Rec15/25

Automatic Circuit Recloser
15 kV, 16 kA, 630 A
27 kV, 12.5 kA, 630 A

Product Guide

Contents

1. Introduction

This Product Guide describes automatic circuit reclosers manufactured by Tavrida Electric.

Tavrida Electric autoreclosers are designed for overhead distribution lines and outdoor substation switchgear with rated voltage up to 27kV.

The main components of the autorecloser are:

Outdoor Switching Module (OSM)

The air insulated OSM incorporates a Tavrida Electric vacuum circuit breaker with per phase magnetic actuators housed in a tank made of corrosion resistant aluminium alloy. Six main circuit bushings are made from UV stable polymer and are completely covered with silicone rubber bushing boots. Each bushing has built-in current and voltage sensors for protection, measurement and indication purposes.

Recloser control (RC)

The RC is a microprocessor based controller that provides protection, metering, data logging and communication functions.

Umbilical cable

The Umbilical cable provides connection between the OSM and the RC.

This guide describes recloser technical parameters, functionality and operating principles. The purpose of the document is providing necessary product information for application engineers and utilities technical personnel.

List of related technical documents:

Document name	Target audience	Purpose of the document
User guide	Procurement representatives, operatives, fitters, commissioning engineers	Brief product description Describing transportation and storage limitations Describing necessary product check-ups, installation and commissioning Describing operation and service Troubleshooting description Disposal requirements description
Routine test certificate	Customer procurement service	Product identification, brief technical parameter description, routine test data

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1.1 Abbreviations

ABR	Automatic Backfeed Restoration
BAT	Battery
BF	Bolted Fault
BTM	Bluetooth Module
CC	Control Cable (Umbilical)
CLP	Cold Load Pickup
CPM	Control Panel Module
CU	Current unbalance
D	Delayed
DPS	Door Position Switch
EF	Earth Fault protection element
EF1	Low set Earth Fault protection element for Delayed trips
EF2	Low set Earth Fault protection element for Instantaneous trips
EF3	High set Earth Fault protection element for Instantaneous trips
EL	Event Log
I	Instantaneous
I/O	Input/Output
IOI	Input/Output Interface
IOM	Input/Output Module
LCD	Liquid Crystal Display
HL	Hot Line protection element
LP	Load Profile
LS	Loss of Supply protection element
ME	Measurement element
ML	Malfunction Log
MMI	Man Machine Interface
MPM	Main Processor Module
OC	Overcurrent protection element
OC1	Low set Overcurrent protection element for Delayed trips
OC2	Low set Overcurrent protection element for Instantaneous trips
OC3	High set Overcurrent protection element for Instantaneous trips
OCR	Overcurrent protection element with reclosing
OSM	Outdoor Switching Module
PCI	Personal Computer Interface
PSFM	Power Supply Filter Module
RC	Recloser Control Cubicle
RCM	Recloser Control Module
RTC	Real Time Clock
RTU	Remote Telecommunication Unit
SCADA	Supervisory Control And Data Acquisition
SD	Source Detector
SEF	Sensitive Earth Fault
SEFR	Sensitive Earth Fault with reclosing
TEL	Tavrida Electric

TCI	Telecommunications Interface
TDI	Telarm Dispatcher Interface
UF	Under Frequency
UV	Under Voltage
VRC	Voltage Reclosing Control
VT	Voltage Transformer
VU	Voltage unbalance
ZSC	Zone Sequence Coordination

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2. Presentation

2.1 Product application field

Reclosers can be applied in radial or loop overhead distribution lines. The main applications are:

* Clearing transient faults by performing autoreclosing;
* Isolating sustained faults in the overhead line network;
* Isolating sustained faults in a network where conventional protection coordination is not possible;
* Automatic backfeed restoration.

The recloser can also be used at outdoor substations feeding overhead distribution lines. It may be used as:

* Substation outgoing feeder with autoreclosing functionality;
* Substation busbar coupler breaker with backfeed restoration capability;
* Substation switchgear incoming feeder breaker with overcurrent protection for busbar faults, undervoltage protection for backfeed restoration purposes and interfaces for transformer non-electrical protection.

2.2 Key benefits

Tavrida Electric reclosers provide the following competitive advantages:

* **Maintenance free**

Lifetime maintenance and supervision free switching module providing 30 000 rated current and 50 full rated short circuit O-CO operations.

* **Lightweight**

Tavrida Electric's light weight vacuum circuit breaker and robust aluminium tank result in a total weight of 68 kg for OSM15_Al_1 and 72 kg for OSM25_Al_1, making it the most lightweight outdoor switching module on the market.

As the result shipment, handling and installation are simpler and faster.

* **Sophisticated measurements system**

All OSMs are equipped with six voltage sensors built into the bushings. It makes the recloser an ideal device for self-healing loop automation solutions.

Linear current sensor — Rogowski coils, used for both phase and ground currents measurements greatly improve protection accuracy and simplify protection coordination.

* **Environmentally Friendly**

OSM15_Al_1 and OSM25_Al_1 are outdoor switching modules with patented combined air and solid insulation. The design reliability is proven by the most severe climate and very heavy pollution tests at the Koeberg Insulator Pollution Test Station (KIPTS) in South Africa.

2.3 Compliance

Tavrida Electric autorecloser compliance to international standards has been confirmed by large international test centers.

The list of test reports is presented in Appendix 1.

3. Product coding

3.1 Recloser coding

Rec15_Al1_5s (Par1_Par2_Par3_Par4_Par5_Par6)

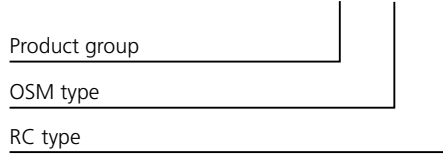Product group
OSM type
RC type

Table 1 - Recloser coding description

Parameter	Parameter description	Applicable options	Code
Par1	RC language	English	EN
		Portuguese	PT
Par2	Bluetooth module for PCI connection	No	0
		Yes	1
Par3	Input/Output module	No	0
		Input/Output module 100/220 VDC	220
		Input/Output module 24/60 VDC	60
Par4	Umbilical cable length	5 meters	5
		7 meters	7
		12 meters	12
Par5	Mounting bracket type	No	0
		Front installation	7
		Complete mounting kit for front installation	7M
		Front or lateral installation	8
		Complete mounting kit for front or lateral installation	8M
Par6	Customization	Default	0
		Contact your local sales representative to customize the recloser as per your requirements	1
			2
			...

Par1

Parameter describes control panel interface language.

Par2

Parameter describes bluetooth module availability.

Bluetooth Module provides point-to-point wireless connection between the RC and the personal computer.

Par3

Parameter describes availability and auxiliary voltage of Input/Output module (IOM). For IOM information refer to section 5.1.14 and Table 11.

Par4

Parameter describes the length of Umbilical cable connecting the RC to the OSM. For Umbilical information refer to section 5.1.8

Par5

Parameter describes availability and type of mounting kit. For details on applicable mounting kits refer to section 7.1.

Par6

Parameter describes recloser modifications designed on particular customers requests.

Contact your local sales representative to choose the option suitable for you.

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3.2 Recloser components coding

OSM coding

OSM15_Al_1(Par1)

Outdoor switching module
Rated voltage, kV
Tank material
OSM type
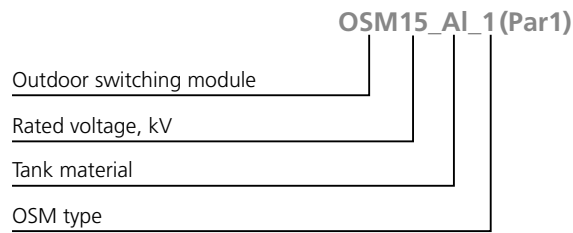
Table 2 - OSM coding description

Parameter	Parameter description	Applicable options	Code
Par1	OSM modification	OSM without intermediate unit and with place for nameplate	4

Par1

Parameter describes the OSM modification versions.

For details refer to drawings in Appendix 1.

Each OSM has the following nameplates:
• Serial number plate
• Parameters nameplate

Serial number plate

Nameplate

Figure 1

Nameplate of OSM

Figure 2

Nameplate and serial number plate placement

The serial number plate contains information about the OSM type and serial number.

Parameters nameplate describes the OSM technical parameters.

RC coding

RC5_3 (Par1_Par2_Par3_Par4_Par5)

Recloser control

RC type

Table 3 - RC coding description

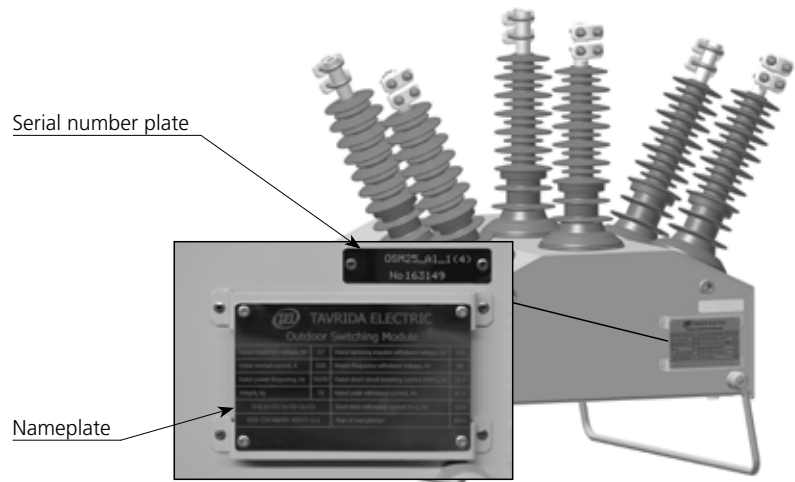| Parameter	Parameter description	Applicable options	Code
Par1	Control panel language	English	EN
		Portuguese	PT
Par2	Bluetooth module for PCI connection	No	0
		Yes	1
Par3	Input/Output module availability	No	0
		Input/Output module 100/220 VDC	220
		Input/Output module 24/60 VDC	60
Par4	Outlet for laptop power supply	No	0
		Contact your local sales representative to choose the option suitable for you	1
			...
Par5	Customization	Default	0
		Contact your local sales representative to customize the recloser as per your requirements	1
			2
			...

Par1

Parameter describes control panel interface language.

Par2

Parameter describes bluetooth module availability.

Bluetooth Module provides point-to-point wireless connection between the RC and the personal computer.

Par3

Parameter describes availability and auxiliary voltage range of Input/Output module (IOM). For IOM information refer to section 5.1.14 and Table 11.

Par4

Parameter describes availability and type of additional recloser modifications performed for particular applications.

Contact your local sales representative to choose the option suitable for you.

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Each RC5_3 has adhesive serial number plate and riveted stainless steel nameplate on the internal door. The nameplates contain information about the RC type, serial number, the RC ratings and manufacture date.

Figure 3

Nameplate and serial number plate of RC
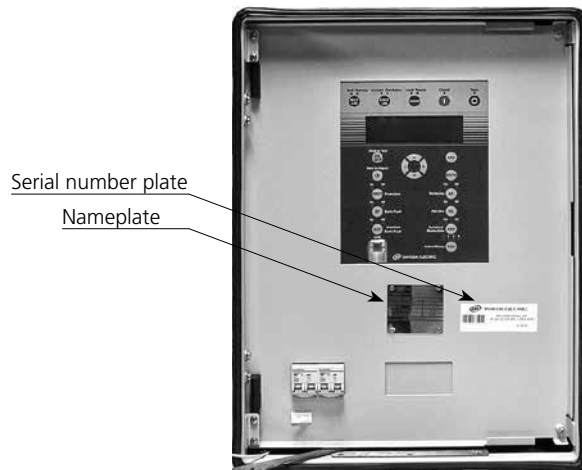
Figure 4

RC nameplate placement

Control cable coding

Umbilical_4(Par1)

Control cable name

Control cable type

Umbilical_4 is the control cable that connects an RC5_3 with an OSM.

Table 4 - Umbilical coding description

Parameter	Parameter description	Applicable options	Code
Par1	Umbilical cable length	6 meters	6
		7 meters	7
		12 meters	12

Par1

Parameter describes the length of the Umbilical cable. For details on the Umbilical cable refer to section „5.1.8 Control cable (Umbilical)" of this guide.

Each Umbilical cable has a steel cable tie with serial number.

Cable tie with serial number
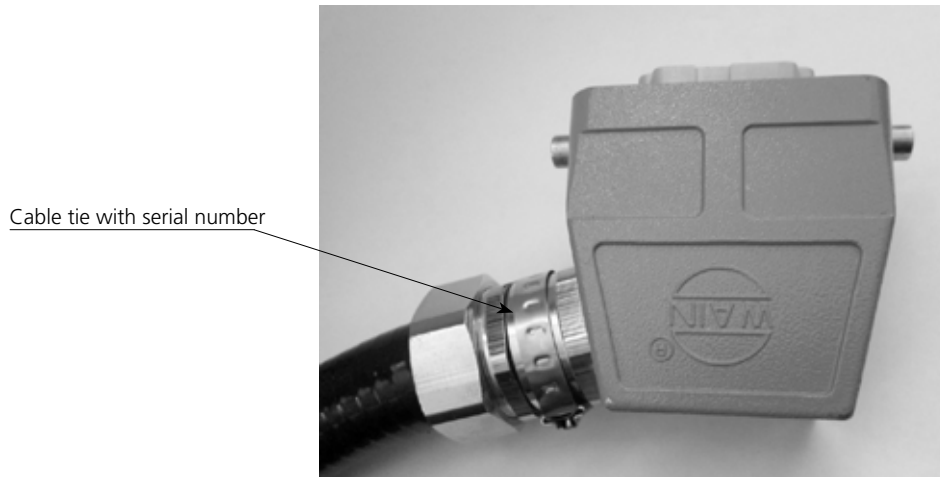
Figure 5
Example of the Umbilical cable tie with serial number

4. Technical parameters

Main technical data and recloser technical parameters are presented in tables below.

Table 5 - Recloser technical parameters

Parameter	OSM15_Al_1	OSM25_Al_1
Rated data		
Rated maximum voltage (Ur)	15.5 kV	27 kV
Rated short-duration powerfrequency withstand voltage (Ud), 1 min dry	50 kV	60 kV
Rated short-duration powerfrequency withstand voltage, 10s wet	45 kV	50 kV
Rated lightning impulse withstand voltage (peak) (Up)	110 kV	125 kV
Rated continuous current (Ir)	630 A	
Rated cable-charging current switching	10 A	25 A
Rated line-charging current switching	2 A	5 A
Rated short-circuit breaking current (Isc)	16 kA	12.5 kA
Rated peak withstand current (Ip)	41.6 kA	32.5 kA
Rated short-time withstand current (Ik)	16 kA	12.5 kA
Rated duration of short circuit (tk)	4 s	4 s
Rated frequency (fr)	50/60 Hz	
Switching performance		
Mechanical life (CO-cycles)	30 000	
Operating cycles, rated current (CO-cycles)	30 000	
Electrical endurance, breaking current (O-CO cycles)	50	
Closing time, not more than	77 ms	
Opening time for overcurrent protection according to IEC 62271-111/C37.60, not more than (at I>2xIp)	43 ms	
Clearing time for overcurrent protection according to IEC 62271-111/C37.60, not more than (at I>2xIp)	51 ms	
Rated operating sequence	O-0.1s-CO-2s-CO-2s-CO	
General information		
Main circuit resistance	< 85 µOhm	< 95 µOhm
Weight	68 kg	72 kg
Altitude	2000 m (derating according to ANSI C37.60 applied above 1000m)	
Humidity	100%, condensing	
Solar Radiation	≤ 1.1 kW/m²	
Temperature Range	-40 °C … +55 °C	
Type of driving mechanism	Monostable magnetic actuator	
Pollution level	very heavy (as per IEC 60815)	

Table 6 - Sensors parameters

Parameter	Phase current sensors	Zero-sequence current sensor	Voltage sensors
Range where accuracy is provided	1-8000 [1] A	1 … 8000 [1] A	0.3 … 27 kV
Range of sensor coefficients at 20°C	1.8 … 2.2 V/kA	1.8 … 2.2 V/kA	0.1 … 0.2 V/kV

Notes:

[1]The Rogowski coil can measure current in a wide range but for the purpose of over-voltage, protection suppressors are fitted in the secondary circuits. These suppressors chop the signal from the Rogowski coil if primary current exceeds 8 kA.

Table 7 - Measurement accuracy[1]

Parameter	Basic error	Ranges where accuracy is guaranteed
Phase currents	The greater of ±1% or ±2A	0...630 A
Residual current[2]	The greater of ±5% or ±0.5A	0...400 A
Phase to earth voltages	The greater of ±1% or ±0.1 kV	0.3...16.0 kV
Line to line voltages	The greater of ±1% or ±0.1 kV	0.5...27.0 kV

Frequency
    - at dF/dt<0.2 Hz/s
    - at dF/dt<0.5 Hz/s
	±0.025 Hz
	±0.05 Hz
		45...55 Hz, 55...65 Hz

Power factor	±0.02	0...1
Active and reactive energy	±2%	40..630A, 4.5...27 kV
Active, reactive and total power	±2%	40..630A, 4.5...27 kV

Notes:

[1]If RC5_3 sensor coefficient settings are configured in accordance with guidelines in Table 6 of this guide. Error is measured at normal climatic conditions.

[2]Note that overcurrent protection pickup setting value shall not exceed SEF pickup setting value times 300.

Table 8 - Electromagnetic compatibility

Parameter	Rated value	Applicable standard
Rated power frequency voltage (1 min)	2 kV	IEC 60255-5
Rated impulse voltage, kV at 0.5J	5 kV	IEC 60255-5
Electrical fast transient/burst immunity	4 kV	IEC 60255-22-4 (Level IV)

Surge immunity (applied to external AC voltage terminals)
    - common
    - transverse
	4 kV
	2 kV
		IEC 61000-4-5 (Level IV)

Control elements surge withstand capability (SWC)	125 kV (7 kA)	IEEE C37.60-2003

Table 9 - Power supply characteristics

Parameter	Value
Supply voltage range, V	85 ÷ 265 AC 110 ÷ 220 DC[1]
Rated power consumption, VA, not more	40
Maximum power consumption, VA, not more	75
Duration of operation without auxiliary supply, hours	48

Notes:

[1] Note that additional DC circuit breakers are required. For details refer to section „7.4 Auxiliary supply"of this guide.

