervision circuit	~1.5 mA
• Minimum voltage over a contact	20 V AC/DC (15...20 V)

Table 11. Data communication interfaces

Interface	Protocol	Cable	Data transfer rate
Front	SPA bus protocol	Optical connection (infrared) via the front communication cable (1MRS050698)	9.6 or 4.8 kbps (9.6 kbps with front communication cable)

Table 12. Enclosure class of the flush-mounted protection relay

Description	Value
Front side	IP 54 Category 2
Rear side, top of the protection relay	IP 40
Rear side, connection terminals	IP 20

Table 13. Environmental conditions

Description	Value
Recommended service temperature range (continuous)	-10...+55ºC
Humidity	<95% RH
Limit temperature range (short-term)	-40...+70ºC
Transport and storage temperature range	-40...+85ºC according to IEC 60068-2-48
Atmospheric pressure	86...106 kPa

Table 14. Environmental tests

Description	Reference
Dry heat test (humidity <50%)	According to IEC 60068-2-2
Dry cold test	According to IEC 60068-2-1
Damp heat test, cyclic (humidity >93%)	According to IEC 60068-2-30

Table 15. Electromagnetic compatibility tests

Description	Type test value	Reference
EMC immunity test level meets the requirements listed below		
1 MHz burst disturbance test, class III		IEC 60255-22-1, IEC 61000-4-18
• Common mode	2.5 kV	
• Differential mode	1.0 kV	
Electrostatic discharge test, class IV		IEC 61000-4-2, IEC 60255-22-2 and ANSI C37.90.3-2001
• For contact discharge	8 kV	
• For air discharge	15 kV	
Radio frequency interference tests		
• Conducted, common mode	10 V (rms), f = 150 kHz...80 MHz	IEC 61000-4-6 and IEC 60255-22-6
• Radiated, amplitude-modulated	10 V/m (rms), f = 80...2700 MHz	IEC 61000-4-3 and IEC 60255-22-3
• Radiated, pulse-modulated	10 V/m, f = 900 MHz	ENV 50204 and IEC 60255-22-3
Fast transient disturbance tests		IEC 60255-22-4 and IEC 61000-4-4
• Power outputs, energizing inputs, power supply	4 kV	
• I/O ports	2 kV	
Surge immunity test		IEC 61000-4-5 and IEC 60255-22-5
• Power outputs, energizing inputs, power supply	4 kV, line-to-earth 2 kV, line-to-line	
• I/O ports	2 kV, line-to earth 1 kV, line-to-line	
Power frequency (50 Hz) magnetic field	300 A/m continuous	IEC 6100-4-8
Power frequency immunity test:		IEC 60255-22-7 and IEC 61000-4-16
REU610CVVHxxx and REU610CVVxxHx	Class A	
• Common mode • Differential mode	300 V rms 150 V rms	
REU610CVVLxxx and REU610CVVxxLx	Class B	
• Common mode • Differential mode	300 V rms 100 V rms	
Voltage dips and short interruptions	30%/10 ms 60%/100 ms 60%/1000 ms >95%/5000 ms	IEC 61000-4-11
Electromagnetic emission tests		EN 55011
• Conducted, RF-emission (Mains terminal)		EN 55011, class A, IEC 60255-25
• Radiated RF-emission		EN 55011, class A, IEC 60255-25
CE compliance		Complies with the EMC directive 2009/108/EC and LV directive 2006/95/IEC

Table 16. Insulation tests

Description	Type test value	Reference
Dielectric tests • Test voltage	2 kV, 50 Hz, 1 min	IEC 60255-5
Impulse voltage test • Test voltage	5 kV, unipolar impulses, waveform 1.2/50 µs, source energy 0.5 J	IEC 60255-5
Insulation resistance measurements • Isolation resistance	>100 MΩ, 500 V DC	IEC 60255-5

Table 17. Mechanical tests

Description	Reference	Requirement
Vibration tests (sinusoidal)	According to IEC 60255-21-1	Class I
Shock and bump test	According to IEC 60255-21-2	Class I