Table 10 - Degree of protection

Component	Degree of protection
Outdoor switching module	IP65
Recloser cubicle	IP55

Table 11 - I/O Module (IOM) parameters

Digital inputs	Value

Rated voltages of signal applied to digital inputs
    - for IOM-04
    - for IOM-03
	12/24/30/48/60 V DC
	110/125/220 V DC

Pickup voltage of signal applied to digital inputs
    - for IOM-04
    - for IOM-03
	Above 7 V
	Above 100 V

Reset voltage
    - for IOM-04
    - for IOM-03
	Below 3 V
	Below 30 V

Maximum continuous voltage of signal applied to digital inputs
    - for IOM-04
    - for IOM-03
	75 V
	275 V

Input resistance
    - for IOM-04
    - for IOM-03
	3 kOhm
	125 kOhm

Recognition time, ms - not more	20
Reset time, ms - not more	20
Digital outputs	Value
Rated voltage	250 VAC
Rated current	16 A
Breaking capacity DC1 (at L/R=1ms): 30/110/220 V	16/0.3/0.12 A
Minimum switching load	500 mW (10V/5mA)

Table 12 - Rechargeable Battery (BAT) parameters

BAT parameters	Value
Type[1]	G26EPX EnerSys 0765-2003 sealed lead acid
Rated voltage	12 V
Rated capacity	26 Ah
Temperature range	-40 °C...+55 °C
Maximum number of recharging cycles from full discharge state	300

Relative capacity at different temperatures
    - at -40°C
    - at -20°C
    - at 0°C
    - at +25°C
    - at +40°C
    - at +55°C
	25 %
	65 %
	84 %
	100 %
	110 %
	120 %

Expected battery life at average operating temperature, years
    - at +20°C
    - at +25°C
    - at +30°C
    - at +40°C
	16
	10
	6.5
	2.7

Notes:

[1] Only the battery types described in this guide can be used in the RC.
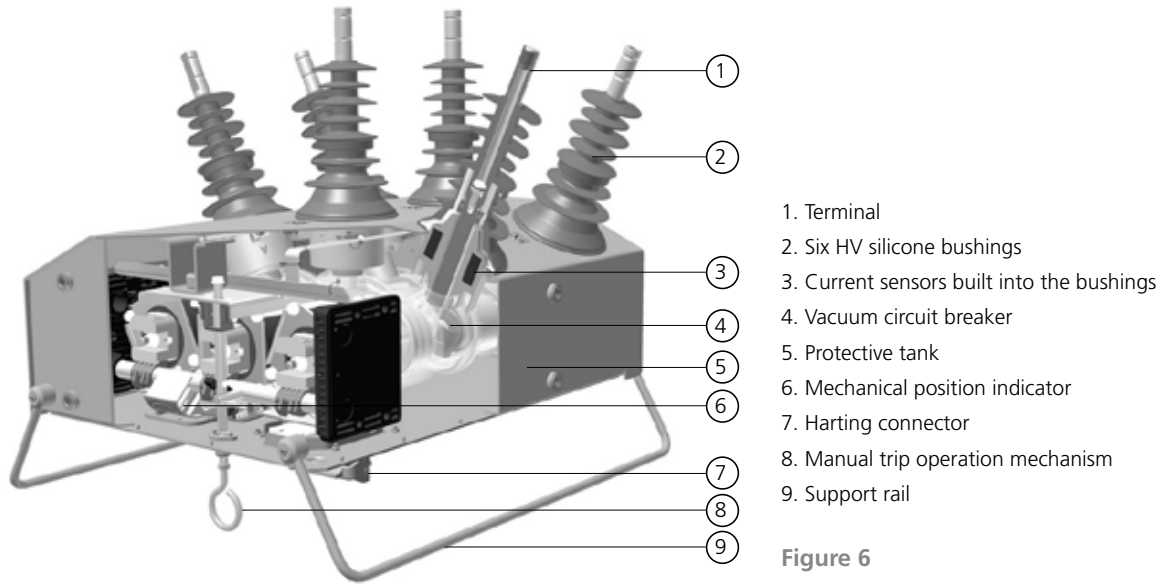
5. Design and operation

5.1 Design

5.1.1 Outdoor switching module

The OSM is equipped with six high voltage bushings with embedded current and voltage sensors. The bushings are covered by silicone rubber insulation which mount on the top of the tank and provide 500 mm (OSM15) or 860 mm (OSM25) creepage distance.

The bushings are marked with the terminal designation X1, X2 or X3 for the default source side and X4, X5 or X6 for the default load side.

The source and load side can be reversed in the RC settings if required.

1. Terminal
2. Six HV silicone bushings
3. Current sensors built into the bushings
4. Vacuum circuit breaker
5. Protective tank
6. Mechanical position indicator
7. Harting connector
8. Manual trip operation mechanism
9. Support rail

Figure 6
General arrangement of the OSM15_Al_1(4)

5.1.2 Protective Tank

The OSM tank is made of a corrosion resistant anodized aluminum alloy. The tank is coated with light gray RAL 7038 powder coating.

Threaded holes (M12x30) on each side of the tank allow the application of various kits and the OSM installation on various poles and structures. These threaded holes can also used to install a set of lifting lugs on the tank.

The earthing provision (M12x30 threaded hole) is labelled for identification.

Provisions for Lifting lugs

Earthing Provision

Mounting Provisions
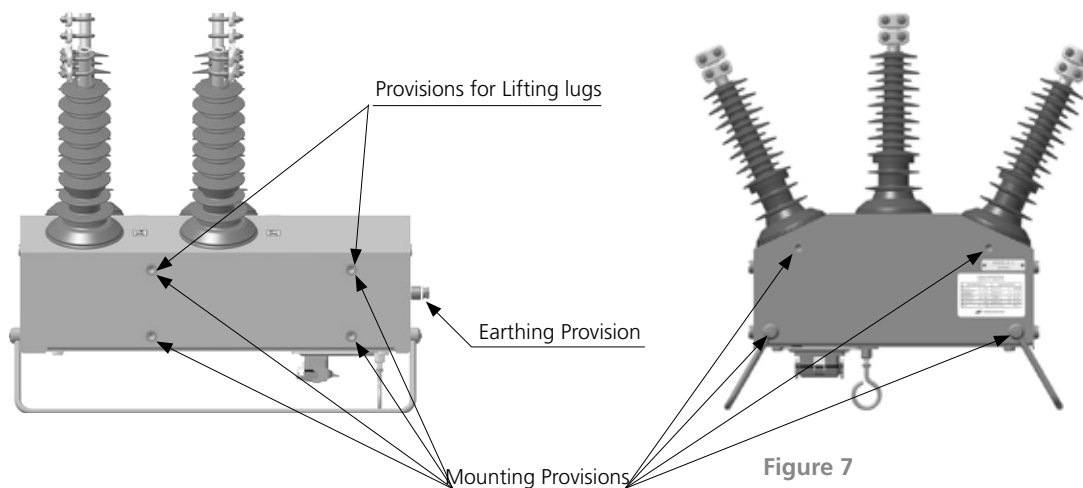
Figure 7
OSM25_Al_1(4)

5.1.3 Current and Voltage Sensing

Each bushing has embedded current and voltage sensors. Current sensing is performed by Rogowski coil sensors. The sensors on the X1, X2 and X3 terminals measure phase currents. The sensors on the X4, X5 and X6 terminals have secondaries connected in series for residual current measurement. Capacitive sensors for voltage measurement are inbuilt in all six bushings.

For details on sensor parameters refer to section „4. Technical parameters" of this guide.

5.1.4 Main Contacts Position Indicator

The position indicator is located under a protective cover at the bottom of the tank and is clearly visible from the ground. The indicator colour is red ▮▮ when the OSM is closed and green ◎ when it is open.

OSM15(25)_Al_1(4)
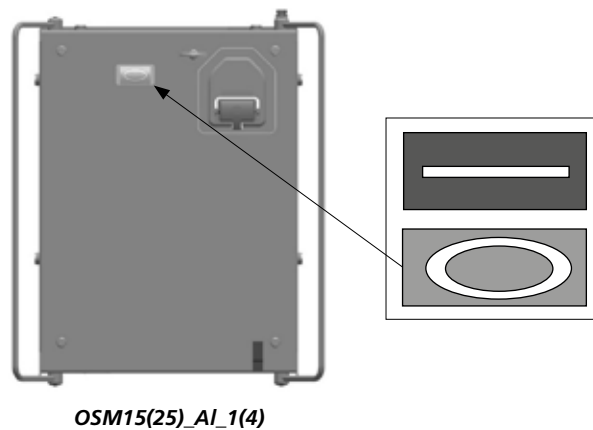
Figure 8
Main contact position indicator

5.1.5 Vacuum Circuit Breaker

The essence of OSM is Tavrida Electric vacuum circuit breaker. Tavrida Electric has simplified the mechanical structure of the vacuum circuit breaker to the greatest possible extent. It uses three single-coil magnetic actuators, one per pole. All switching elements of a pole are assembled along a single axis. All mechanical movements are therefore direct and linear. Three actuators are installed in a steel frame and mechanically linked by a synchronizing shaft.

Due to the design, any failure of critical components, such as mechanical latching, gears, chains, bearings and levers, tripping and closing coils, motors to charge springs are completely avoided.

Tavrida Electric manufactures vacuum interrupters that combine small dimensions with extremely long mechanical and electrical lifespan. The use of a specially designed axial magnetic field distribution provides even current density over the contact surface and consequently substantial improvement of vacuum interrupting performance.

Carefully selected contact material, expert contact design and optimized switching result in bounce-free closing.

The result is 30,000 C-O operations at rated current or 50 O-CO operations at maximum short-circuit breaking current without replacing or adjusting any parts of the circuit breaker.

Tavrida Electric vacuum circuit breakers are entirely maintenance free over a total life expectancy of at least 30 years.

1. Upper terminal
2. Vacuum interrupter
3. Lower terminal
4. Movable contact with bellows
5. Flexible junction shunt
6. Drive insulator
7. Opening and contact pressure springs
8. Magnetic actuator (complete module)
9. Armature
10. Synchronizing shaft
11. Actuator coil
12. Interlocking pins
13. Auxiliary contacts
14. Frame
15. Support insulator

Figure 9
View into the Vacuum Circuit Breaker

5.1.6 Recloser control

Tavrida Electric Recloser Control provides the following advantages:

Recloser Control Cubicle
• Control panel with 6-lines-40-characters graphical LCD for clear event indication

Measurement
• The recloser control allows wide measurement capabilities, including phase, neutral and sequence currents, phase, phase-to-phase and sequence voltages, phase and 3-phase active and reactive power and energy. Logging is provided for key measurement data.

Protection
• The recloser control provides sophisticated protection functionality. The protection incorporates unique features that significantly simplify the protection engineering process. For details on protection functionality, refer to section „6.1 Protection" of this guide.

Monitoring
• Highly comprehensive log files:
• Event Log;
• Malfunction Log;
• Communication Log;
• Load Profile;
• Fault Profile;
• Change Messages;
• Protection Counters;
• Lifetime Counters;
• Log filling counters.

Communications

- Advanced communication functionality including support of different communication protocols and data communication equipment including Bluetooth.
- Exceptional configuration flexibility (ability to apply different sets of local and remote communication interfaces)

User Software

Tavrida Electric Automated Relay Manager (TELARM) is designed for the specific needs of electrical distribution networks based on Tavrida Electric products. It allows:

- Downloading logs, profiles, oscillograms, settings, etc;
- Uploading protection, communication and system settings to the device;
- Recording logs (event, malfunction, communication etc.), provides detailed fault profile;
- Customizing control signal map for customer's SCADA applications.

5.1.7 Recloser Control Cubicle

The RC5_3 recloser control cubicle is made from powder coated anodized aluminium, same as the OSM tank.

The RC5_3 is a new generation control box that is the result of more than 20 years of recloser production and service experience. The RC5_3 has 4 drainage filters installed in the bottom, one per corner. It allows effective RC dehumidification.
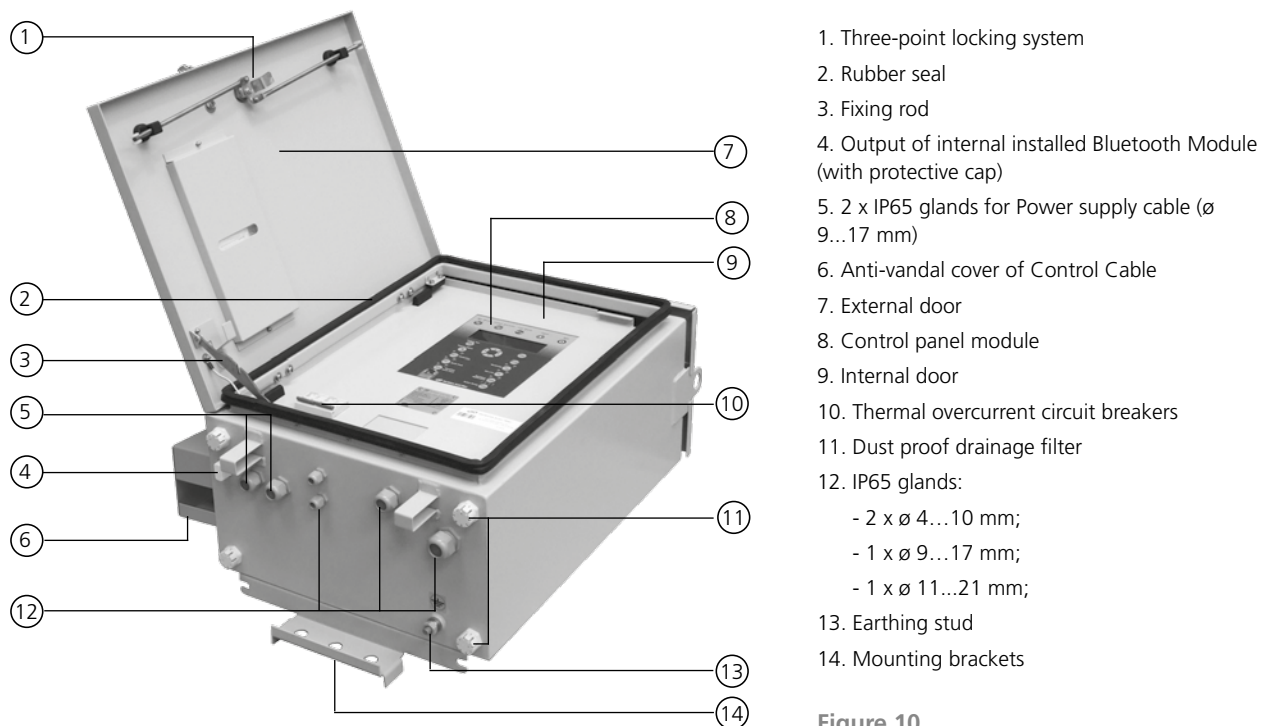
1. Three-point locking system
2. Rubber seal
3. Fixing rod
4. Output of internal installed Bluetooth Module (with protective cap)
5. 2 x IP65 glands for Power supply cable (ø 9...17 mm)
6. Anti-vandal cover of Control Cable
7. External door
8. Control panel module
9. Internal door
10. Thermal overcurrent circuit breakers
11. Dust proof drainage filter
12. IP65 glands:
    - 2 x ø 4…10 mm;
    - 1 x ø 9…17 mm;
    - 1 x ø 11...21 mm;
13. Earthing stud
14. Mounting brackets

Figure 10
RC5_3 with internal door closed

1. Door position switch
2. Remote telecommunication unit (RTU) mounting plate
3. Place for Input/Output module (IOM)
4. Recloser Control Module (RCM)
5. Battery circuit breaker
6. Battery
7. Power supply filter module
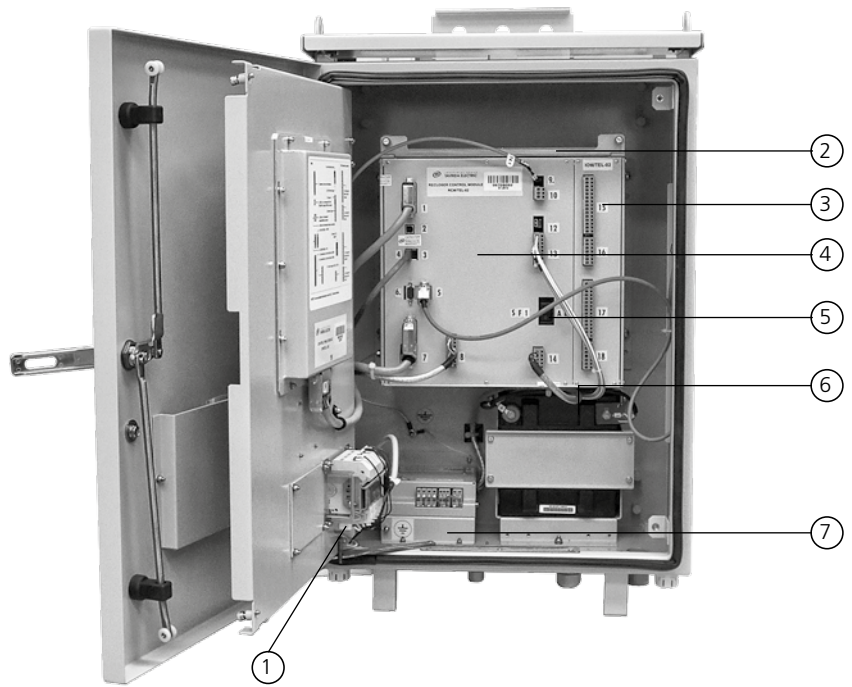
Figure 11
RC5_3 with internal door open

The external door has a padlock provision that is suitable for a shackle with up to a 12 mm diameter. The external door can be securely fixed in the open position.

The anti-vandal cover is fixed from inside the housing with one captive screw. It protects the Umbilical cable from unauthorised disconnection.

1. Control cable terminal
2. Anti-vandal cover
3. Locking stud
4. Captive screw
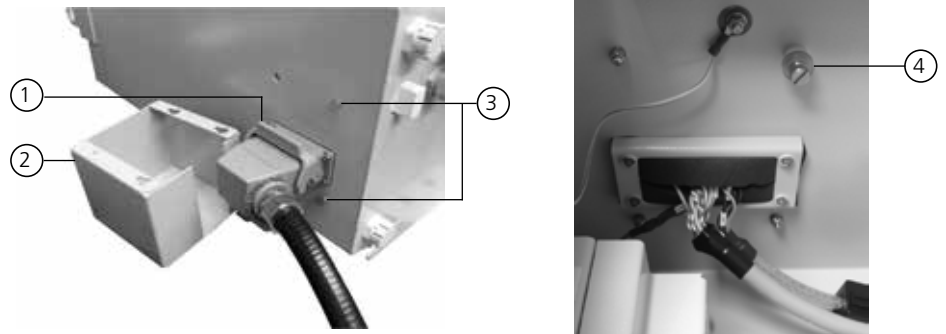
Figure 12

The RC5_3 is equipped with different cable glands for:
• I/O cable or external RTU connections (ø 11…21 mm)
• antenna (ø 4.5…10 mm)
• power supply cable (ø 9…17 mm)

Cable glands are delivered with plastic caps installed.

The housing has provisions for protection against dust and water ingress.

1. Dustproof drainage filter
2. Plastic caps
3. Earthing stud

Figure 13

The RC5_3 is equipped with a Door Position Switch which is used for disabling the CPM when the RC door is closed, as well as providing a SCADA indication of RC door position.

The door position switch is mounted on the inside of the door and is actuated by the lever mounted opposite to the switch on the inside of the door.

Door position switch lever

Door position switch

Figure 14
Door position switch

RC5_3 control cubicle has the following components:

• Control Panel Module (CPM);
• Recloser Control Module (RCM);
• Power Supply Filter Module (PSFM);
• Input/Output Module (IOM);
• Bluetooth Module (BTM);
• Battery (BAT).

Table 13 - Standard and optional components of RC5_3

Module or Component	Standard	Optional
CPM	•	
RCM	•	
PSFM	•	
BAT	•	
BTM		•
IOM		•

5.1.8 Control cable (Umbilical)

Umbilical_4 control cable connects the OSM actuators, metering and auxiliary wiring to the RC5_3. Control cable wires are each protected by a PVC coated steel armoured sleeve. The cable is equipped with a heavy duty 42 pin male connector on the OSM side and a heavy duty 32 pin female connector on the RC side

Standard cable length is 5, 7 or 12 meters.

Figure 15
Umbilical cable
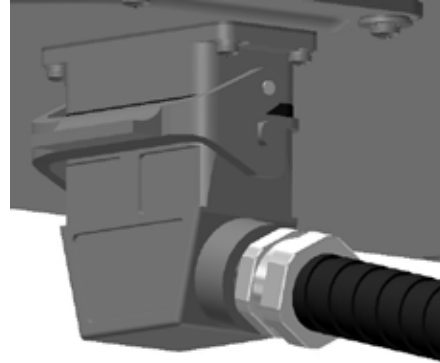
Figure 16
Heavy duty connector

5.1.9 Control Panel Module (CPM)

The CPM provides local control and indication functions to the RC5_3.

The CPM has an integrated USB interface for PC connection.
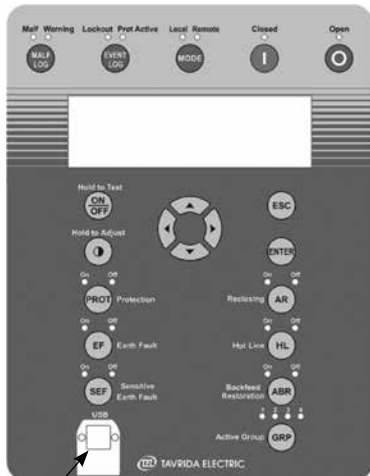
USB interface

Connector CPM-RCM

Figure 17
CPM front (left) and back (right) views

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5.1.10 Recloser Control Module (RCM)

The RCM is the recloser control module. The RCM provides protection, communication, measurement and control functions.

Figure 18
RCM connections with other RC modules
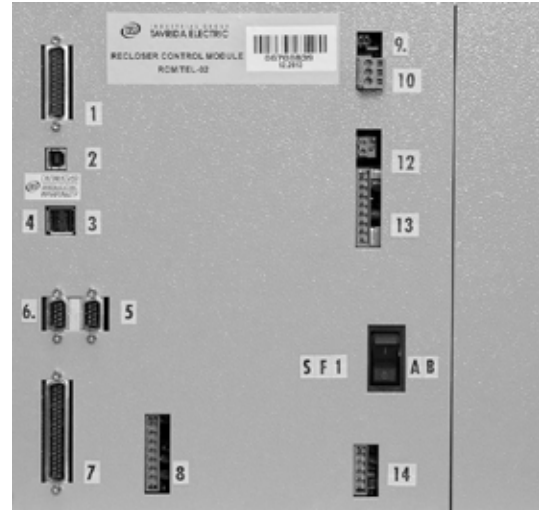
Figure 19
RCM without connections

5.1.11 Power Supply Filter Module (PSFM)

This module provides impulse noise protection for all internal modules of the RC5_3.
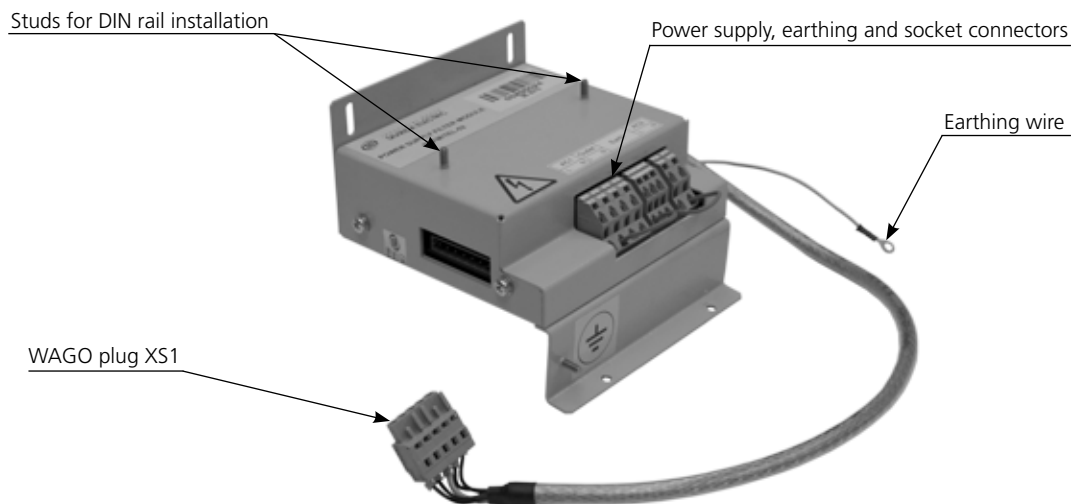
Figure 20
Power Supply Filter Module

The PSFM is connected to the RCM via a WAGO plug (Figure 20).

5.1.12 Rechargeable Battery (BAT)

The rechargeable battery provides the RC5_3 with auxiliary power when the main auxiliary power is not present.

The power supply system is designed to provide optimum battery charging and to optimize battery lifetime.

5.1.13 Bluetooth Module (BTM)

The RC5_3 can be supplied with a Bluetooth module on request (refer to section „3. Product coding" of this guide).

The Bluetooth module provides point-to-point wireless connection between the RC and a personal computer.

It is connected to the RCM via a USB cable (Figure 21).

USB cable for Bluetooth module connection
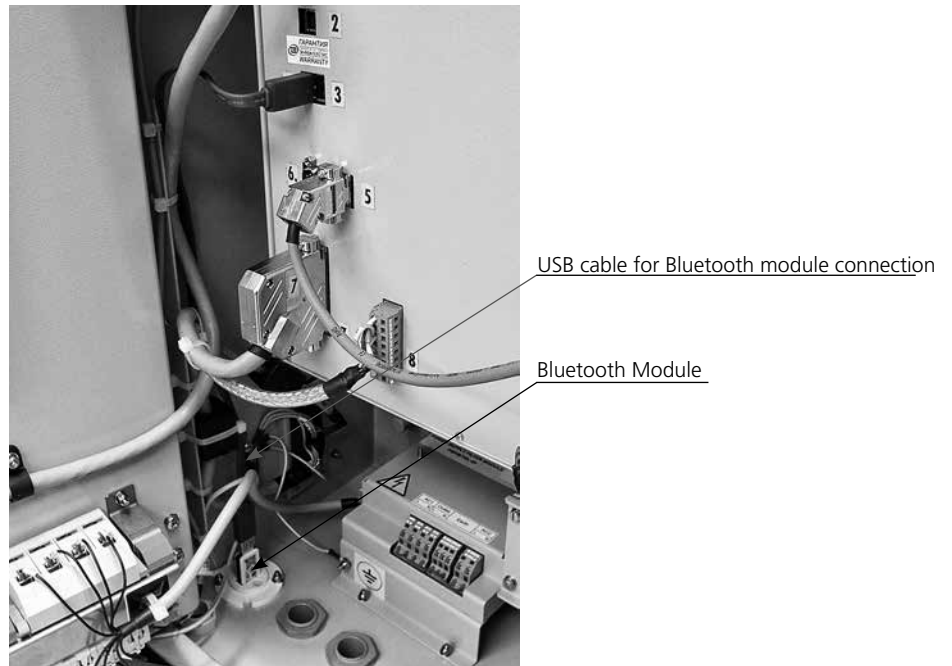
Bluetooth Module

Figure 21
Bluetooth Module with its USB cable

5.1.14 I/O Module (IOM)

The RC5_3 can be supplied with an IOM (Figure 22) on request (refer to section „3. Product coding" of this guide). The IOM provides control and indication functions via digital inputs/outputs (for details on functionality refer to section „6.3.4 Digital input/output interface (IOI)" of this guide). The IOM has twelve digital inputs and twelve digital outputs. The location of connectors (marked „15"…"18") with these inputs and outputs are shown in Figure 23.

Figure 22
Overall view of IO module

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Digital inputs are electrically isolated by means of opto-couplers (Figure 24).
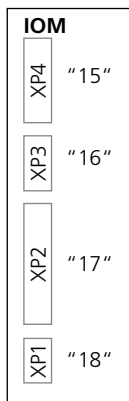
Figure 23

Location of IOM connectors
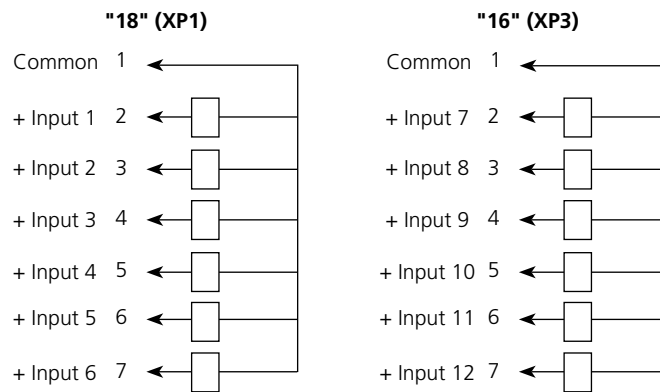
Figure 24

Digital inputs

Bistable relays with changeover contacts are used for the digital outputs as illustrated in Figure 25.
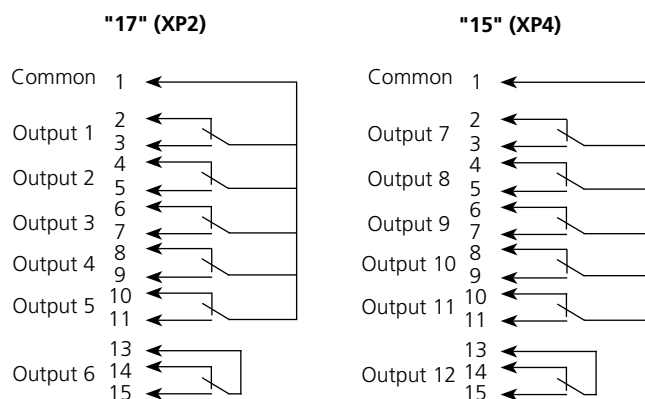
Figure 25

Digital outputs

5.2 Operation

5.2.1 Opening

Emergency opening

A mechanical trip hook is located at the bottom of the tank. When the hook is pulled down, the OSM is mechanically tripped, locked in the OPEN position and electrically isolated from the driver. An „OSM Coil Isolated" warning event is generated by the recloser control to provide indication of a locked state. The OSM remains locked and cannot be operated until the trip hook is pushed back into the operating position.
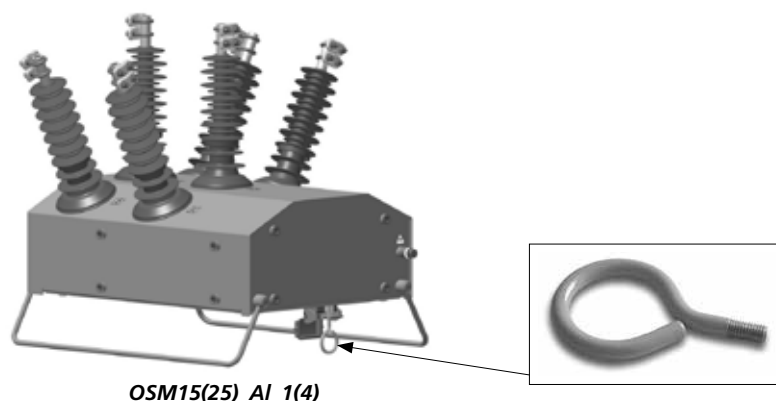
Figure 26

Mechanical trip hook

OSM15(25)_Al_1(4)

Opening via MMI

To open OSM main circuits, push the green Open pushbutton labeled ⊙. The Open command is executed in both Local and Remote mode.

5.2.2 Closing

Closing via MMI

To close OSM main circuits, push the red Close pushbutton labeled ①. The command is only executed if the Control Mode is set to „Local" and the mechanical trip hook is pushed back into its operating position. If the Control Mode is set to „Remote" and/or the mechanical trip hook is pulled down, the Close command will not be executed. The message „Pushbutton Closed is disabled in Remote mode" appears on the screen if Control Mode is „Remote". If the mechanical trip hook is pulled down the message „Excessive close time" will appear in the Malfunction log.
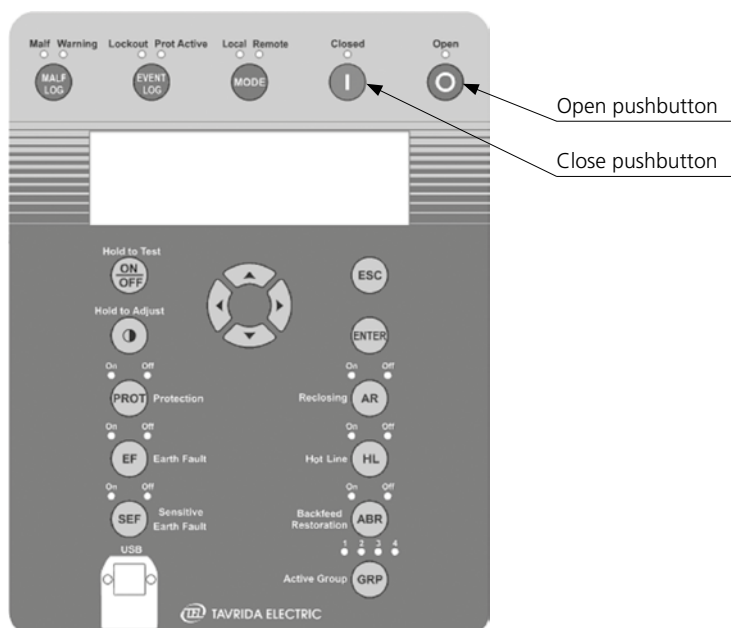
Figure 27
RC5_3 Control Panel Module

6. Functionality

6.1 Protection

6.1.1 Overview

The protection functionality is designed for the following key applications:

- Radial line recloser;
- Normally closed ring recloser
- Normally open ring recloser;
- Rezip recloser - provides protection and reconfiguration in radial, ring and meshed networks where conventional protection grading is impossible.

The radial line recloser provides the protection against the following faults:

- **Short circuit.** Phase-to-phase and three-phase short circuits,

- **Earth fault.** Single-phase and double-phase earth faults;

- **Bolted fault.** Very low impedance fault, typically caused by human factor or mischance;

- **Low current earth fault** caused by high impedance phase to ground short circuit;

- **Upstream broken conductor.** Conductor touching ground at the sourse side;

- **Downstream broken conductor.** Conductor touching ground at the load side;

- **Low system voltage** caused by incorrect network operation mode, tap changer malfunction, undergeneration or islanding. The protection prevents sensitive load , such as motors, from overload and failure;

- **Low system frequency** caused by local undergeneration, islanding or generation system malfunctions;

- **High system voltage** caused by tap changer malfunctioning, overgeneration or islanding. The protection prevents sensitive load from damage;

- **High system frequency** caused by islanding.

The ring line recloser provides Loss of Supply and Automatic Backfeed Restoration functionality required for loop automation and self-healing schemes. The ring line recloser provides protection against the same faults as the radial line recloser. The ring line recloser has directional element to determine power flow direction. Ring line recloser has independently configurable sets of settings for direct and reverse power flow direction.

The Rezip recloser is used to automate various networks where traditional time and current grading is impossible. Unlike a conventional recloser, the Rezip recloser can be used in ring and meshed networks and self-healing schemes. Any number of Rezip reclosers can be connected in series.

Protection elements against short circuit, high impedance earth fault, low system voltage and low system frequency faults are provided with independent reclosing elements.

The ring line recloser is provided with a unique setting-free source detector. The source detector continuously detects the direction the power flows through the recloser main contacts.

Reclosing elements as well as the Automatic Backfeed Restoration are controlled by the Voltage Reclosing Control (VRC). The VRC blocks autoreclosing if power quality doesn't comply with customer requirements.