Protection functions

Table 18. Three-phase overvoltage protection (U>, U>>, U_2>)

Feature	Stage U>	Stage U>> 1)	Stage U_2> 1)
Set start value U>, U>> and U_2>:			
• At definite-time characteristic	0.60...1.40 x U_n	0.80...1.60 x U_n	0.05...1.00 x U_n
• At IDMT characteristic	0.60...1.25 x U_n 2)	0.80...1.25 x U_n	0.05...1.00 x U_n
Start time, typical	60 ms	50 ms	50 ms
Time/voltage characteristic:			
• Definite-time operate time, t>, t>>	0.06...600 s	0.05...600 s	0.05...600 s
• IDMT	curve A curve B	curve A curve B	curve A curve B
Time multiplier, k>, k>>	0.05...2.00	0.05...2.00	0.05...2.00
Resetting time, typical/maximum	70/80 ms 3)	70/80 ms	70/80 ms
Retardation time, typical	30 ms	30 ms	50 ms
Set resetting time, t_I>	0.07...60.0	-	-
Drop-off/pick-up ratio, D/P>	0.95...0.99	0.95...0.99	0.96
Operate time accuracy:			
• At definite-time characteristic	±2% of the set operate time or ±25 ms	±2% of the set operate time or ±25 ms	±2% of the set operate time or ±25 ms
• At IDMT characteristic	±25 ms or the accuracy appearing when the measured voltage varies ±3%	±25 ms or the accuracy appearing when the measured voltage varies ±3%	±25 ms or the accuracy appearing when the measured voltage varies ±3%
Operation accuracy	±1.5% of the set start value	±1.5% of the set start value	-
• 0.05...0.15 x U_n	-	-	±10% of the set start value
• 0.15...1.00 x U_n	-	-	±5% of the set start value

1) Stage U>> and stage U_2> cannot be used at the same time.
2) Because of the maximum measured voltage (2 x U_n), the setting value 1.25 is used for the IDMT calculation if the set value is greater than 1.25. This makes the operate time faster than the theoretical IDMT curve. However, the stage always starts according to the set value.
3) Resetting time of the trip signal.

Table 19. Three-phase undervoltage protection (U<, U<<, U_1<)

Feature	Stage U<	Stage U<< 1)	Stage U_1< 1)
Set start value U<, U<< and U_1<:			
• At definite-time characteristic	0.02...1.20 x U_n	0.02...1.20 x U_n	0.02...1.20 x U_n
• At IDMT characteristic	0.02...1.20 x U_n	0.02...1.20 x U_n	0.02...1.20 x U_n
Start time, typical	80 ms	50 ms	50 ms
Time/voltage characteristic:			
• At definite operate time, t<, t<<	0.10...600 s	0.10...600 s	0.10...600 s
• IDMT	curve C	curve C	curve C
Time multiplier, k<, k<<	0.10...2.00	0.10...2.00	0.10...2.00
Resetting time, typical/maximum	70/80 ms	70/80 ms	70/80 ms
Retardation time, typical	30 ms	30 ms	50ms
Set resetting time, t_r<	0.07...60.0 s 2)	-	-
Drop-off/pick-up ratio, D/P<	1.01...1.05	1.01...1.05	1.04
Operate time accuracy:			
• At definite-time characteristic	±2% of the set operate time or ±25 ms	±2% of the set operate time or ±25 ms	±2% of the set operate time or ±25 ms
• At IDMT characteristic	±25 ms or the accuracy appearing when the measured voltage varies ±3%	±25 ms or the accuracy appearing when the measured voltage varies ±3%	±25 ms or the accuracy appearing when the measured voltage varies ±3%
Operation accuracy	±1.5% of the set start value	±1.5% of the set start value	±5% of the set start value

1) Stage U<< and stage U_1< cannot be used at the same time.
2) Because of the maximum measured voltage (2 x U_n) the setting value 1.25 is used for the IDMT calculation if the set value is greater than 1.25. This makes the operate time faster than the theoretical IDMT curve. However, the stage always starts according to the set value.