Cold Load Pickup (CLP)

In some cases, when power supply is restored after prolonged outage, this results in greater than normal power demand. The main cause of this problem is the large number of electric heaters, furnaces, refrigerators, air conditioners and other thermostat-controlled loads. Higher current is often seen by protection as short circuit or overload, that result in circuit breakers automatically tripping to protect the system from overload, and the power goes off again. The CLP element enables temporary increasing current pickup setting to sustain cold load current and avoid tripping without compromising protection sensitivity. This functionality is applicable for radial recloser as only in this case can the duration of power interruption for a group of customers be observed.

6.1.2 Protection Elements

Source Detector (SD)

The source detector element has two main functions:

- Provides power flow direction to directional protection elements (ring operation mode);
- Provides source side information for loss of supply protection element.

Protection elements: AR OC, HL, AR SEF, VU, CU, AR UV, AR UF, AR OV, AR OF and ABR operation depends on the source side being identified. If power flows from „Source +" side, then „Set +" protection settings are active, if power flows from „Source -" side, then „Set -" protection settings are active.

Bolted Fault (BF)

This element provides instantaneous tripping when bolted fault conditions are detected. As it deals both with positive sequence voltage and current it provides better sensitivity for bolted faults than conventional highset overcurrent elements.

Phase Overcurrent (OC)

This element provides protection against overloads, phase-to-phase and three-phase short circuits.

OC protection consists of six (6) individual overcurrent elements providing three stages of protection for both the Forward (Source+) and Reverse (Source-) powerflow directions: OC1+, OC1-, OC2+, OC2-, OC3+, OC3-

OC1
Phase overcurrent low set element OC1 is designated to provide time delayed trips. It is enabled in any selected sequence in the Overcurrent Reclosing element. „I" (Instantaneous) stands for accelerated and „D" (Delayed) for delayed step of overcurrent protection in an autoreclosing sequence.

OC2
Phase overcurrent low set element OC2 is designated to provide accelerated trips. If a sequence step in the Overcurrent Reclosing Element is set „D" OC2 element is disabled. If a sequence step in the Overcurrent Reclosing element is set „I" OC2 element is enabled.

OC3
Phase fault high set instantaneous element provides protection against phase high current faults with a reduced number of trips to lockout. If there is no intention to reduce the number of trips to lockout at high current faults, enabling this element is not recommended. OC1 and OC2 allow reduction of tripping time to any desired value at high currents.

For details on available TCC refer to Table 13 of this guide.

OC3 element settings are described in Table 14

Earth Fault (EF)

This element provides protection against single phase and double phase earth faults.

EF protection consist of six (6) individual overcurrent protection elements providing three stages of protection for both the Direct (Source+) and Reverse powerflow (Source-) directions: EF1+, EF1-, EF2+, EF2-, EF3+, EF3-

EF1
Earth fault low set element EF1 is designated to provide time delayed trips. It is enabled in any selected sequence in the Overcurrent Reclosing element. „I" (Instantaneous) stands for accelerated and „D" (Delayed) for delayed step of overcurrent protection in an autoreclosing sequence.

EF2

Earth fault low set element EF2 is designated to provide accelerated trips. If a sequence step in the Overcurrent Reclosing Element is set „D" EF2 element is disabled. If the sequence step in the Overcurrent Reclosing element is set „I" EF2 element is enabled.

EF3

Earth fault high set instantaneous element provides protection against high earth current faults with a reduced number of trips to lockout. If there is no intention to reduce the number of trips to lockout at high current faults, enabling this element is not recommended. EF1 and EF2 allow reduction of tripping time to any desired value at high currents.

For details on available TCC refer to Table 14 of this guide.

EF3 element settings are described in Table 15

Table 14 - TCC types

Setting	Designation	Range	Default
Type of time current characteristic	TCC	ANSI: Extremely Inverse (EI), Moderately Inverse (MI), Very Inverse (VI) IEC: Extremely Inverse (EI), Very Inverse (VI), Inverse (I) Definite Time (TD) Custom: custom curves are available on request. Contact Tavrida Electric representative.	TD

Table 15 - High Set elements settings

Setting	Designation	Range	Resolution	Default
Operating mode	Mode	Enable/Disable	n.a.	Disable
Pickup current, A	Ip	40-6000	1	40
Tripping time, s	Tt	0.00-2.00	0.01	0.00

TCC can be uploaded to the RC5_3 via TELARM configuration software.

Phase overcurrent and earth fault TD, IEC and ANSI time current curves settings are described in Tables 16–20.

Table 16 - OC/EF TD TCC settings

Settings	Designation	Range	Step size	Factory defaults
Tripping time, s	Tt	0.00-100.00	0.01	10.00
Pickup current, A	Ip	10-6000	1	100

Table 17 - Available IEC TCC with parameters

TCC type	Designation	A	n
Extremely Inverse	IEC EI	80	2.0
Very Inverse	IEC VI	13.5	1.0
Inverse	IEC I	0.14	0.02

Table 18 - OC/EF IEC TCC settings

Settings	Designation	Range	Step size	Factory defaults
Asymptote current, A	Ias	10-1280	1	100
Time multiplier	Tm	0.01-15.00	0.01	1.00

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Minimum time, s	Tmin	0.05-100.00	0.01	0.05
Maximum time, s	Tmax	0.05-100.00	0.01	10.00
Pickup current, A	Ip	10-6000	1	100
Time adder, s	Ta	0.00-2.00	0.01	0.00
Reset time, s	Tres	0.00-20.00	0.01	0.00

Table 19 - Available ANSI TCC with parameters

TCC type	Designation	A	B	D	n
Extremely Inverse	ANSI EI	28.2	1.217	29.1	2.0
Very Inverse	ANSI VI	19.61	0.114	21.6	2.0
Moderately Inverse	ANSI MI	0.0515	0.114	4.85	0.02

Table 20 - OC/EF ANSI TCC settings

Settings	Designation	Range	Step size	Factory defaults
Asymptote current, A	Ias	10-1280	1	100
Time multiplier	Tm	0.01-15.00	0.01	1.00
Minimum time, s	Tmin	0.05-100.00	0.01	0.05
Maximum time, s	Tmax	0.05-100.00	0.01	10.00
Pickup current, A	Ip	10-6000	1	100
Time adder, s	Ta	0.00-2.00	0.01	0.00

Phase and Earth Overcurrent Reclosing (AR OC)

The AR OC element provides reclosing initiated by tripping of one of OC1, OC2, OC3, EF1, EF2 or EF3 elements. The user set delay between trip and reclose is called „reclose time" (Tr) and can be set independently for each trip in the sequence. If the fault is not cleared during „reclose time", the recloser will trip again. This will repeat a number of times until the fault is cleared or the AR OC element reaches the end of the user defined reclose sequence. At this point the recloser remains open and will no longer reclose automatically. This is known as „lockout" and the recloser can only be closed by local or remote operator command, which clears the lockout condition.

AR OC settings are described in Tables 21, 22.

Table 21 - Radial line recloser AR OC element settings

Setting	Designation	Range		Default
Operating mode	Mode	Normal/Rezip/ZSC		ZSC
Number of trips to lockout	Nt	Mode = Normal/ZSC	1/2/3/4	4
		Mode = Rezip	2/3/4	2
Highset trips to lockout	Nhs	1/2/3/4		1

Setting	Designation		Range	Default
Reclosing sequence	Seq	Mode = Normal/ZSC	For 4 trips to lockout: IIII/IIID/IIDD/IDDD/DDDD/DDDI/DDII/ DIII/ IIDI/IDII/IDDI For 3 trips to lockout: III/IID/IDD/DDD/DDI/DII/IDI For 2 trips to lockout: II/ID/DD/DI For 1 trip to lockout: I/D	IIDD
		Mode = Rezip	n.a.	For 4 trips to lockout: DIII For 3 trips to lockout: DII For 2 trips to lockout: DI
First closure mode	SST mode	Mode = Normal/ZSC	Accelerate, Decelerate, Normal	Normal
		Mode = Rezip	n.a.	Accelerate
First reclose time, s	Tr1	Mode = Normal/ZSC	0.10-1800.00	1.00
		Mode = Rezip	0.20-1800.00	0.20
Second reclose time, s	Tr2		1.00-1800.00	10.00
Third reclose time, s	Tr3		1.00-1800.00	30.00
Reset time, s	Tres	Mode = Normal/ZSC	1-180	1
		Mode = Rezip	n.a.	0.10

Table 22 - Ring line recloser AR OC element settings

Setting	Designation		Range	Default
Operating mode	Mode		Normal/Rezip/ZSC	ZSC
Number of trips to lockout+	Nt+	Mode = Normal/ZSC	1/2/3/4	4
		Mode = Rezip	2/3/4	2
Highset trips to lockout+	Nhs+		1/2/3/4	1
Reclosing sequence+	Seq+	Mode = Normal/ZSC	For 4 trips to lockout: IIII/IIID/IIDD/IDDD/DDDD/DDDI/DDII/ DIII/ IIDI/IDII/IDDI For 3 trips to lockout: III/IID/IDD/DDD/DDI/DII/IDI For 2 trips to lockout: II/ID/DD/DI For 1 trip to lockout: I/D	IIDD
		Mode = Rezip	n.a.	For 4 trips to lockout: DIII For 3 trips to lockout: DII For 2 trips to lockout: DI
First closure mode+	SST mode+	Mode = Normal/ZSC	Accelerate, Decelerate, Normal	Normal
		Mode = Rezip	n.a.	Accelerate
First reclose time+, s	Tr1+	Mode = Normal/ZSC	0.10-1800.00	1.00
		Mode = Rezip	0.20-1800.00	0.20
Second reclose time+, s	Tr2+		1.00-1800.00	10.00
Third reclose time+, s	Tr3+		1.00-1800.00	30.00
Reset time+, s	Tres+	Mode = Normal/ZSC	1-180	1
		Mode = Rezip	n.a.	0.10

Number of trips to lockout-	Nt-	Mode = Normal/ZSC	1/2/3/4	4
		Mode = Rezip	2/3/4	2
Highset trips to lockout-	Nhs-		1/2/3/4	1
Reclosing sequence-	Seq-	Mode = Normal/ZSC	For 4 trips to lockout: IIII/IIID/IIDD/IDDD/DDDD/DDDI/DDII/ DIII/ IIDI/IDII/IDDI For 3 trips to lockout: III/IID/IDD/DDD/DDI/DII/IDI For 2 trips to lockout: II/ID/DD/DI For 1 trip to lockout: I/D	IIDD
		Mode = Rezip	n.a.	For 4 trips to lockout: DIII For 3 trips to lockout: DII For 2 trips to lockout: DI
First closure mode-	SST mode-	Mode = Normal/ZSC	Accelerate, Decelerate, Normal	Normal
		Mode = Rezip	n.a.	Accelerate
First reclose time-, s	Tr1-	Mode = Normal/ZSC	0.10-1800.00	1.00
		Mode = Rezip	0.20-1800.00	0.20
Second reclose time-, s	Tr2-		1.00-1800.00	10.00
Third reclose time-, s	Tr3-		1.00-1800.00	30.00
Reset time-, s	Tres-	Mode = Normal/ZSC	1-180	1
		Mode = Rezip	n.a.	0.10

Single shot to lockout algorithm is supported by the AR OC element. This function allows to trip to lockout (without autoreclosing) if a fault has been detected during reset time after operator closing into a fault.

Loss of Supply (LS)

This element trips recloser if the source is lost (no HV voltage is present).

LS settings are described in Table 23.

Table 23 - LS element settings

Setting	Designation	Range	Resolution	Default
Operating mode	Mode	Enable/Disable	n.a.	Disable
Tripping time, s	Tt	0.10 - 100.00	0.01	10.00

Loss of supply autoreclosing (ARLS)

The ARLS element provides reclosing initiated by the LS element tripping.

The delay between power supply restoration and reclose is called „reclose time" (Tr). Tr time setting is configured by the user. If loss of supply occurs again prior to reset time expiration, the recloser will trip again and will not reclose automatically. This is known as „lockout" and the recloser can only be closed by local or remote operator command, which clears the lockout condition.

ARLS settings are described in Table 24.

Table 24 - ARLS element settings

Setting	Designation	Range		Default
Operating mode	Mode	Normal/Rezip		Normal
Number of trips to lockout[1]	Nt	Mode = Normal	1/2	1
		Mode = Rezip	NA	2
Reclose time, s	Tr	Mode = Normal	0.10 - 180.00	10.00
		Mode = Rezip	0.20 - 180.00	0.20

Note:
[1]In Rezip mode this setting has a fixed value and is unavailable (hidden)

REZIP

Rezip is the automation algorithm that enables complex distribution network automation. Rezip can be used in networks where the recloser application is not possible due to protection coordination restrictions. The algorithm is initiated by an upstream recloser trip. Once the loss of supply is detected, all Rezip reclosers will trip during recloser dead-time. When the recloser closes, it restores supply to the closest Rezip recloser(s). It activates the ARLS timer and after a preset time Rezip reclosers will close restoring the power supply to downstream Rezip recloser(s). Immediately after closure Rezip the recloser(s) are operating in Instantaneous protection mode and if any of them detects the fault, it will trip before the upstream protection device will. By the time next Rezip recloser is closer by the ARLS, the upstream Rezip OC/EF protection is disabled, so no grading between Rezip reclosers is needed.

The algorythm provides the set-up simplicity of a traditional sectionalizer and at the same time reducing the fault clearing time and network reconfiguration time application in far more complex networks and provide an unlimited number of sections to limit the number of customers affected.

Rezip is applicable in meshed grid automation schemes together with ABR functionality. Rezip enables the building of self-healing networks where it is not possible with conventional reclosers and sectionalizers.

Zone Sequence Coordination

The AR OC provides Zone Sequence Coordination (ZSC). ZSC forces the AR OC element to step to the next count in the reclose sequence on reset of all protection elements if it detects a downstream protection device has operated. This functionality is required for applications where a fuse-saving philosophy is used.

Hot Line (HL)

This element consists of two sub-elements which provide protection against short circuit faults during Hot Line maintenance. It generally has more sensitive settings than corresponding OCR settings and it has no reclosing functions.

HL consists of two Overcurrent elements, one for Phase Overcurrent (HLOC) and one for Earth Fault (HLEF). Operation of either element results in the trip to lockout.

HL settings are described in Tables 25-28.

Table 25 - Radial line recloser HLOC element settings

Setting	Designation	Range	Resolution	Default
Pickup current, A	Ip	10-1280	1	10
Tripping time, s	Tt	0.00-2.00	0.01	0.00

Setting	Designation	Range	Resolution	Default``
Pickup current +, A	Ip +	10-1280	1	10
Tripping time +, s	Tt +	0.00-2.00	0.01	0.00
Pickup current -, A	Ip -	10-1280	1	10
Tripping time -, s	Tt -	0.00-2.00	0.01	0.00

Table 27 - Radial line recloser HLEF element settings

Setting	Designation	Range	Resolution	Default
Pickup current, A	Ip	4-1280	1	4
Tripping time, s	Tt	0.00-2.00	0.01	0.00

Table 28 - Ring line recloser HLEF element settings

Setting	Designation	Range	Resolution	Default
Pickup current +, A	Ip +	4-1280	1	4
Tripping time +, s	Tt +	0.00-2.00	0.01	0.00
Pickup current -, A	Ip -	4-1280	1	4
Tripping time -, s	Tt -	0.00-2.00	0.01	0.00

Sensitive Earth Fault (SEF)

This element provides protection against high impedance earth faults.

SEF settings are described in Tables 29, 30.

Table 29 - Radial line recloser SEF element settings

Setting	Designation	Range	Resolution	Default
Operating mode	Mode	Enable/Disable	n.a.	Enable
Pickup current, A	Ip	1-80[1]	1	4
Tripping time, s	Tt	0.10-100.00	0.01	10.00

Note:
[1]Note that overcurrent protection pickup setting value shall not exceed SEF pickup setting value times 300.

Table 30 - Ring line recloser SEF element settings

Setting	Designation	Range	Resolution	Default
Operating mode +	Mode +	Enable/Disable	n.a.	Enable
Pickup current +, A	Ip +	1-80	1	4
Tripping time +, s	Tt +	0.10-100.00	0.01	10.00
Operating mode -	Mode -	Enable/Disable	n.a.	Enable
Pickup current -, A	Ip -	1-80	1	4
Tripping time -, s	Tt -	0.10-100.00	0.01	10.00

Sensitive Earth Fault Reclosing (AR SEF)

This element provides reclosing initiated by the SEF element operation. It also supports single shot to lockout functionality.

AR SEF settings are described in Tables 31, 32.

Table 31 - Radial line recloser AR SEF element

Setting	Designation	Range	Resolution	Default
Number of trips to lockout	Nt	1/2/3/4	n.a.	3
First reclose time, s	Tr1	0.10-180.00	0.01	1.00
Second reclose time, s	Tr2	1.00-180.00	0.01	10.00
Third reclose time, s	Tr3	1.00-180.00	0.01	30.00
Reset time, s	Tres	1-180	1	1

Table 32 - Ring line recloser AR SEF element settings

Setting	Designation	Range	Resolution	Default
Number of trips to lockout +	Nt +	1/2/3/4	n.a.	3
First reclose time +, s	Tr1 +	0.10-180.00	0.01	1.00
Second reclose time +, s	Tr2 +	1.00-180.00	0.01	10.00
Third reclose time +, s	Tr3 +	1.00-180.00	0.01	30.00
Reset time +, s	Tres +	1-180	1	1
Number of trips to lockout -	Nt -	1/2/3/4	n.a.	3
First reclose time -, s	Tr1 -	0.10-180.00	0.01	1.00
Second reclose time -, s	Tr2 -	1.00-180.00	0.01	10.00
Third reclose time -, s	Tr3 -	1.00-180.00	0.01	30.00
Reset time -, s	Tres -	1-180 s	1s	1s

Voltage Unbalance (VU)

This element provides sensitive load protection and detects an upstream broken conductor condition.

VU settings are described in Tables 33, 34.