Table 20. Residual overvoltage protection (U_0>, U_0>>)

Feature	Stage U_0>	Stage U_0>>
Set start value U_0> and U_0>>:		
• At definite-time characteristic	2.0...80% U_n	2.0...80% U_n
Start time, typical	70 ms	60 ms
Time/voltage characteristic:		
• Definite-time operate time, t_0>, t_0>>	0.10...600 s	0.10...600 s
Resetting time, typical/maximum	30/50 ms 1)	30/50 ms 1)
Retardation time, typical	30 ms	30 ms
Set resetting time, t_{0r}>	0.07...60.0 s	100 ms
Drop-off/pick-up ratio, typical	0.96	0.96
Operate time accuracy:		
• At definite-time characteristic	±2%of the set operate time or ±25 ms	±2%of the set operate time or ±25 ms
Operation accuracy	±1.5% of the set start value or ±0.05% U_n	±1.5% of the set start value or ±0.05% U_n

1) Resetting time to the trip signal.

Table 21. Circuit-breaker failure protection (CBFP)

Feature	Value
Set operate time	0.10...60.0 s
Phase-to phase voltage threshold for external triggering of the CBFP:	
• Pick-up/drop-off	0.15/0.10 x U_n

13. Mounting methods

Using the appropriate mounting accessories, the standard relay case for the 610 series relays 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°) by 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.Alternatively, the relays can be mounted in 19” instrument cabinets by means of 4U Combiflex equipment frames.

For routine testing purposes, the relay cases can be equipped with test switches, type RTXP 18, which can be mounted side by side with the relay cases.

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

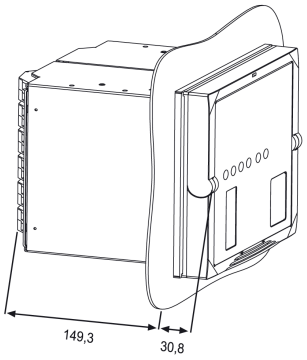


Figure 4. Flush mounting

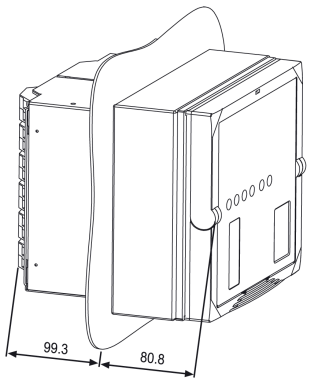


Figure 5. Semi-flush mounting

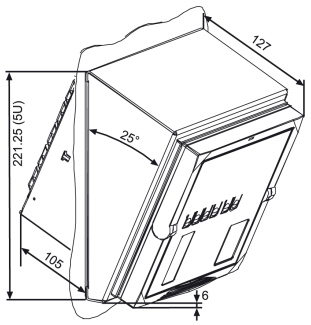


Figure 6. Semi-flush mounting in a 25º angle

14. Relay case and plug-in unit

As a safety measure, the relay cases for the current measuring protection relays are provided with automatically acting contacts for short-circuiting the CT secondaries, when a relay plug-in unit is withdrawn from the relay case. In addition, the relay case is provided with a mechanical coding system to prevent the current measuring relay plug-in units from being inserted into a case for a voltage protection relay unit and vice versa, that is the relay cases are associated to a certain type of relay plug-in unit.

There is, however, a universal relay case available, which is not associated to a certain plug-in unit type. When a relay plug-in unit is plugged into such a relay case for the first time, the relay case automatically adapts to that particular protection relay type, that is the short-circuiting contacts are activated as well as the mechanical blocking system. Hereafter, the relay case is permanently associated to a certain protection relay type.

15. Selection and ordering data

When ordering protection relays and/or accessories, please specify the following information: order number, HMI language set number and quantity. The order number identifies the protection relay type and hardware and is labelled on the marking strip under the lower handle of the protection relay.