Table 33 - Radial line recloser VU element settings

Setting	Designation	Range	Resolution	Default
Operating mode	Mode	Enable/Disable	n.a.	Disable
Voltage unbalance	Uu	0.05-1.00	0.01	0.10
Tripping time, s	Tt	0.10-100.00	0.01	10.00

Table 34 - Ring line recloser VU element settings

Setting	Designation	Range	Resolution	Default
Operating mode +	Mode +	Enable/Disable	n.a.	Disable
Voltage unbalance +	Uu +	0.05-1.00	0.01	0.10
Tripping time +, s	Tt +	0.10-100.00	0.01 s	10.00
Operating mode -	Mode -	Enable/Disable	n.a.	Disable
Voltage unbalance -	Uu -	0.05-1.00	0.01	0.10
Tripping time -, s	Tt -	0.10-100.00	0.01 s	10.00

Current Unbalance (CU)

This element provides three phase load protection and detects a downstream broken conductor condition.

CU settings are described in Tables 35, 36.

Table 35 - Radial line recloser CU element settings

Setting	Designation	Range	Resolution	Default
Operating mode	Mode	Enable/Disable	n.a.	Disable
Current unbalance	Iu	0.05-1.00	0.01	0.20
Tripping time, s	Tt	0.10-300.00	0.01	10.00

Table 36 - Ring line recloser CU element

Setting	Designation	Range	Resolution	Default
Operating mode +	Mode +	Enable/Disable	n.a.	Disable
Current unbalance +	Iu +	0.05-1.00	0.01	0.20
Tripping time +, s	Tt +	0.10-300.00	0.01	10.00
Operating mode -	Mode -	Enable/Disable	n.a.	Disable
Current unbalance -	Iu -	0.05-1.00	0.01	0.20
Tripping time -, s	Tt -	0.10-300.00	0.01	10.00

Voltage Reclosing Control (VRC)

This element monitors the quality of the high voltage power supply. It blocks reclosing initiated by any AR element when voltage and/or frequency do not meet user set values.

VRC settings are described in Tables 37, 38.

Table 37 - Radial line recloser VRC element settings

Setting	Designation	Range	Default
Voltage unbalance mode	VU control mode	Enable/Disable	Enable
Neutral voltage shift mode	NVS control mode	Enable/Disable	Enable
Over voltage mode	OV control mode	Enable/Disable	Enable
Under voltage mode	UV control mode	Enable/Disable	Enable
Under frequency mode	UF control mode	Enable/Disable	Enable
Voltage unbalance	VUp	0.05-1.00	0.20
Neutral voltage shift (zero sequence voltage)	NVSp	0.05-1.00	0.40
Pickup overvoltage multiplier	OVp	1.00-1.30	1.20
Pickup undervoltage multiplier	UVp	0.60-1.00	0.80
Pickup underfrequency, Hz	UFp	45.00 - 49.99 for Frated=50Hz 55.00 - 59.99 for Frated=60Hz	49.50 for Frated=50Hz 59.50 for Frated=60Hz

Table 38 - Ring line recloser VRC element settings

Setting	Designation	Range	Default
Voltage unbalance mode	VU control mode	Enable/Disable	Enable
Neutral voltage shift mode	NVS control mode	Enable/Disable	Enable
Over voltage mode	OV control mode	Enable/Disable	Enable
Under voltage mode	UV control mode	Enable/Disable	Enable
Under frequency mode	UF control mode	Enable/Disable	Enable
Voltage unbalance+	VUp+	0.05-1.00	0.20
Neutral voltage shift+ (zero sequence voltage)	NVSp+	0.05-1.00	0.40
Pickup overvoltage multiplier+	OVp+	1.00-1.30	1.20
Pickup undervoltage multiplier+	UVp+	0.60-1.00	0.80
Pickup underfrequency+, Hz	UFp+	45.00 - 49.99 for Frated=50Hz 55.00 - 59.99 for Frated=60Hz	49.50 for Frated=50Hz 59.50 for Frated=60Hz
Voltage unbalance-	VUp-	0.05-1.00	0.20
Neutral voltage shift- (zero sequence voltage)	NVSp-	0.05-1.00	0.40
Pickup overvoltage multiplier-	OVp-	1.00-1.30	1.20
Pickup undervoltage multiplier-	UVp-	0.60-1.00	0.80
Pickup underfrequency-, Hz	UFp-	45.00 - 49.99 for Frated=50Hz 55.00 - 59.99 for Frated=60Hz	49.50 for Frated=50Hz 59.50 for Frated=60Hz

Undervoltage (UV)

This element provides a trip command when the voltage falls below a set value.

UV settings are described in Tables 39, 40.

Table 39 - Radial line recloser UV element settings

Setting	Designation	Range	Resolution	Default
Operating mode	Mode	Enable/Disable	n.a.	Disable
Pickup voltage multiplier	Up	0.60-1.00	0.01	0.80
Tripping time, s	Tt	0.10-100.00	0.01	10.00

Table 40 - Ring line recloser UV element settings

Setting	Designation	Range	Resolution	Default
Operating mode +	Mode +	Enable/Disable	n.a.	Disable
Pickup voltage multiplier +	Up +	0.60-1.00	0.01	0.80
Tripping time +, s	Tt +	0.10-100.00	0.01	10.00
Operating mode -	Mode -	Enable/Disable	n.a.	Disable
Pickup voltage multiplier -	Up -	0.60-1.00	0.01	0.80
Tripping time -, s	Tt -	0.10-100.00	0.01	10.00

Undervoltage Reclosing (AR UV)

This element provides reclosing initiated by the UV element operation..

AR UV settings are described in Tables 41, 42.

Table 41 - Radial line recloser AR UV element settings

Setting	Designation	Range	Resolution	Default
Number of trips to lockout	Nt	1/2	n.a.	1
Reclose time, s	Tr	0.10-180.00	0.01	10.00

Table 42 - Ring line recloser AR UV element settings

Setting	Designation	Range	Resolution	Default
Number of trips to lockout +	Nt +	1/2	n.a.	1
Reclose time +, s	Tr +	0.10-180.00	0.01	10.00
Number of trips to lockout -	Nt -	1/2	n.a.	1
Reclose time -, s	Tr -	0.10-180.00	0.01	10.00

Overvoltage (OV)

This element provides load protection and detects high source voltage.

OV settings are described in Tables 43, 44.

Table 43 - Radial line recloser OV element settings

Setting	Designation	Range	Resolution	Default
Operating mode	Mode	Enable/Disable	n.a.	Disable
Pickup voltage multiplier	Up	1.00-1.40	0.01	1.05
Tripping time, s	Tt	0.10-100.00	0.01	10.00

Table 44 - Ring line recloser OV element settings

Setting	Designation	Range	Resolution	Default
Operating mode+	Mode+	Enable/Disable	n.a.	Disable
Pickup voltage multiplier+	Up+	1.00-1.40	0.01	1.05
Tripping time+, s	Tt+	0.10-100.00	0.01	10.00
Operating mode-	Mode-	Enable/Disable	n.a.	Disable
Pickup voltage multiplier-	Up-	1.00-1.40	0.01	1.05
Tripping time-, s	Tt-	0.10-100.00	0.01	10.00

Overvoltage reclosing (AR OV)

This element provides reclosing initiated by the OV element operation.

AR OV settings are described in Tables 45, 46.

Table 45 - Radial line recloser AR OV element settings

Setting	Designation	Range	Resolution	Default
Number of trips to lockout	Nt	1/ 2	n.a.	1
Reclose time, s	Tr	0.10-300.00	0.01	10.00

Table 46 - Ring line recloser AR OV element settings

Setting	Designation	Range	Resolution	Default
Number of trips to lockout+	Nt+	1/ 2	n.a.	1
Reclose time+, s	Tr+	0.10-300.00	0.01	10.00
Number of trips to lockout-	Nt-	1/ 2	n.a.	1
Reclose time-, s	Tr-	0.10-300.00	0.01	10.00

Underfrequency (UF)

This element provides load protection and detects low system frequency.

UF settings are described in Tables 47, 48.

Table 47 - Radial line recloser UF element settings

Setting	Designation	Range	Resolution	Default
Operating mode	Mode	Enable/Disable	n.a.	Disable
Pickup frequency, Hz	Fp	45.00-50.00 Hz for rated frequency=50 Hz 55.00-60.00 Hz for rated frequency=60 Hz	0.01	45.00 55.00
Tripping time, s	Tt	0.10-180.00	0.01	0.10

Table 48 - Ring line recloser UF element settings

Setting	Designation	Range	Resolution	Default
Operating mode +	Mode +	Enable/Disable	n.a.	Disable
Pickup frequency +, Hz	Fp +	45.00-50.00 Hz for rated frequency=50 Hz 55.00-60.00 Hz for rated frequency=60 Hz	0.01	45.00 55.00
Tripping time +, s	Tt +	0.10-180.00	0.01	0.10
Operating mode -	Mode -	Enable/Disable	n.a.	Disable
Pickup frequency -, Hz	Fp -	45.00-50.00 Hz for rated frequency=50 Hz 55.00-60.00 Hz for rated frequency=60 Hz	0.01	45.00 55.00
Tripping time -, s	Tt -	0.10-180.00	0.01	0.10

Underfrequency Reclosing (AR UF)

This element provides reclosing initiated by the UF element operation.

AR UF settings are described in Tables 49, 50.

Table 49 - Radial line recloser AR UF element settings

Setting	Designation	Range	Resolution	Default
Number of trips to lockout	Nt	1/2	n.a.	1
Reclose time, s	Tr	0.10-180.00	0.01	10.00

Table 50 - Ring line recloser AR UF element settings

Setting	Designation	Range	Resolution	Default
Number of trips to lockout +	Nt +	1/2	n.a.	1
Reclose time +, s	Tr +	0.10-180.00	0.01	10.00
Number of trips to lockout -	Nt -	1/2	n.a.	1
Reclose time -, s	Tr -	0.10-180.00	0.01	10.00

Table 51 - Radial line recloser OF element settings

Setting	Designation	Range	Resolution	Default
Operating mode	Mode	Enable/Disable	n.a.	Disable
Pickup frequency, Hz	Fp	50.00-55.00 for rated frequency=50 Hz 60.00-65.00 for rated frequency=60 Hz	0.01	55.00 65.00
Tripping time, s	Tt	0.10-180.00	0.01	1.00

Table 52 - Ring line recloser OF element settings

Setting	Designation	Range	Resolution	Default
Operating mode +	Mode +	Enable/Disable	n.a.	Disable
Pickup frequency +, Hz	Fp +	50.00-55.00 for rated frequency=50Hz 60.00-65.00 for rated frequency=60Hz	0.01	55.00 65.00
Tripping time +, s	Tt +	0.10-180.00 s	0.01 s	1.00 s
Operating mode -	Mode -	Enable/Disable	n.a.	Disable
Pickup frequency -, Hz	Fp -	50.00-55.00 for rated frequency=50Hz 60.00-65.00 for rated frequency=60Hz	0.01	55.00 65.00
Tripping time -, s	Tt -	0.10-180.00	0.01	1.00

Overfrequency Reclosing (AR OF)

This element provides reclosing initiated by the OF element operation.

AR OF settings are described in Tables 53, 54.

Table 53 - Radial line recloser AR OF element settings

Setting	Designation	Range	Resolution	Default
Number of trips to lockout	Nt	1/2	n.a.	1
Reclose time, s	Tr	0.10-180.00	0.01	10.00

Table 54 - Ring line recloser AR OF element settings

Setting	Designation	Range	Resolution	Default
Number of trips to lockout +	Nt +	1/2	n.a.	1
Reclose time +, s	Tr +	0.10-180.00	0.01	10.00
Number of trips to lockout -	Nt -	1/2	n.a.	1
Reclose time -, s	Tr -	0.10-180.00	0.01	10.00

Automatic Backfeed Restoration (ABR)

Automatic Backfeed Restoration is used to automatically close a normally open recloser if it detects a source (via the SD element) on the either side of the recloser and absence of a sourse on the other side.

This element is only applicable for ring line type reclosers.

ABR element settings are described in Table 55.

Table 55 - ABR element settings

Setting	Designation	Range	Resolution	Default
Operating mode	Mode	Disable/Both/Only+/Only-	n.a.	Disable
Restoration time +, s	Tr +	0.10-180.00	0.01	60.00
Restoration time -, s	Tr -	0.10-180.00	0.01	60.00

6.2 Measurement

6.2.1 Overview

The Main Processor gets the analog signals from the OSM current and voltage sensors, converts them into digital format, and filters it for Harmonic content. The RMS values of the filtered signals are used for protection and indication as shown in the table below.

Table 56 - Applicability of RMS values of the signals

Parameter	Designation	Range	Resolu-tion	Applicability	
				Protection	Indication
Phase currents, A	Ia, Ib, Ic	0...7000	1A	✓	✓
Residual current1), A	In	0...7000	1A	✓	✓
Positive sequence current, A	I1	0...7000	1A	✓	✓
Negative sequence current, A	I2	0...7000	1A	✓	✓
Positive sequence voltage measured from Source + side, kV	U1+	0...18	0.1kV	✓	✓
Positive sequence voltage measured from Source - side, kV	U1-	0...18	0.1kV	✓	✓
Negative sequence voltage measured from Source + side, kV	U2+	0...18	0.1kV	✓	✓
Negative sequence voltage measured from Source - side, kV	U2-	0...18	0.1kV	✓	✓
Frequency measured from Source + side2), Hz	F+	40...65	0.01Hz	✓	✓
Frequency measured from Source - side2), Hz	F-	40...65	0.01Hz	✓	✓
Single-phase power factor	PFa, PFb, PFc	0...0.01	0.01		✓
Three-phase power factor	PF3ph	0...0.01	0.01		✓
Phase-to-earth voltages measured from Source + side, kV	Ua+, Ub+, Uc+	0…18	0.1kV		✓
Phase-to-earth voltages measured from Source - side, kV	Ua-, Ub-, Uc-	0…18	0.1kV		✓
Phase-to-phase voltages measured from Source + side, kV	Uab+, Ubc+, Uac+	0…30	0.1kV		✓
Phase-to-phase voltages measured from Source - side, kV	Uab-, Ubc-, Uac-	0…30	0.1kV		✓
Positive sequence active power, kW	P1	0…65535	1kW		✓
Single-phase active power, kW	Pa, Pb, Pc	0…65535	1kW		✓
Three-phase active power, kW	P3ph	0…65535	1kW		✓
Single-phase reactive power, kVAr	Qa, Qb, Qc	0…65535	1kVAr		✓
Three-phase reactive power, kVAr	Q3ph	0…65535	1kVAr		✓
Single-phase active energy, kWh	Wa, Wb, Wc	0…9999999	1kWh		✓
Three-phase active energy, kWh	W3ph	0…9999999	1kWh		✓
Single-phase reactive energy, kVArh	Ea, Eb, Ec	0…9999999	1kVArh		✓
Three-phase reactive energy, kVArh	E3ph	0…9999999	1kVArh		✓

Note:

[1] Residual current In is equal to three times the zero sequence current Io

[2] Voltage and frequency memory is used if all three phase to earth voltages on any side drop below approximately 0.5 kV.

Signal filtering effectively rejects higher harmonics. Phase current measuring channels are additionally equipped with inrush filters.
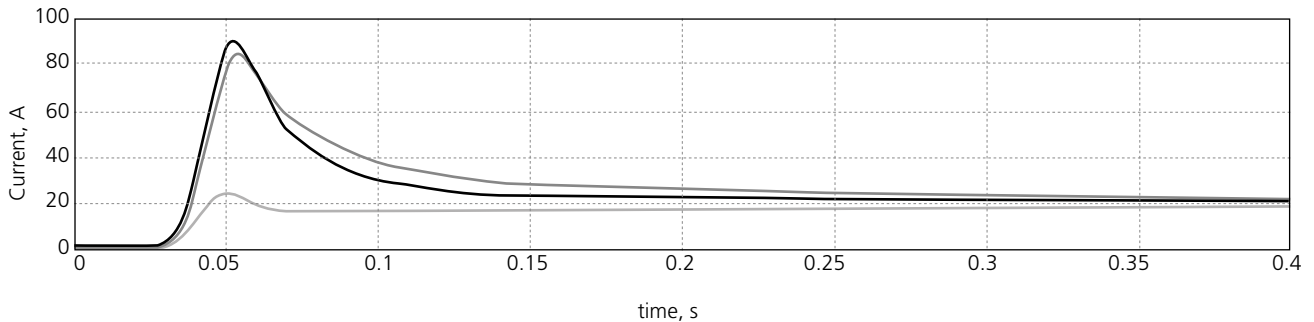
6.2.2 Inrush filter

Reclosers described in the current product guide incorporate a unique inrush filter. This allows filtering of magnetizing currents occurring at energizing transformers or distribution feeders with step-down-transformers.

In contrast to the widely used inrush restraint, which blocks the operation of protection for the period of inrush, the filter leaves all protection active and sensitive to faults for the whole period of line energizing.

The advantages are:
• This feature makes it possible to select the settings of current-based protection elements based on actual load and fault levels, not considering any side effects due to transformer load energizing;
• If, after maintenance closing or performing backfeed restoration for a faulty feeder part, the fault clearing time is significantly reduced as all protection elements operate correctly without any delays.

Figures 30 and 31 demonstrate the comparison of current measurement results at load energizing captured by the recloser without and with inrush filter enabled.