Use the ordering key information in Figure 7 to generate the order number when ordering complete protection relays.

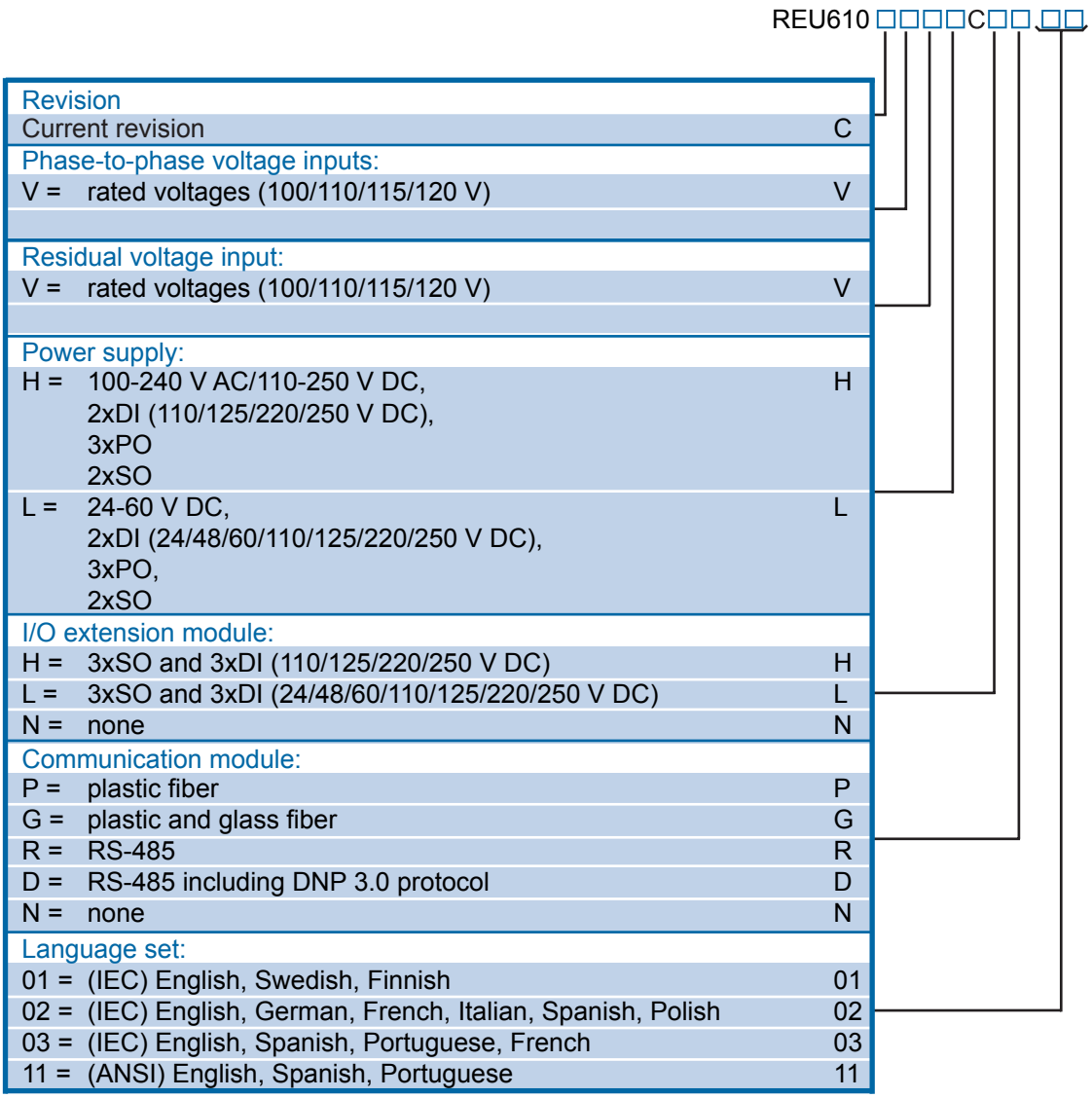


Figure 7. Ordering key for complete protection relays

Use the ordering key information in Figure 8 to generate the order number when ordering spare units.

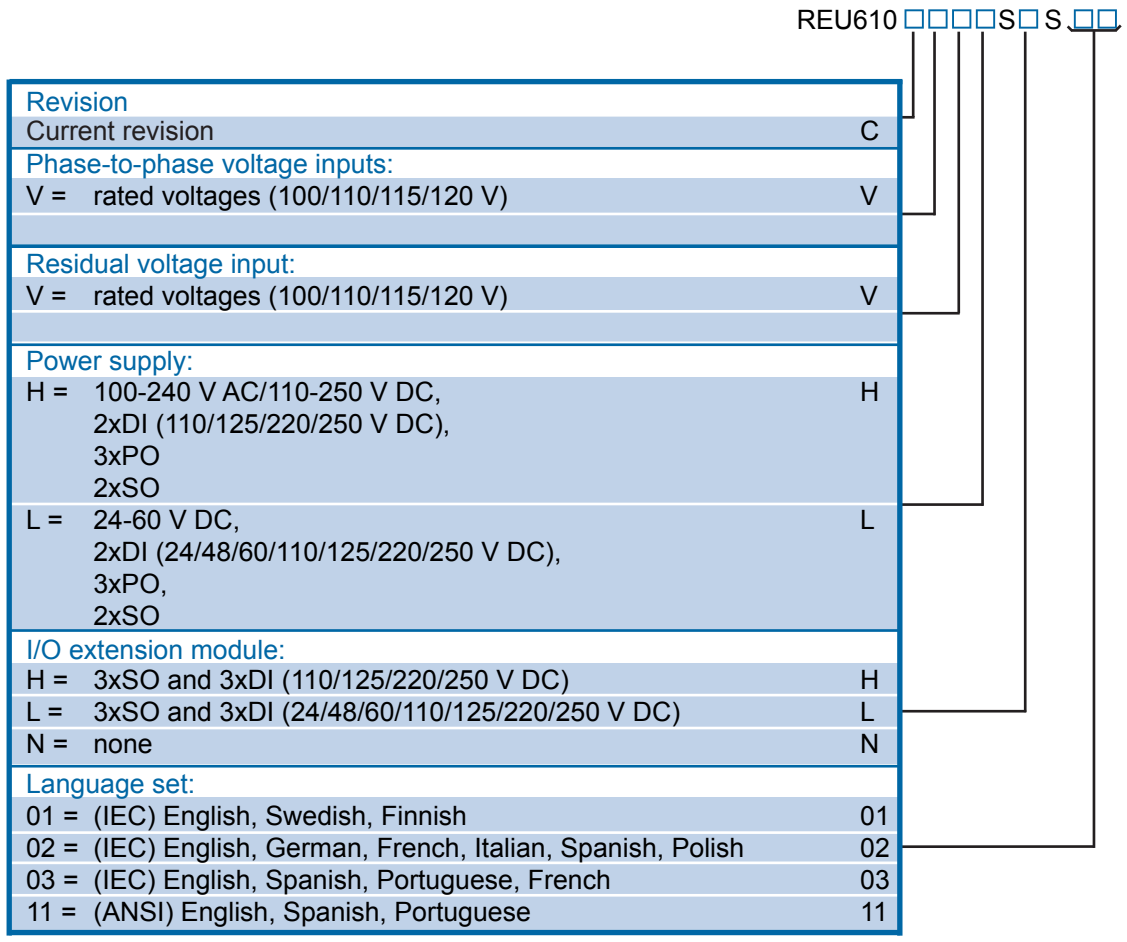


Figure 8. Ordering key for spare units

16. Accessories

Table 22. Cables

Item	Order number
Front communication cable	1MRS050698

Table 23. Mounting accessories

Item	Order number
Semi-flush mounting kit	1MRS050696
Inclined semi-flush mounting kit	1MRS050831
19” rack mounting kit with cutout for one protection relay	1MRS050694
19” rack mounting kit with cutout for two protection relays	1MRS050695
Surface mounting frame	1MRS050697
Mounting bracket for RTXP 18	1MRS061207
Mounting bracket for 4U high Combiflex equipment frame	1MRS061208