Figure 28

Basic frequency phase currents RMS. No inrush filter applied
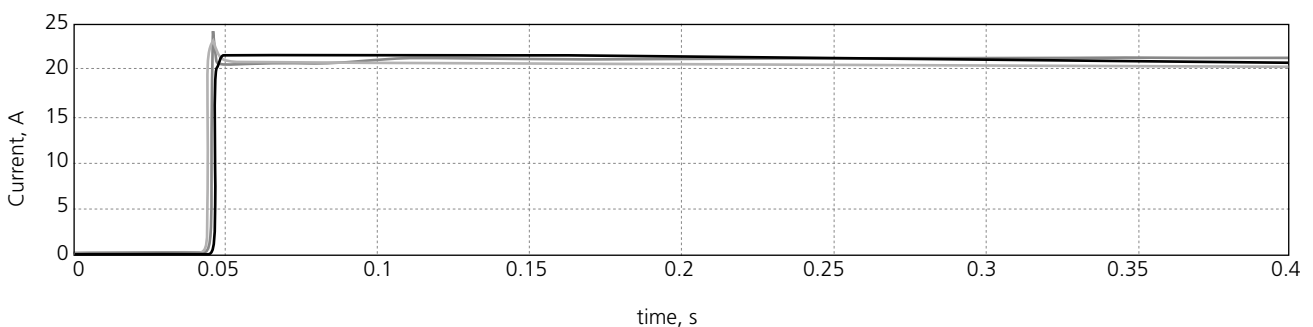
Figure 29

Basic frequency phase currents RMS. Tavrida Electric inrush filter applied

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6.3 Communication

6.3.1 Overview

Indication and control are provided through the following interfaces:
- Personal Computer Interface (PCI)
- Telecommunication Interface (TCI)
- Digital Input/Output Interface (IOI)
- TELARM dispatcher Interface (TDI)

In the „Local" mode, the recloser is controlled via the MMI or the Personal Computer Interface (PCI). In the „Remote" mode the recloser is controlled via TCI, TDI or IOI. Indication is provided via all interfaces in both modes.

6.3.2 Personal Computer Interface (PCI)

The PCI provides Indication and control via a PC (with installed TELARM software). The connection is established via the USB port located on the front the Control Panel Module (CPM), via RS-232 on the RCM or via a Bluetooth module (BTM).

The PCI provides the following functionality (refer to TELARM software):
- Data upload/download;
- Firmware upload.

Uploading/Downloading data

Data can be uploaded/downloaded via the PC (refer also to the description of the on-line mode of TELARM software) when the communication link is established. The communication link is password protected. The password is configured via the PCI at the time of the first communication session and stored in the MPM flash memory. If the control signal „Erase passwords" has been activated the password is erased. A new password can be uploaded from the PC during the next communication session.

Uploading firmware

A PC with installed TELARM is required for firmware uploading.

6.3.3 Telecommunication Interface (TCI)

TCI is an embedded RTU interface that can be used for remote indication and control.

The RTU is connected to the SCADA via a radio modem, phone modem, GSM modem, RS485-RS232 converter or directly.

Available communication protocols are DNP3, Modbus and IEC 60870-5-104.

6.3.4 Digital input/output interface (IOI)

The IOI provides control and indication via the digital Input-Output Module (IOM). The IOM provides 12 digital inputs and 12 digital outputs for SCADA control and indication. Each input/output function is individually customizable.

6.4 Telarm Dispatcher Interface (TDI)

The TDI enables multiple recloser connections to Tavrida Electric TELARM Dispatcher® for remote control and supervision. TELARM Dispatcher can be installed on one or multiple PCs with full or limited access to all or some of the reclosers. Connection via Internet or Local Area Network (LAN) is available. Physical connection of an RC5_3 to the Internet can be done via wireless connection - GPRS modem (Figure 30) or wired connection - USB-Ethernet adapter (Figure 31).

Both the RC5_3 recloser control(s) and PC(s) with TELARM software can connect to RC Internet Server software (RCIS). This software provides communication between a PC and multiple RC5_3. RCIS itself is a Windows® service. Connection between TELARM software and RCIS is protected with SSL encryption. Individual certificates are issued for each PC with TELARM which will connect to RCIS.

Benefits of using a TDI are the following:
* Remote control is avaliable even without a SCADA system in place (or as backup for existing SCADA sytem).
* SCADA is usually avaliable in dispatcher centers only. With TDI regional operators can check protection devices remotely without any support request form the Dispatcher Center.
* Potential problems can be identified and elimenated faster because all logs from protection device, including Event log, detailed Fault profile and fault oscillography are avaliable remotely and can be analyzed by an operator immediately after protection device has operated.
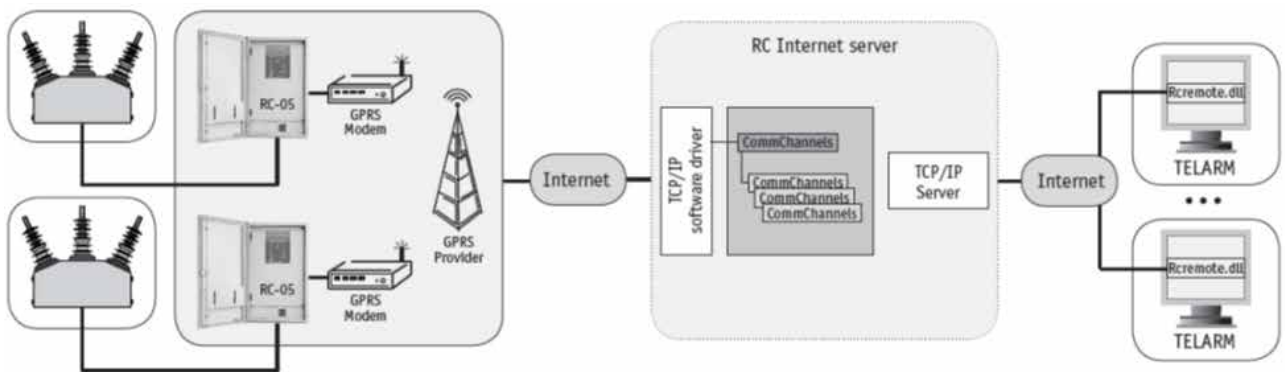
Figure 30
Structure of the system with wireless connection
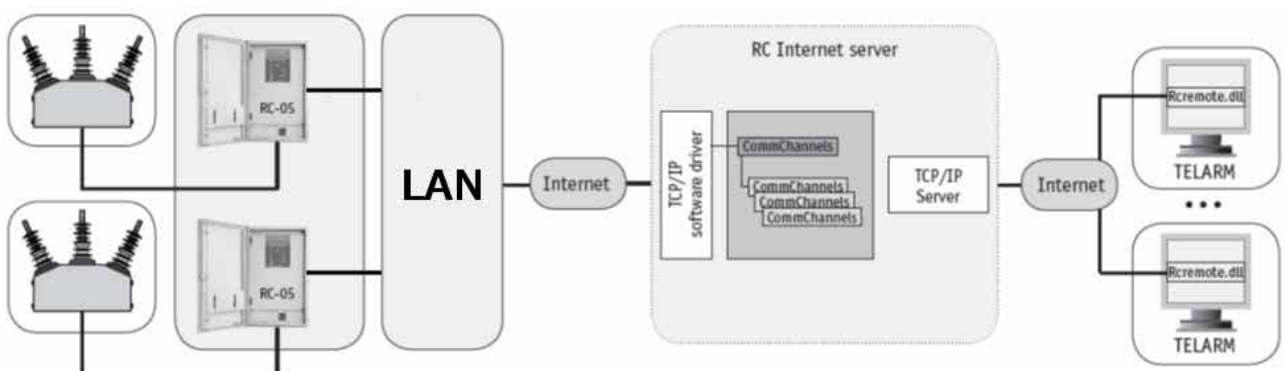
Figure 31
Structure of the system with wired connection

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6.5 Indication

6.5.1 Man-Machine Interface (MMI)

The MMI provides control and indication via the Control Panel Module (CPM) if the CPM is enabled. If the CPM is disabled, no control and indication functions are supported by the MMI.

1. LCD
2. USB Port

General Control Pushbuttons

3. ON / OFF / Test
4. Control Mode
5. Closed
6. Open

LCD Control Pushbuttons

7. LCD Contrast
8. Navigation
9. Enter
10. Escape

Fast Key Pushbuttons

11. Malfunction Log
12. Event Log
13. Protection ON/OFF
14. Earth Fault ON/OFF
15. Sensitive Earth Fault ON/OFF
16. Reclosing ON/OFF
17. Hot Line ON/OFF
18. Backfeed Restoration ON/OFF
19. Active (Protection) Group

Figure 32
Control Panel Module (CPM)
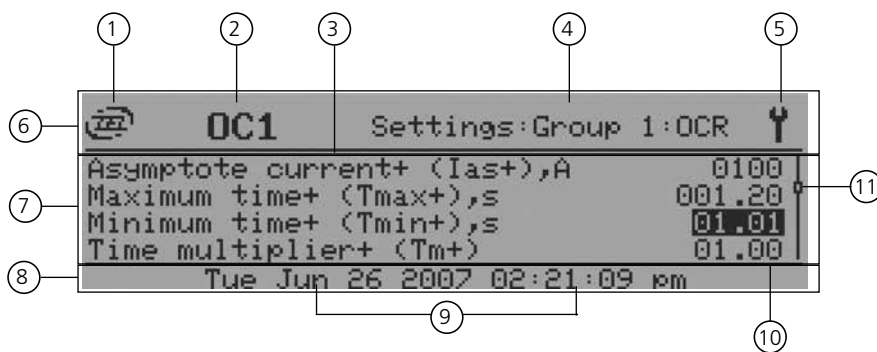
LCD Display

1. TEL Logo
2. Title string
3. Label of Indication data, Control data or Settings
4. Path
5. Context icon

6. Title Bar
7. Menu Bar
8. Status Bar
9. Date and Time
10. Parameter values of Indication data, Control data or Settings
11. Scroll Bar

Figure 33
Liquid Crystal Display (LCD)

The Title bar is shown in all menus and include the following elements:

- TEL logo icon
- Title string defining menu type
- Path to the current menu
- Context icon

7. Application notes

7.1 Mounting kits

Tavrida Electric can provide reclosers with pole-mounting kit for front or lateral installation.

For substation mounting kits or other options contact your local representatives.

7.1.1 Mounting kit for front installation

The mounting kit for front installation (see Figure 34) is applicable for Rec15/25 installation on a single wooden, concrete or metal pole. This kit shall be used with standard U/L-shaped profiles/brackets and threaded rods (not included).

For details on mounting kit dimensions refer to Figure 54 in "Appendix 2. Dimensions"
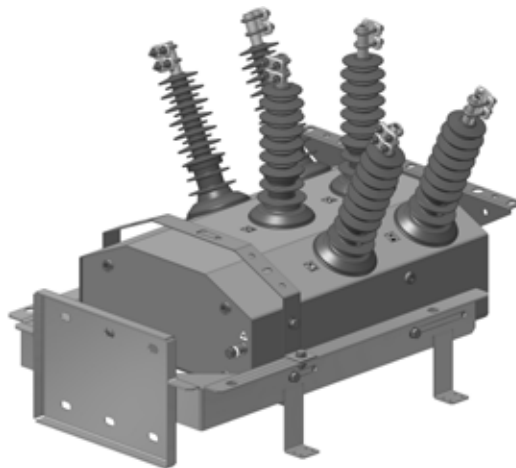
Figure 34
Mounting kit for front installation

7.1.2 Complete mounting kit for front installation

The mounting kit for front installation can be supplied with interface bracket allowing Rec15/25 intallation on wooden poles with 260...400 mm diameter. This kit shall be used with standard threaded rods or stainless steel bands (not included).

For details on interface bracket dimensions refer to Figure 56 in „Appendix 2. Dimensions"
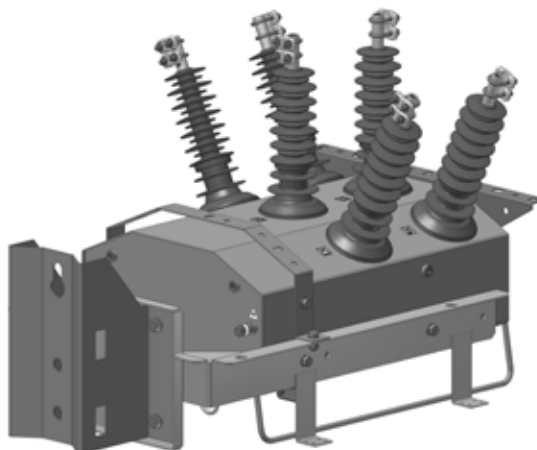
Figure 35
Complete mounting kit for front installation

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7.1.3 Mounting kit for front or lateral installation

The mounting kit for front or lateral installation (see Figure 36) is applicable for Rec15/25 installation on wooden, concrete or metal H-pole structures. This kit shall be used with standard U/L-shaped profiles/brackets and threaded rods (not included).

For details on mounting kit dimensions refer to Figure 55 in „Appendix 2. Dimensions"
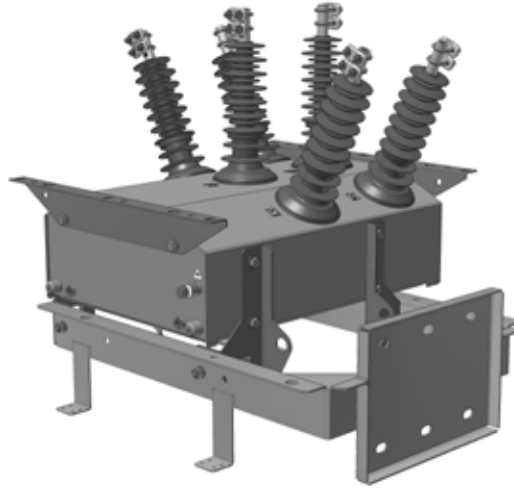
Figure 36
Mounting kit for front or lateral installation

This mounting kit allows installation of the Rec15/25 in a front position applicable for single poles. For details refer to Handling and Installation Guide.

7.1.4 Complete mounting kit for front or lateral installation

The mounting kit for front or lateral installation can be supplied with interface bracket allowing Rec15/25 intallation on wooden H-poles with 260...400 mm diameter. This kit shall be used with standard threaded rods or stainless steel bands (not included).

For details on interface bracket dimensions refer to Figure 56 in „Appendix 2. Dimensions"
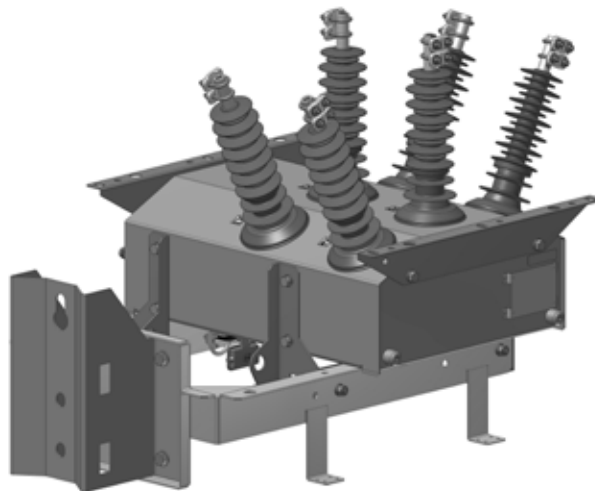
Figure 37
Complete mounting kit for front or lateral installation

7.2 Primary line connections

7.2.1 Bushing extensions

OSM bushing extensions (Figure 38 and Figure 39) have cylinder endings with milled cable connection surfaces. This surface provides reliable contact area for cable or conductor connection. All parts are made of copper with Sn-Bi (tin-bismuth) coating and allow both aluminum and copper conductor connection. Terminal connectors are used to fix the cables.
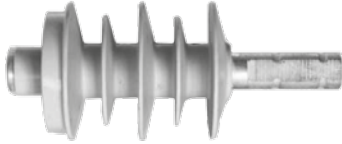
Figure 38

OSM15 bushing extensions
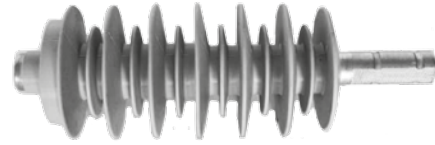
Figure 39

OSM25 bushing extensions

Bushing extensions have threaded inserts on the butt-end made of brass with Sn-Bi coating (Figure 40). Inserts are covered by plastic plugs (Figure 41) that shall to be removed before connecting lugs.

Insert

Figure 40

Plastic plugs
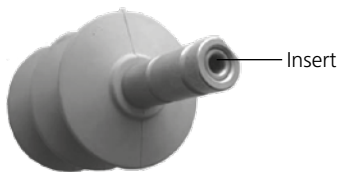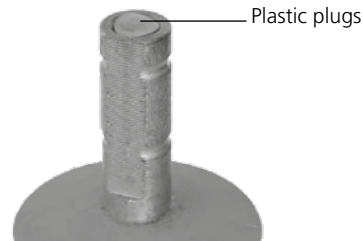
Figure 41

7.2.2 Conductor connection options

U-bolt connectors

U-bolt connectors (Figure 42) provides reliable connection of cable conductors with 35 to 240 mm² cross section. Each OSM package includes a set of 12 connectors by default.

U-bolts and fasteners are made of stailess steel. Clamping plate is made Si-Bn coated brass.

U-bolt

Clamp

Nut

Plain washer

Spring lock washer
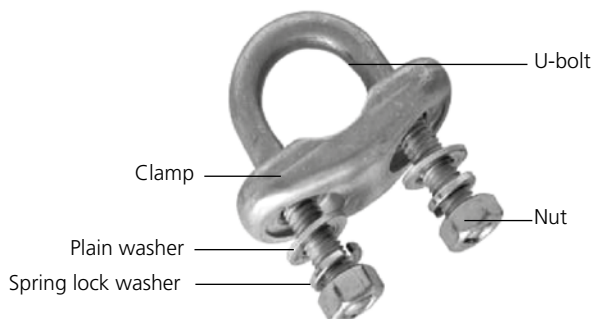
Figure 42

Figure 43

Figure 44

One connector is enough to connect conductors up to 90 mm^2 (Figure 43). Two connectors shall be used to connect 120 mm^2 and greater cross section conductors (Figure 44).

Tightening torque of connector nuts is 15±1 Nm.

Figure 45

Figure 46

Figure 47

Figure 48

Protective covers can be used to protect connections against the environment (Figure 45 and Figure 46).

If cable diameter is more than 10 mm, the cone end of each cover shall be cut to the corresponding diameter to fit the cable tightly (Figure 47).

Lug connection
Lugs can be used to connect cables from 16 to 240 mm^2.

Lugs shall have 10.5 mm holes. Lugs are fixed with M10x25 bolts. Tightening torque of 30±2 Nm shall be applied. Protective covers are not installed in this case (Figure 48).