Table 24. Test switches

Item	Order number
Test switch RTXP 18	1MRS090937

Table 25. Optional communication cards

Item	Order number
Plastic fiber	1MRS050889
RS-485	1MRS050892
Plastic and glass fiber	1MRS050891
RS-485 including DNP3 protocol	1MRS050887

Table 26. 610 series universal cases

Item	Order number
Empty universal relay case for 610 series	1MRS050904

17. Tools

Table 27. Configuration and setting tools

Tool	Version
Protection and Control IED Manager PCM600	2.1 or later
REU610 Connectivity Package	2.1 or later
CAP 501 Relay Setting Tool CAP 50	2.4.0-1 or later
CAP 505 Relay Setting Tool CAP 505 v. 2.4.0-1 or later	2.4.0-1 or later
Communication Engineering Tool (CET) for SPA-ZC 40x	1.1.1
Lon Network Tool LNT 505	1.1.1 Add-on 1
Profibus-DPV1/SPA Configuration Tool (PCT)	

Table 28. Supported functions

Function	PCM600[1)]	CAP 501	CAP 505	CET for SPA-ZC 40x[1)]	LNT 505	PCT
Parameter setting	●	●	●	-	-	-
Disturbance handling	●	●	●	-	-	-
Signal monitoring	●	●	●	-	-	-
Disturbance record analysis	●	●	●	-	-	-
Relay configuration templates	●	●	●	-	-	-
Creating/handling projects	●	●	●	-	-	-
IEC 61850 communication configuration	-	-	-	●	-	-
LON communication configuration	-	-	-	-	●	-
Profibus communication configuration	-	-	-	-	-	●