7.3 Secondary equipment

7.3.1 Voltage transformers (VT)

An additional voltage transformer can be used for auxiliary power supply for the recloser. The VT primary voltage should correspond to the network where the recloser is installed and the secondary voltage should match the range of the recloser auxiliary power supply (for details on auxiliary power supply refer to section „7.4 Auxiliary supply" of this guide). VTs and VT mounting kits can be supplied by Tavrida Electric on request. Contact your local sales representative for further information.

7.3.2 Telecommunication equipment

The space available in the RC5_3 for external modem mounting on the mounting tray is 300w x 175d x 60h mm. The RC5_3 provides 5...15VDC auxiliary power supply voltage. Two RS232 ports are provided at the rear of the recloser control:
• port „5" (TDI) for connection of GPRS modem communicating with remote TELARM and for local RS-232 connection with TELARM.
• port „6" (TCI) for connection of RTU communicating with SCADA.
The modem shall be mounted using the special tray through mounting holes.

7.4 Auxiliary supply

Connection of Power Supply Cables

The RC5_3 cubicle can be fitted with two separate AC/DC supply inputs. Auxiliary power sources with 85...265 VAC or 110…220 VDC voltage can be used.

If a DC power supply is used, standard RC MCCB can not provide protection against short circuits. In this case, the 3A DC MCCB with characteristic C should be used for protection.
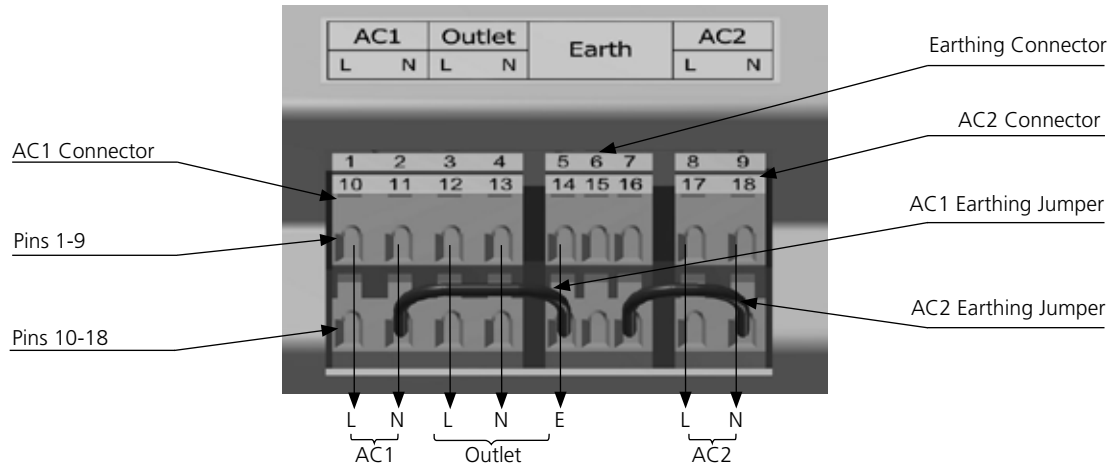

Figure 49
Auxiliary supply wiring inside PSFM

Appendix 1. Type tests

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Type tests of Rec15_Al1_5

Standard	Chapter	Test name	Test center name	Test report
IEEE C37.60-2003	6.2.6.1	Power-frequency withstand voltage test (dry)	PowerTech	PowerTech_18490-27
IEEE C37.60-2003	6.2.6.1	Power-frequency withstand voltage test (wet)	PowerTech	PowerTech_18490-27
IEEE C37.60-2003	6.7	Partial discharge tests	PowerTech	PowerTech_18490-27
IEEE C37.60-2003	6.2.6.2	Lightning impulse withstand voltage test	PowerTech	PowerTech_18490-27
IEEE C37.60-2003	6.7	DC withstand voltage test	PowerTech	PowerTech_18490-27
IEEE C37.60-2003	6.111	Control electronic elements surge withstand capability tests	PowerTech	PowerTech_18490-27
IEEE C37.60-2003	6.107	Surge current tests	PowerTech	PowerTech_18490-27
IEEE C37.60-2003	6.4	Measurement of the resistance of the main circuit	PowerTech	PowerTech_18919-21-00
IEEE C37.60-2003	6.5	Temperature-rise tests	PowerTech	PowerTech_18919-21-00
IEEE C37.60-2005	6.101	Line charging and cable charging current tests	PowerTech	PowerTech_18930-26
IEEE C37.60-2005	6.3.2.1	Load switching tests	PowerTech	PowerTech_18930-26
IEEE C37.74-2003	6.3.2.3	Transformer magnetizing current switching tests	PowerTech	PowerTech_18930-26
IEEE C37.60-2003	6.109	Mechanical duty tests	PowerTech	PowerTech_18919-21-REP4
IEEE C37.60-2003	6.105	Minimum tripping current tests	PowerTech	PowerTech_18919-21-REP3
IEEE C37.60-2003	6.108	Time-current tests	PowerTech	PowerTech_18919-21-REP2
IEEE C37.60-2003	6.103	Rated symmetrical interruption test (standard operation duty)	KEMA	KEMA_109-04
IEEE C37.60-2003	6.102	Making current tests	KEMA	KEMA_109-04

Type tests of Rec25_Al1_5

Standard	Chapter	Test name	Test center name	Test report
IEEE C37.60-2003	6.2.6.1	Power-frequency withstand voltage test (dry)	CESI	CESI_A8026525
ESKOM specification	-		CESI	CESI_B1009180
IEEE C37.60-2003	6.2.6.1	Power-frequency withstand voltage test (wet)	CESI	CESI_A8026525
ESKOM specification	-		CESI	CESI_B1009180
CEMIG specification	-		KEMA	KEMA Final TDT 1473-10 V1
IEEE C37.60-2003	6.7	Partial discharge tests	CESI	CESI_A8034569
IEEE C37.60-2003	6.2.6.2	Lightning impulse withstand voltage test	CESI	CESI_A8026525
IEEE C37.60-2003	6.2.6.2		KEMA	KEMA Final TDT 1473-10 V1
ESKOM specification	-		CESI	CESI_A9021639

|				
IEEE C37.60-2005	6.6	Short time withstand current and peak withstand current tests	CESI	CESI_A8028049 CESI_A9007127
IEEE C37.60-2005	6.4	Measurement of the resistance of the main circuit	CESI	CESI_A8027496
IEEE C37.60-2005	6.5	Temperature-rise tests	CESI	CESI_A8027496
IEEE C37.60-2005	6.101	Line charging and cable charging current tests	CESI	CESI _A8028049 CESI_A9007127
IEEE C37.60-2005	6.3.2.1	Load switching tests	CESI	CESI _A8028049 CESI_A9007127
IEEE C37.60-2003	6.109	Mechanical duty tests	CESI	CESI_A8034408
IEEE C37.60-2005	6.105	Minimum tripping current tests	CESI	CESI_A8027496
IEEE C37.60-2003	6.108	Time-current tests	KEMA	KEMA Final TDT 1510-10 V1
IEEE C37.60-2005	6.103	Rated symmetrical interrupting current tests	CESI	CESI _A8028049 CESI_A9007127
IEEE C37.60-2005	6.102	Making current tests	CESI	CESI _A8028049 CESI_A9007127
IEC 62271-1	6.10.6	Power-frequency withstand voltage test on auxiliary and control circuits	CESI	CESI_A8034569
IEC 60664 IEC 60255-5	-	Lightning impulse withstand voltage test on auxiliary and control circuits	CESI	CESI_A8034569
IEC 60068-2-1	-	Cold test - operational	KEMA	KEMA Final TIC 1471-12 V1
IEC 60068-2-2	-	Dry heat test - operational	KEMA	KEMA Final TIC 1471-12 V1
IEC 60068-2-30	-	Cyclic temperature with humidity test - operational	KEMA	KEMA Final TIC 1471-12 V1
EDP_07-0969 rev 1F	-	Battery test	KEMA	KEMA Final TIC 1471-12 V1
IEC 60529	-	Enclosure protection test	KEMA TEL TestLab	KEMA Final TIC 1471-12 V1 EDRTL_216-2013E
IEC 60870-5-104 Ed.2	-	Communication protocol test	KEMA	KEMA Final TIC 1471-12 V1 KEMA 12-01304
ESKOM specification	-	Pollution test (KIPTS)	KIPTS	KIPTS 31-07-2010

Appendix 2. Dimensions

OSM15 dimensions
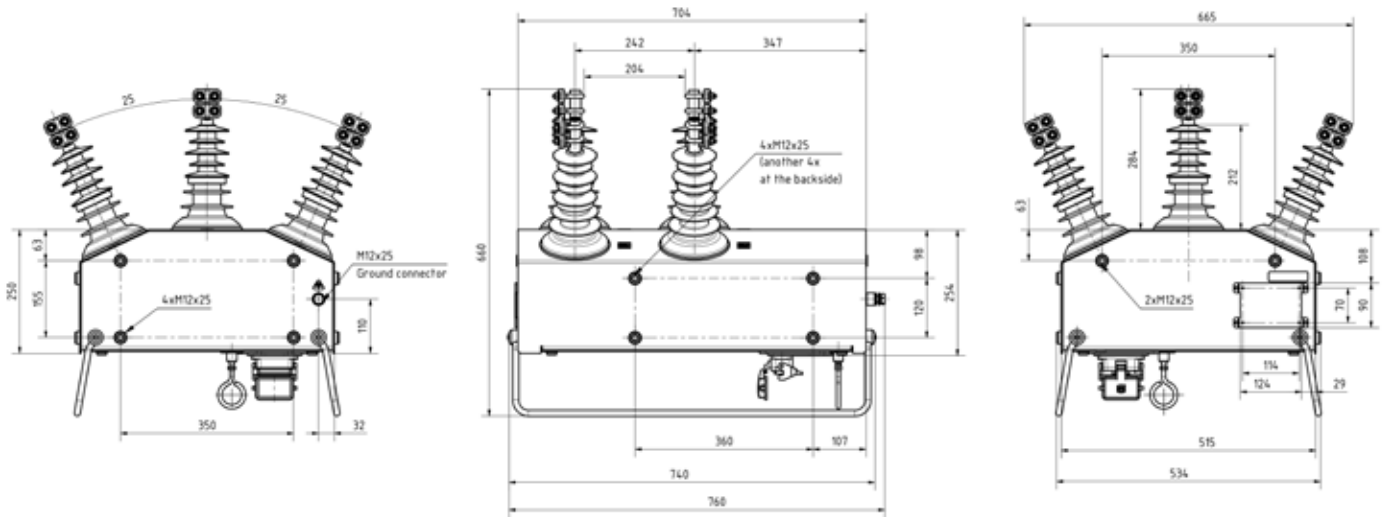
Figure 50
OSM15_Al_1(4) Dimensions

Table 57 - OSM15_Al_1(2) and OSM25_Al_1(2) dimensions

Rated voltage, kV	Dimensions, mm		Weights, kg
	Creepage distance	Minimum taut string distance	
15.5	500	204	68
27	860	204	72

OSM25 dimensions
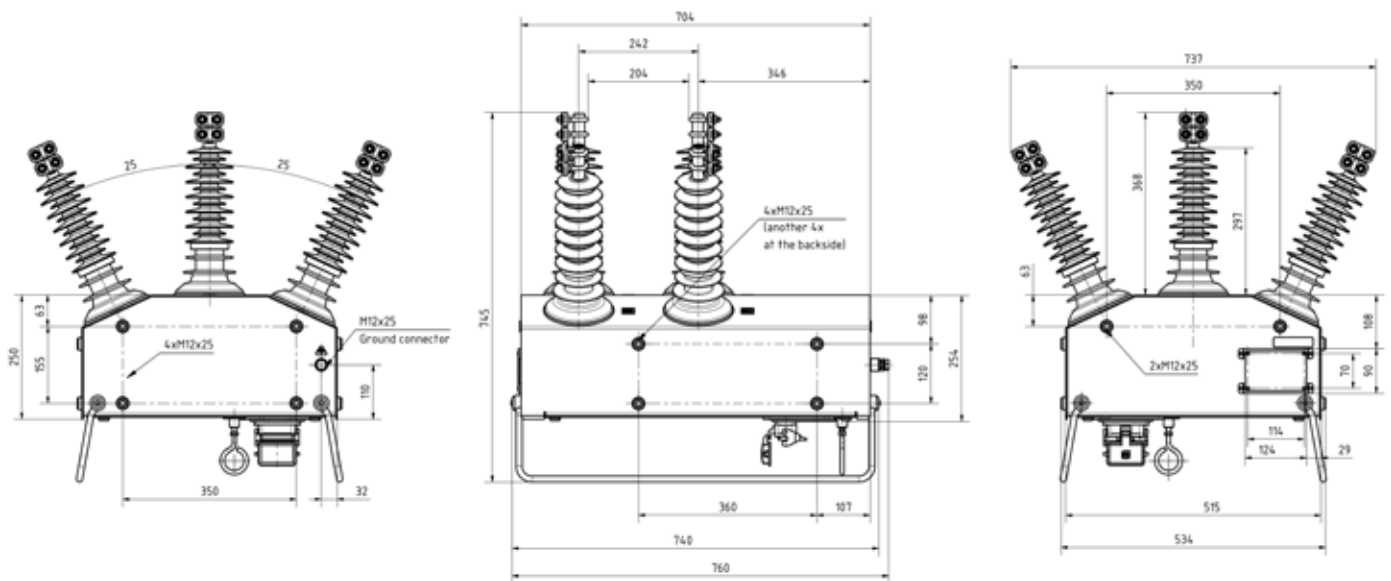
Figure 51
OSM25_Al_1(4) Dimensions

RC5_3 dimensions

Anti-vandal cover removed

Cable gland for cables Ø4..10mm
Cable gland for cables Ø11..21mm
Cable gland for cables Ø9..17mm
Breather drain
Cap for Bluetooth adapter
Heavy duty connector

275
245
232
190
36,5
32
0

Earthing stud M12

0
32
92
142
217
343
410
437
472
500

620
512
212
10
Ø22,5
40
44
Sunshield
756,5
114
229
144
Ø22,5
340

408,5
63
307,5
Ø30
Lifting provisions
32
816,5
670
144
Anti-vandal cover

Figure 52
Dimensions of RC5_3

Umbilical cable dimensions
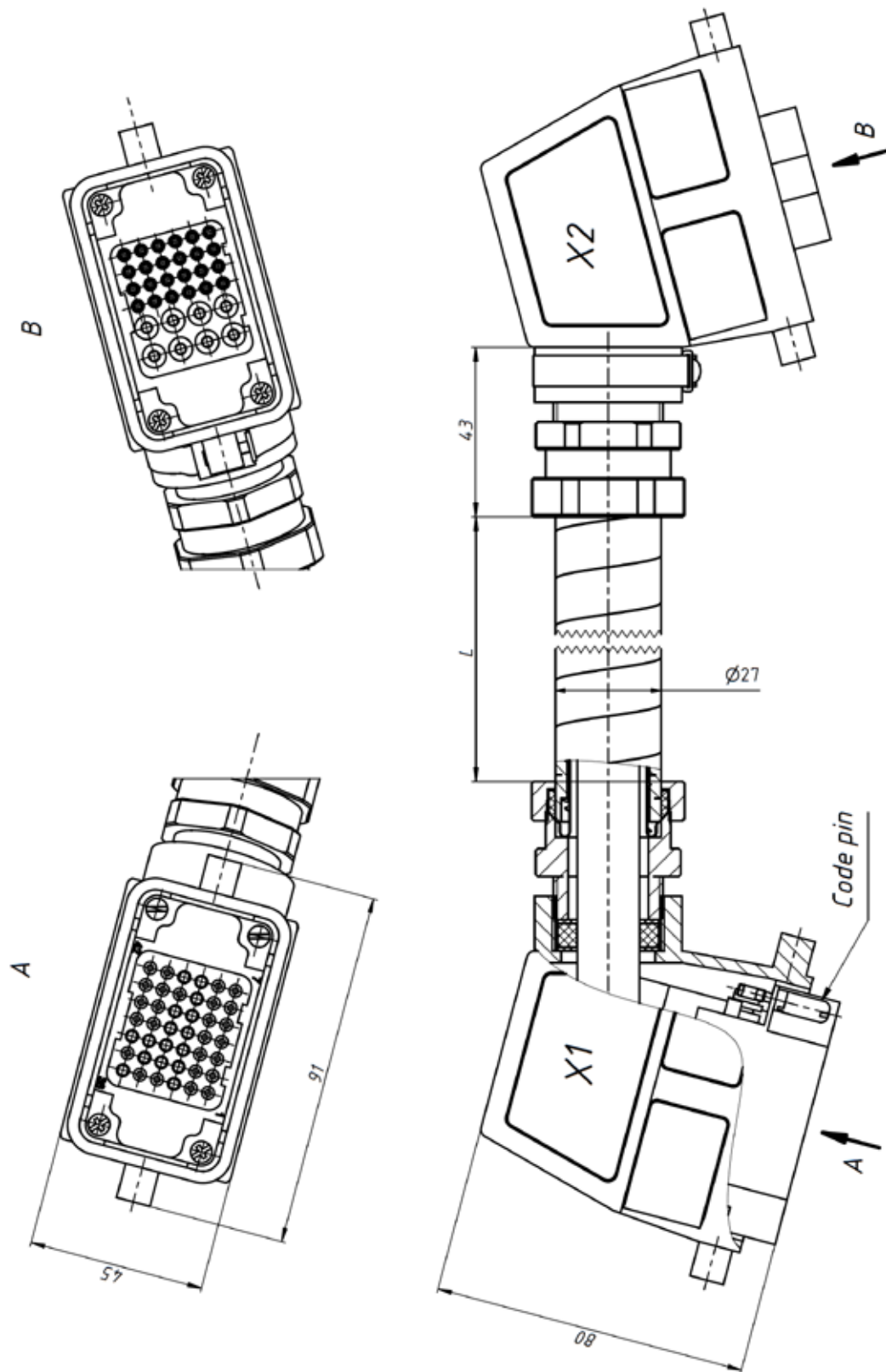
Figure 53
Dimensions of Umbilical cable

Table 58 - Umbilical cable characteristics

Part number	L, m	Weights, kg
Umbilical_4(6)	6	5.6
Umbilical_4(7)	7	6.5
Umbilical_4(12)	12	11.2

Mounting kit dimensions
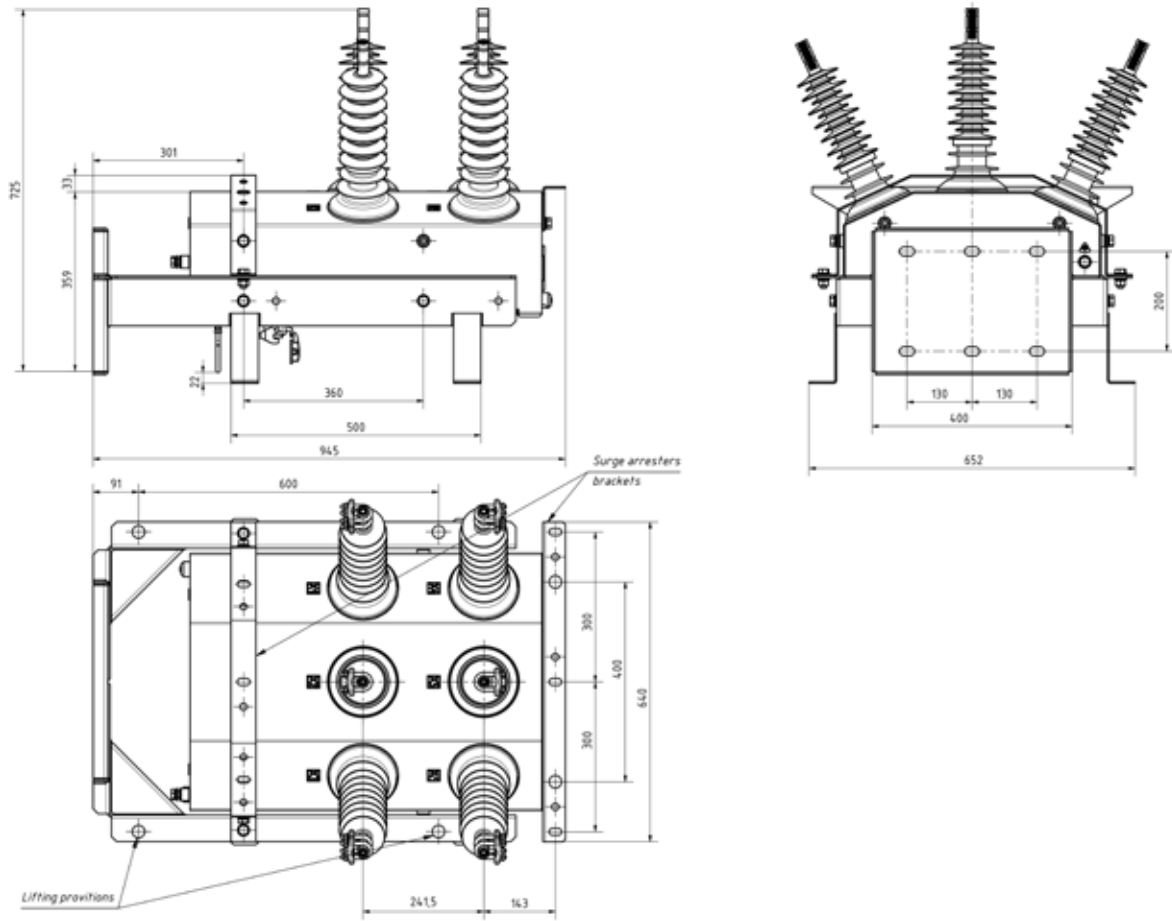
Figure 54
Mounting kit for front installation dimensions
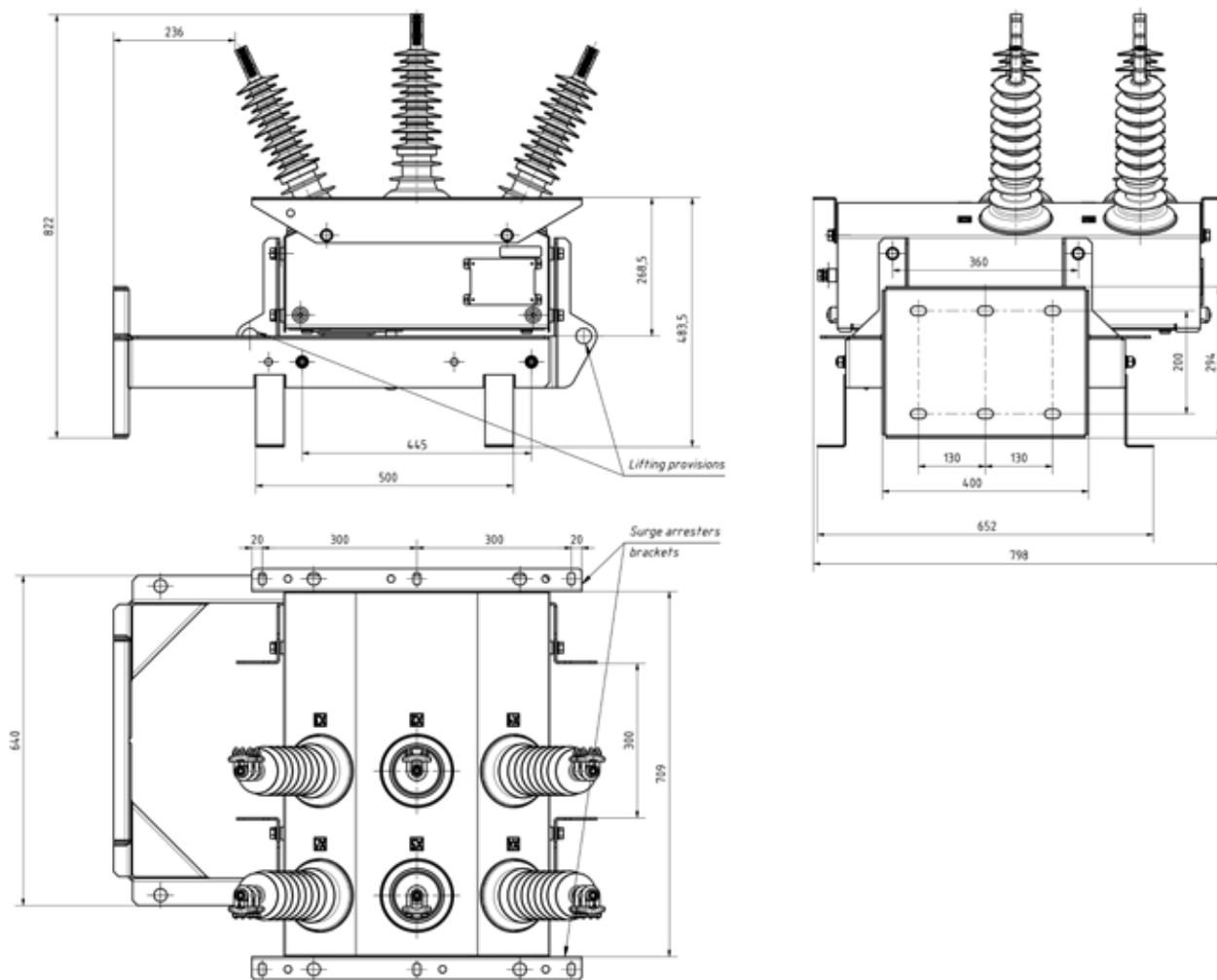
Figure 55
Mounting kit for front and lateral installation dimensions

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Interface bracket dimensions
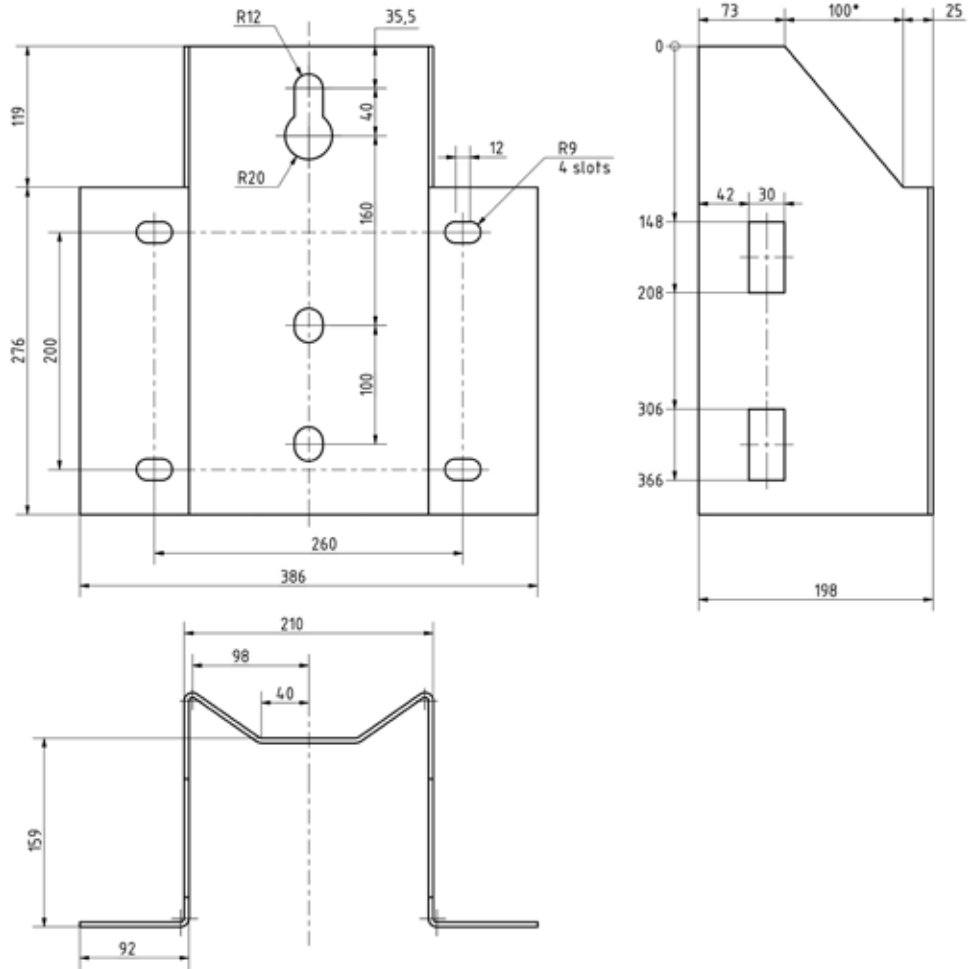
Figure 56
Interface bracket dimensions

Terminal connector dimensions and weights
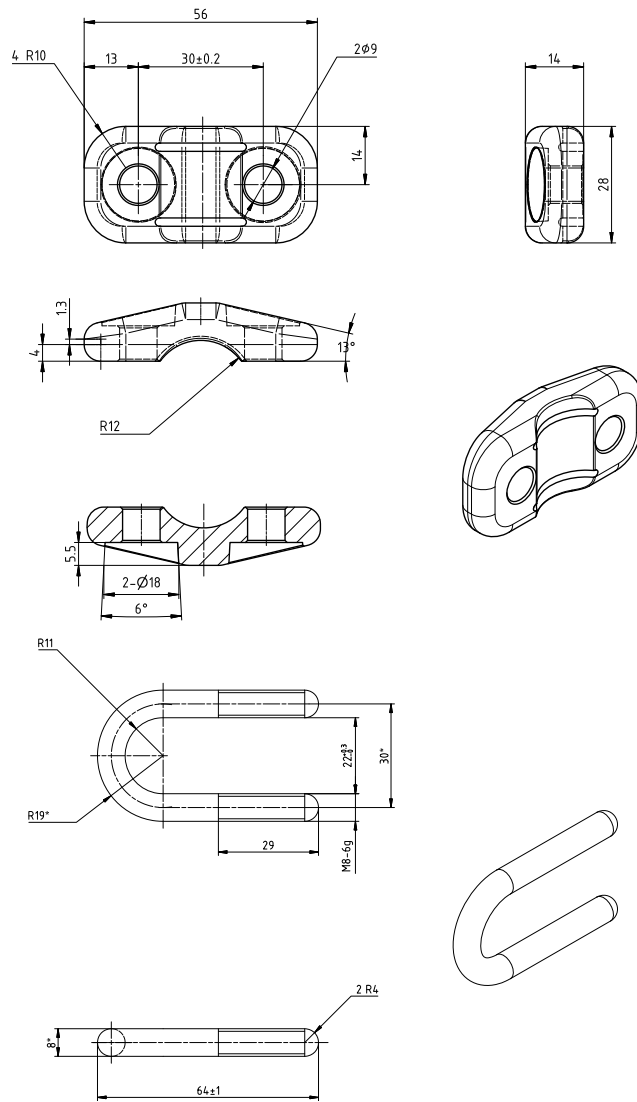
Figure 57
U-bolt terminal connector
Weight: 0.3 kg

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Package dimensions

Galvanized steel cover

Galvanized steel boards

1186

1200

1000
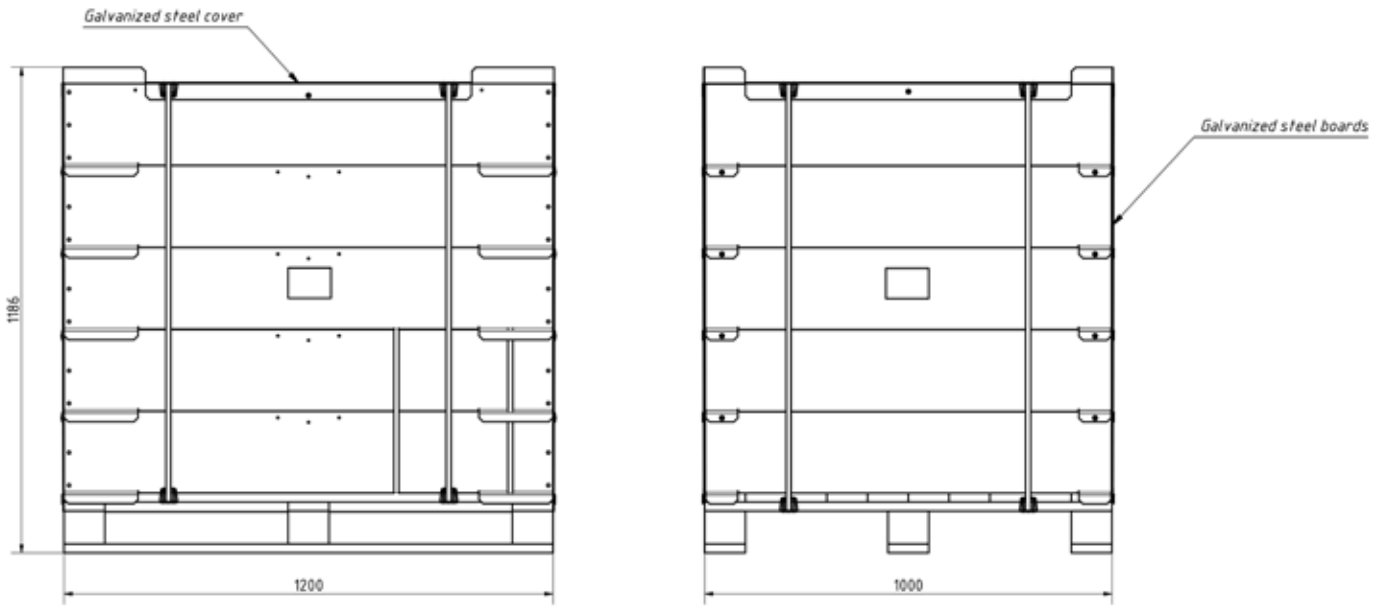
Figure 58
Recloser package dimensions

a)

b)
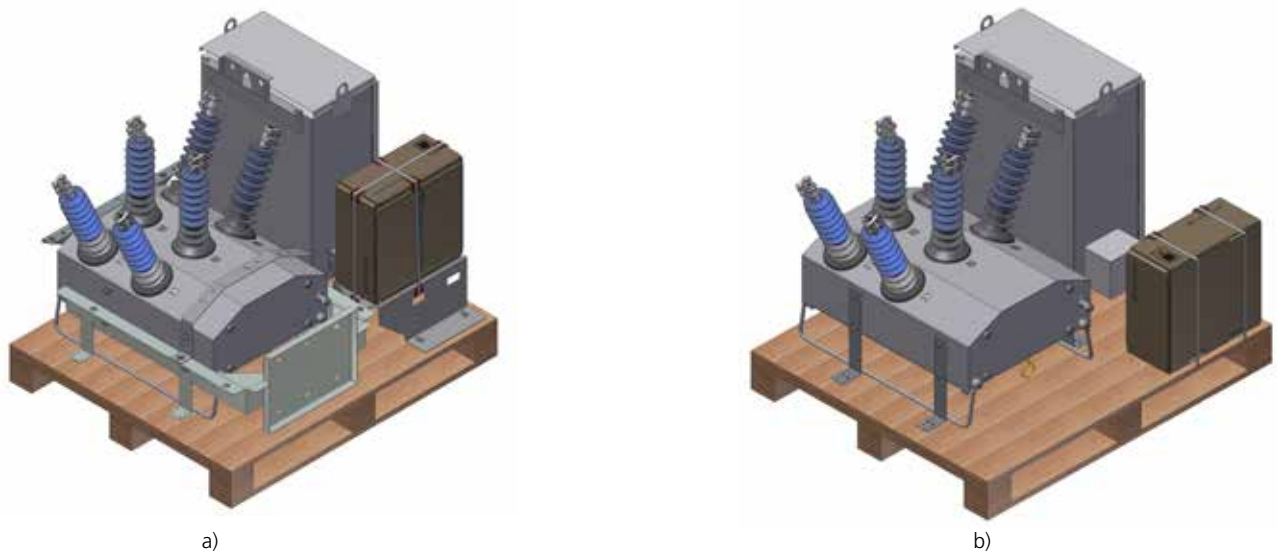
Figure 59
Placement of recloser components in a box:
a) with mounting kit;
b) without mounting kit.

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