● = Supported

1) Requires a connectivity package

18. Terminal diagram

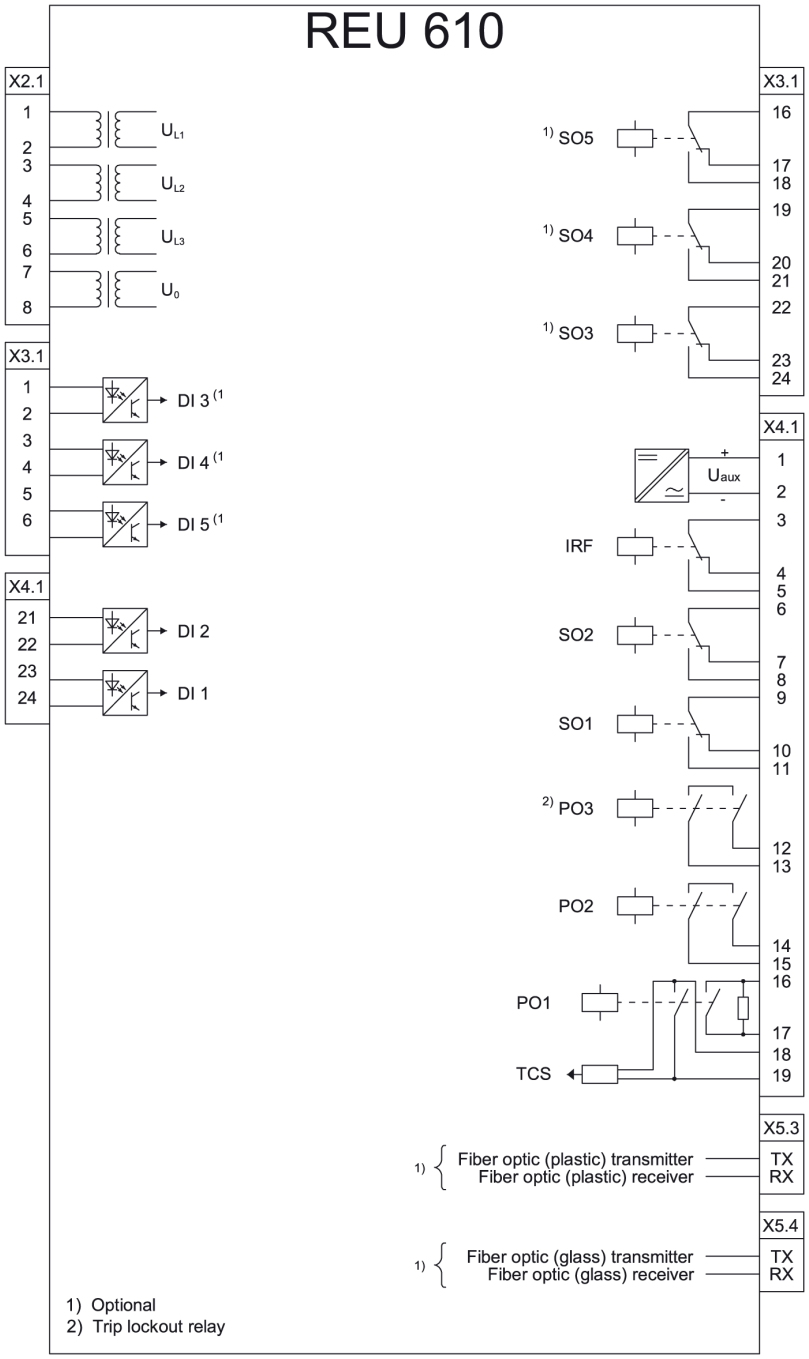


Figure 9. Terminal diagram of REU610

19. Certificates

KEMA has issued a Type test Certificate of Complete type test for the 610 series products. Certificate No. 08-1071, 08-1072 and 08-1073.

DNV (Det Norske Veritas) has issued a Type Approval Certificate for the 610 series protection relays. Certificate No. E-9945. The 610 series protection relays comply with Det Norske Veritas' Rules for Classification of Ships, High Speed & Light Craft and Det Norske Veritas' Offshore Standards.

Korea Electrical Safety Corporation (KESCO) has issued a KAS V-Check Mark certificate for the 610 series products. Ref. Cert. No. KAS-KESCO-7018-02.

20. References

The www.abb.com/substationautomation portal provides information on the entire range of distribution automation products and services.

The latest relevant information on the REU610 protection relay is found on the product page. Scroll down the page to find and download the related documentation.

21. Functions, codes and symbols

Table 29. Functions included in REU610

Functionality	IEC 60617	IEC-ANSI
Protection		
Three-phase overvoltage, low-set stage	U>	59P-1
Three-phase overvoltage, high-set stage	U>>	59P-2
Negative phase-sequence overvoltage	U_2>	47
Three-phase undervoltage, low-set stage	U<	27P-1
Three-phase undervoltage, high-set stage	U<<	27P-2
Positive phase-sequence undervoltage	U_1<	27D
Residual overvoltage, low-set stage	U_0>	59N-1
Residual overvoltage, high-set stage	U_0>>	59N-2
Circuit-breaker failure	CBFP	62BF
Lockout relay function		86
Condition monitoring		
Trip circuit supervision	TCS	TCS
Trip lockout function	TRIP LOCKOUT	TRIP LOCKOUT
Trip counters for circuit-breaker condition monitoring		
Measurement		
Disturbance recorder		
Residual voltage	U_0	Un
Three-phase voltages (phase-to-phase)	U_{12}, U_{23}, U_{31}	U_{ab}, U_{bc}, U_{ca}
Negative and positive phase-sequence voltage	U_{2s}, U_{1s}	U_2, U_1

22. Document revision history

Document revision/date	Product version	History
A/2007-05-16	A	First release
B/2009-02-17	B	Content updated to correspond to the product version
C/2009-10-30	C	Content updated to correspond to the product version
D/2010-04-20	C	Order codes corrected
E/2011-11-18	C	Order codes corrected
F/2019-03-14	C	Content updated

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